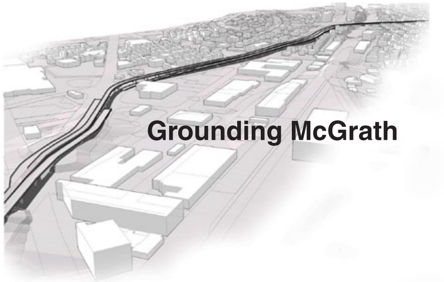


CHAPTER 5: ALTERNATIVES ANALYSIS

Introduction

As the Grounding McGrath study progressed, feedback from the community and the Working Group, informed by preliminary evaluation of the conceptual alternatives, resulted in a focus on the at-grade – or "bring it down" – alternatives for the McGrath corridor. The alternatives as discussed in Chapter 4 were conceptual and informed more by planning and policy principles than engineering standards.

As the alternatives analysis advanced, the project team developed the alternatives further, to a level of detail that allowed three potential alternatives to be tested using the CTPS regional travel demand model . The following are the design alternatives, evaluated by the Grounding McGrath project team:

- Boulevard (see Figure 5-1)
- U-turn/Rotary Hybrid (see Figure 5-2)
- Linwood Access Road (see Figure 5-3)

As part of this study's coordination with the other planning efforts in the study area, a fourth alternative developed through the City of Somerville's Inner Belt/ Brickbottom Study (IBBB) was also modeled using the CTPS regional travel demand model. This alternative known as the Inner Belt/Brickbottom Alternative (see Figure 5-4) evaluated separately from the Grounding McGrath study, but the results are included (to the extent possible with available information) with the three alternatives generated through the Grounding McGrath process. This fourth alternative is similar to the Boulevard Alternative but includes a new road through the Inner Belt area, connecting Washington Street to the McGrath corridor in the NorthPoint area, as well as an extension of Poplar Street across the MBTA Lowell Line tracks from the Brickbottom neighborhood to the Inner Belt neighborhood.

Each of the four alternatives includes assumptions that the following features will be included in the physical layouts:

- Extension of the Somerville Community Path, and a shared use path within the McGrath corridor.
- Sidewalks within the focus area that are 10 feet wide.
- Pedestrian connections across the McGrath corridor as frequently as possible, to break up long block segments.
- Bicycle accommodations within the public right-of-way (ROW).
- Space within the existing right-of-way currently (and in the No Build Alternative) that is currently allocated to surface roads and ramps can be reused for other purposes, such as green space/parks or other "reclaimed" space within the ROW.

Boulevard Alternative

The Boulevard Alternative includes the following signal phasing, geometric, and infrastructure changes compared to the No Build condition:

- Removal of the McCarthy Viaduct structure from Washington Street to Medford Street.
- Reconfiguration of the Washington Street intersection with the McGrath corridor to provide three-lane approaches northbound and southbound on the McGrath corridor, and a single through lane and double left-turn lanes for the Washington Street eastbound and westbound approaches.
    - No left turns are to be permitted from the McGrath corridor northbound or southbound approaches onto Washington Street. Vehicles that previously made these left-turns will be able to access Washington Street via tturns at other intersections: vehicles destined for Union Square traveling from the south will be able to turn left onto Somerville Avenue, and vehicles from the north destined for Sullivan Square will be able to turn left onto Poplar Street and travel north to their destination along Washington Street.
- Reconfiguration of the intersections of Somerville Avenue and Medford Street, and the McGrath corridor and Poplar Street into two adjacent signalized intersections under a single controller. A short roadway with a three-lane cross-section connects the two signals, providing a westbound through/right-turn lane, an eastbound left-turn lane and an eastbound shared through/right-turn lane. The eastern intersection will provide three through lanes with a dedicated left turn lane for both the southbound and northbound directions on the McGrath corridor.
- Realignment of Poplar Street to meet the McGrath corridor at the reconfigured intersection with Medford Street and Somerville Avenue. Poplar Street has

Figure 5-1: Boulevard Alternative

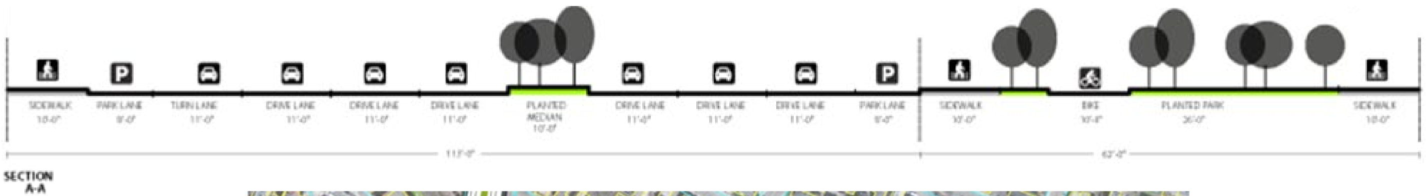
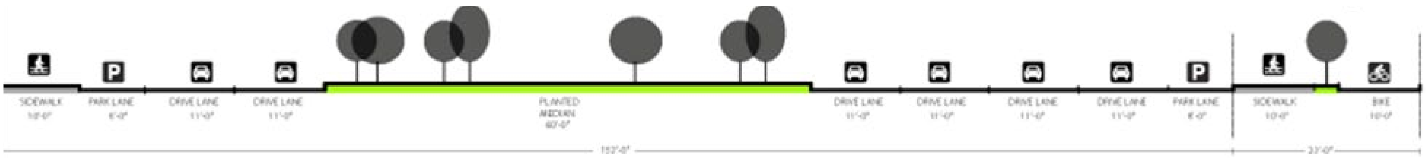


Figure 5-2 : U-Turn/Rotary Hybrid Alternative



SECTION
A-A

Figure 5-3 : Linwood Access Road Alternative

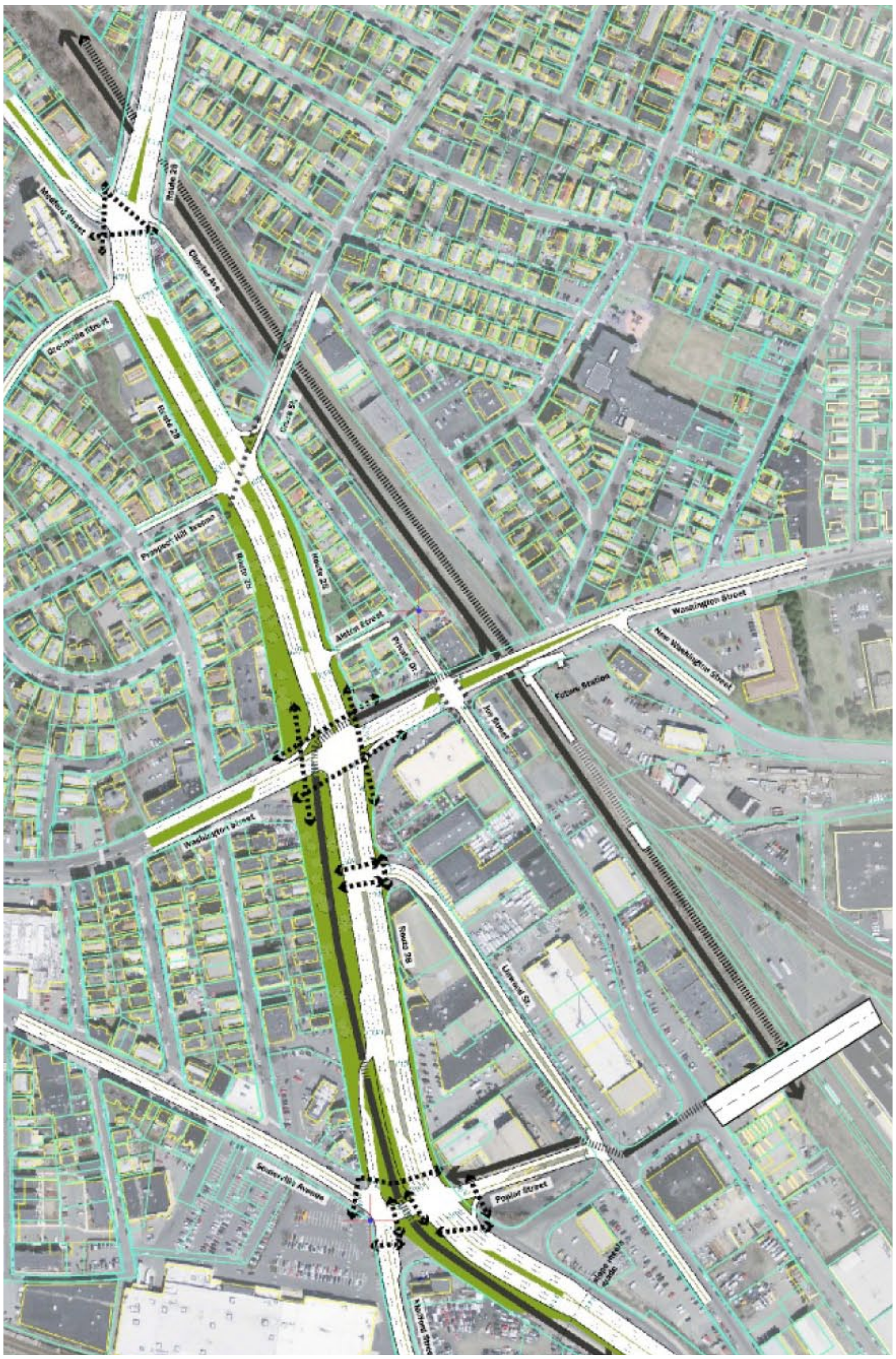


Figure 5-4 : IBBB Alternative

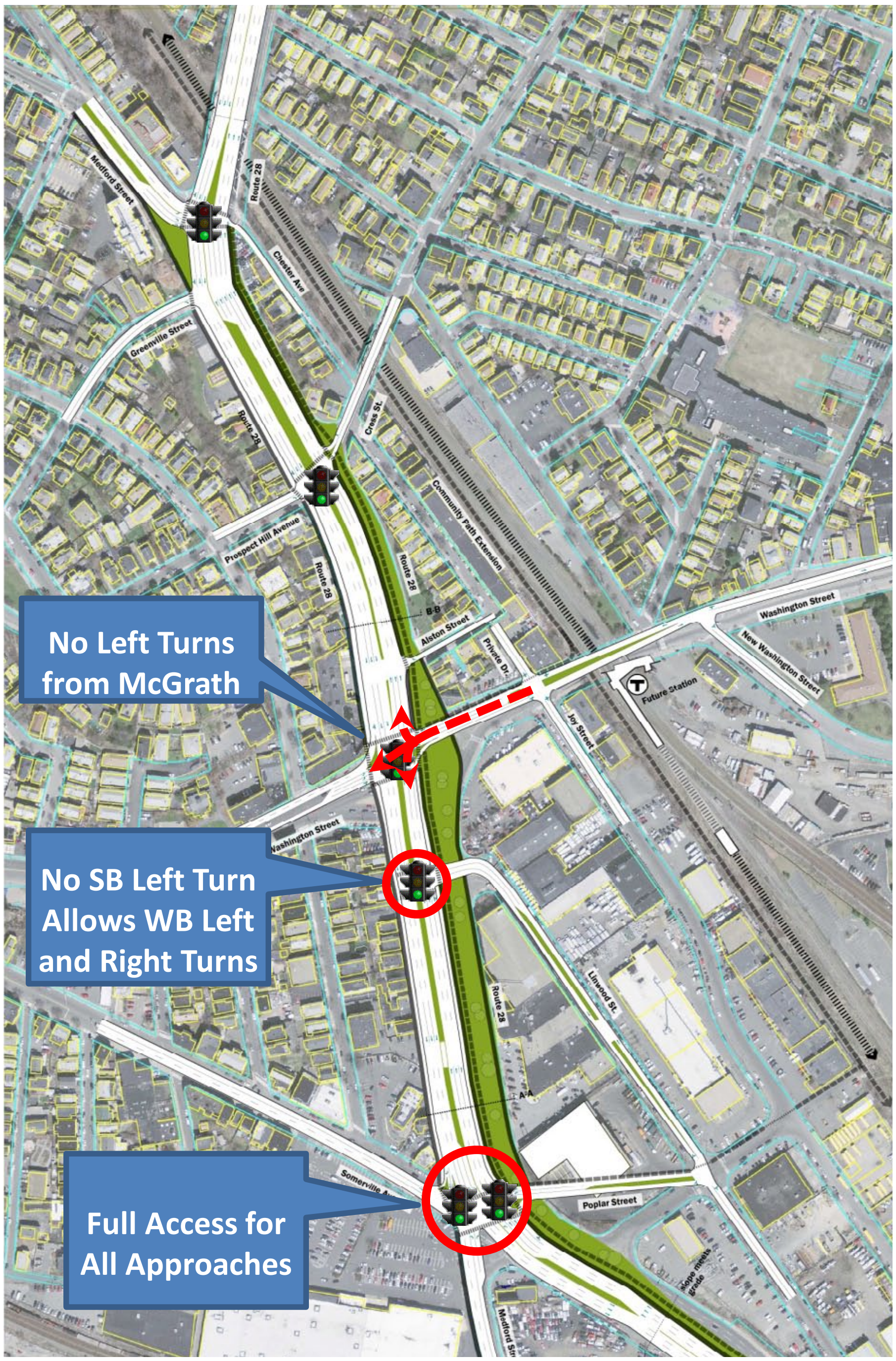
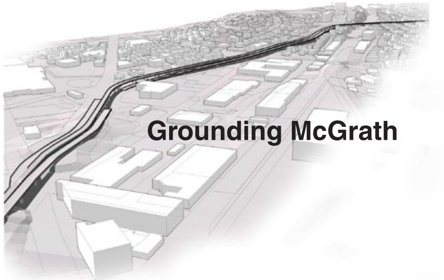


Figure 5-5: Key Elements of Circulation for Boulevard Alternative



one lane eastbound and one lane westbound. A dedicated southbound left turn lane is provided from the McGrath corridor to Poplar Street. Somerville Avenue is one lane westbound, and two lanes eastbound, with a single through lane, and a shared through/right-turn lane at the intersection approach.
- Reconfiguration of the signalized intersection at Linwood Street and the McGrath corridor providing three northbound lanes, three southbound lanes, and a westbound lane from Linwood Street. A signalized pedestrian crossing is provided. No left turns are permitted from the McGrath corridor southbound onto Linwood Street.
- New signalized intersection at Cross Street and Prospect Hill Avenue at the McGrath corridor providing a signalized pedestrian crossing. No left turns are permitted from the McGrath corridor northbound or southbound.
- Stop-controlled intersection at Greenville Street with two left-turn lanes from the McGrath corridor northbound.
- Realignment of Chester Avenue into the intersection of the McGrath corridor with Medford Street.

Figure 5-5 illustrates the key elements of circulation for the Boulevard Alternative.

U-turn/Rotary Hybrid Alternative

The U-turn/Rotary Hybrid Alternative includes the following signal phasing, geometric, and infrastructural changes compared to the No Build condition:

- Removal of the McCarthy Viaduct structure from Washington Street to Medford Street.
- Reconstruction of the McGrath corridor intersection with Poplar Street, Somerville Avenue and Medford Street into a single signalized rotary. All turning movements will be made from the rotary, while through movements on the McGrath corridor mainline will pass through the middle of the rotary. All vehicular access between the side streets and the McGrath corridor will be provided via the circulation road. The circulation road is signalized at its intersections with the McGrath corridor at the northern and southern areas of the rotary.
- Realignment of Poplar Street and Medford Street to include a single lane approach to the circulation road, each under yield control. Somerville Avenue is to be realigned to include a two lane, unsignalized eastbound approach to the circulation road. Vehicles traveling along the circulation road will also be able to gain access to Poplar Street, Medford Street and Somerville Avenue via right-turn lanes departing the roadway.
- Reconstruction of the intersection of the McGrath corridor and Washington Street, eliminating all left-turn movements at the intersection. The eastbound and westbound Washington Street approaches will include two through lanes and two exclusive right-turn lanes while the northbound and southbound McGrath corridor approaches will include three through lanes and a single exclusive right-turn lane. All left-turns at the McGrath corridor and Washington Street intersection are processed via new signalized U-turn intersections located north and south of Washington Street. Vehicles wishing to turn left would travel through the intersection to the new U-turn intersections, complete a U-turn and travel back to the intersection of the McGrath corridor and Washington Street, to turn right and continue on the intended path of travel.
- The eastbound left-turn from Highland Avenue/ Medford Street onto the McGrath corridor northbound is to be eliminated in this alternative. All traffic would be directed to travel southbound on the McGrath corridor. Any vehicles from Highland Avenue/Medford Street destined to travel northbound on the McGrath corridor must do so via a signalized U-turn at the northern U-turn intersection located between Medford Street and Washington Street.
- Two-phase traffic signals are required at the Somerville Avenue rotary and Washington Street intersections with the McGrath corridor.
- This alternative requires a wider right-of-way at Washington and Somerville Avenue, which includes potential impacts to private property.

Figures 5-6 through 5-10 illustrate the circulation for the U-turn/Rotary Hybrid Alternative.

Linwood Access Road

The Linwood Access Road Alternative includes the following signal phasing, geometric, and infrastructural changes compared to the No Build condition:

Figure 5-6: Circulation to Union Square for U-turn/Rotary Alternative

Figure 5-7 : Circulation from Union Square for U-turn/ Rotary Alternative

Figure 5-8: Southbound U-turn Circulation for U-turn/ Rotary Alternative

Figure 5-9: Northbound U-turn Circulation for U-turn/ Rotary Alternative

Figure 5-10: Circulation from Highland Avenue for U-turn/ Rotary Alternative

- Removal of the McCarthy Viaduct structure from Washington Street to Medford Street.
- Conversion of Linwood Road into a northbound access road and the construction of a southbound access road parallel to the McGrath corridor. The path of the northbound access road (one lane) follows the existing Linwood Street alignment through the Brickbottom District, and the southbound access road (two lanes) is located along the McGrath corridor mainline.
- The access road would allow for one-way circulation and provide access between the McGrath corridor and the intersecting side streets (Washington Street, Poplar Street, Somerville Avenue and Medford Street). The access road would be signalized at its northern and southern intersections with the McGrath corridor, where all the turning movements would occur.
- The Linwood Access Road would provide access to/from Poplar Street, Washington Street, Somerville Avenue and Medford Street via two-lane, yield control approaches (with the exception of Poplar Street which is a single lane approach). Vehicles traveling towards the McGrath corridor on any of these roadways would travel onto the access road and continue to the next signalized intersection to complete the necessary movement to continue on their intended path.
- The McGrath corridor mainline is proposed to contain two travel lanes in both the northbound and southbound directions through the access road area, with an additional travel lane to be located at each of the signalized access road intersections.
- The new signalized intersections of the northern and southern access roads with the McGrath corridor are proposed to include two phase traffic signals. The eastbound access road approach at the southern access road intersection provides two exclusive left-turn lanes and a shared through/right-turn lane. The westbound access road approach at the northern access road intersection provides a single left-turn lane, through-lane and right-turn lane. The signals at each of these locations provide a phase for the northbound and southbound McGrath corridor approaches and then a phase for the access road approaches, which circulating vehicles can use to make their appropriate desired turning movements.

Figures 5-11 through 5-14 illustrate circulation for the Linwood Access Road Alternative.

Evaluation Criteria

Evaluation criteria were developed to measure how each alternative, including the No Build Alternative, accomplishes the goals and objectives of the Grounding McGrath study (see Table 5-1). The criteria were structured to provide both qualitative and quantitative measures to rank each alternative. The criteria are not intended to be an absolute measure, rather they are meant to provide insight into how the McGrath alternatives compare and relate to one another. The goals, and therefore major categories in the Evaluation Matrix, include:

Goal 1. Improve access and mobility: Move people efficiently by all modes along and across the corridor on all local and regional desire lines

1.1. Improve regional and local travel time

1.2. Improve health of residents

1.3. Facilitate multimodal transportation opportunities

Goal 2. Promote connectivity: Improve the cohesion of abutting neighborhoods for the sake of community, placemaking and economic development

2.1. Identify opportunities for new connections

2.2. Improve urban form/places

2.3. Improve access to open space

2.4. Support and/or generate economic development

Goal 3. Improve and balance functionality: Ensure cost-effective and efficient use of many modes

3.1. Enhance safety for all modes

3.2. Maintain regional travel capacity

3.3. Limit impacts on surrounding roadways

3.4. Ensure cost efficiency of long-term corridor maintenance

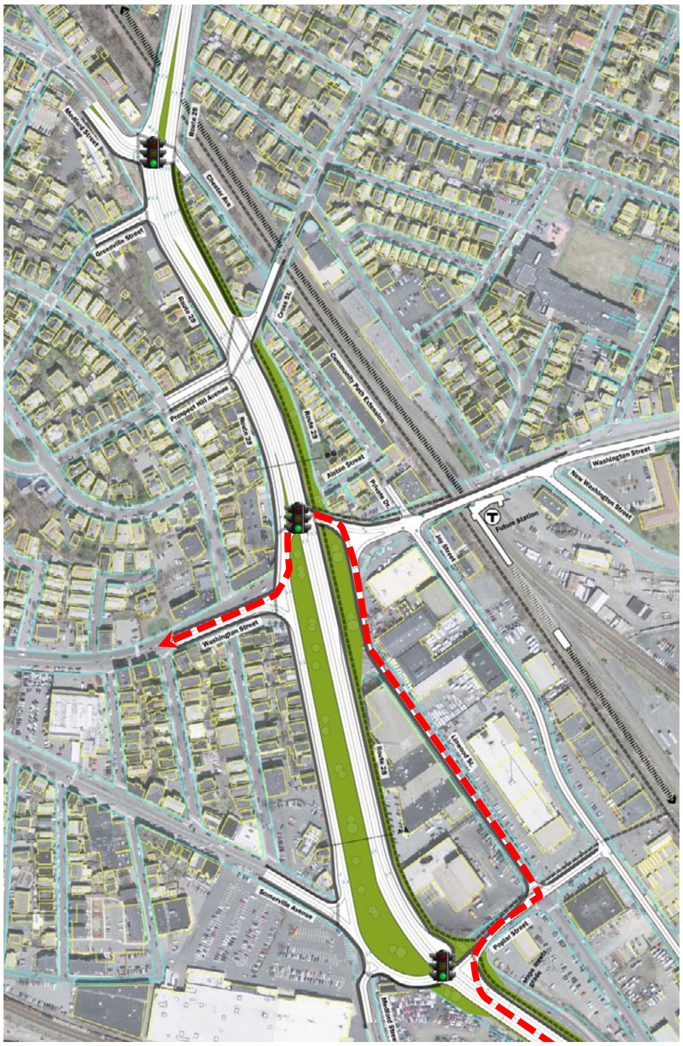


Figure 5-11: Circulation to Union Square for Linwood Access Road Alternative

Figure 5-12: Circulation from Union Square for Linwood Access Road Alternative

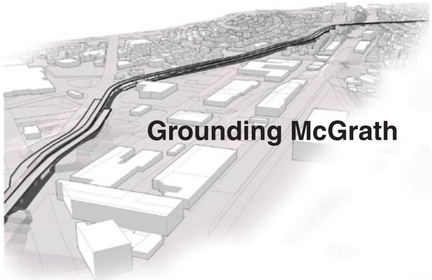


Figure 5-13: Washington Street Westbound Through Circulation for Linwood Access Road Alternative

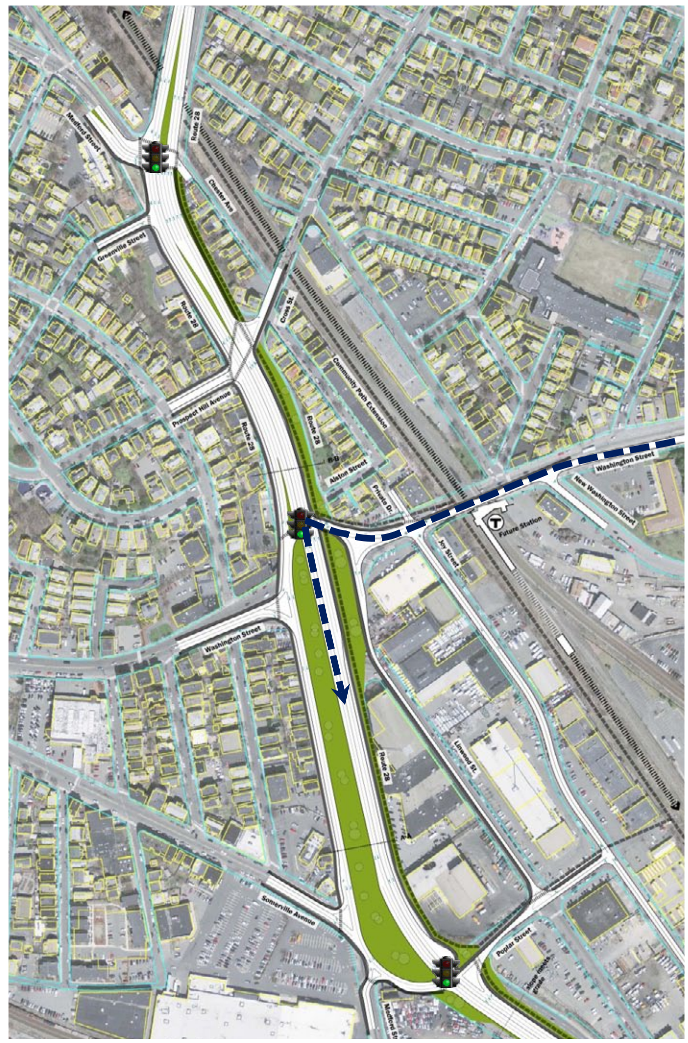


Figure 5-14: Washington Street Westbound Left Circulation for Linwood Access Road Alternative

Goal 4. Provide accountability: Advance a design that is sensitive to the needs and desires of stakeholders

4.1. Strong public input and responsiveness to local concerns

4.2. Demonstrate consistency with local and regional plans

4.3. Share benefits and burdens of changes

4.4. Limit impact to environment

Quantitative Evaluation Criteria

The project team, working with the community and Working Group, developed quantifiable measures for most of the Objectives. Measures were derived from the technical information developed for all scenarios from the following major primary sources:

- The CTPS regional travel demand model
- Micro-simulation Transportation Analysis using Synchro software
- Geographic Information System (GIS) based analysis

In some cases, information from multiple primary sources is combined to best provide a measure of the desired objective. For each objective, the raw value of each measure was included in the Matrix for each scenario. All were compared to the 2035 No Build, with the change in each alternative further identified.

Column Headings

The columns in the Evaluation Matrix provide a summarized description of how each of the objectives was measured and the results of those measurements, as well as how each alternative compares to the 2035 No Build. A further description of each Column is provided below:

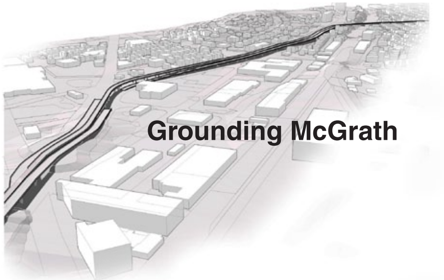
Evaluation Criteria

No.: - A numbering convention showing the Goal (1), Sub Goal (1.1) and Objective (1.1.1)
Goals and Objectives: The Goals, Sub Goals and Objectives outlined by the Grounding McGrath project. These are meant to capture impacts to various user groups and desires of the Study.
Description: A description of the factor that will be measured to evaluate the objective.
Criteria: The more specific metric used to quantitatively (to the extent possible) ascertain the impact of the alternative relative to the Objective.
Geography: The study area used for a given criteria. Note that this metric varies based on the criterion, ranging from those focused immediately on the corridor, to those that are regionally based. Many of the objectives in the Study are intended to explain and clarify the balance and tradeoffs between regional and local demands.
Inputs: The specific dataset used to provide quantifiable information. Many of these are culled from larger datasets (CTPS Regional Model, Micro Simulation, Concept Design), or developed specifically as described. Further information and more detail on each are available in the appendices.
Methodology/Details: The calculation applied to the dataset used as an Input, or the description thereof.
2035 No Build: The No Build future year was developed using the adopted 2035 land use and transportation network from the Boston Region MPO's Regional Transportation Plan.

Alternatives Evaluation

This section of the Matrix shows how each of the four alternatives performed on the Evaluation Criteria and how they compared to the 2035 No Build. Note that the evaluation of the Inner Belt Alternative was developed by the City of Somerville through the Inner Belt/Brickbottom Study.

Ranking: A qualitative type of analysis showing the relative difference between the alternatives and the No Build, effectively showing the range (Worse, Slightly Worse, the Same, Slightly Better, Better) for each objective as compared to the No Build.
Value: The actual numerical value derived through the evaluation process for each objective. The 2035 No Build is considered the baseline value.
Change: The difference between the value for an alternative and the baseline 2035 No Build alternative.



Descriptions

As described above, the Evaluation Matrix outlines the objectives and provides a shorthand description of the various criteria developed to best capture the goals and values of the project as a whole. These indicators provide both qualitative and quantitative measures to rank each of the scenarios, and are described further below. In many cases, the complete data sets (i.e., Synchro reports detailing intersection level of service) and further information on each criteria and data source (i.e., CTPS outputs from the regional travel demand model) are available in the appendices of this report.

1. <u>IMPROVE ACCESS AND MOBILITY – MOVE PEOPLE EFFICIENTLY BY ALL MODES ALONG AND ACROSS THE CORRIDOR ON ALL LOCAL AND REGIONAL DESIRE LINES.</u>

1.1. Improve local and regional travel time

1.1.1. Balance of regional and local access needs- Uses the CTPS model to determine the percentage of peak hour auto trips within the study area neighborhoods that are local versus regional. Better local connections for all modes, coupled with greater auto delay, are likely to reduce the number of auto trips.

1.1.2. Access to and around corridor- Counts the number of intersection approaches along the McGrath corridor. New connections provide additional opportunities for corridor and neighborhood access.

1.1.3. Travel time - Measures average travel time for auto and transit trips (using the CTPS model) for local and regional trips originating or ending in the study area neighborhoods, compared to trips originating or ending in the MPO region as whole. The aggregate number in the matrix shows the ratio of travel time for local trips to travel time for regional trips.

1.2. Improve health of residents

1.2.1. Comprehensiveness of pedestrian and cycling network – The study team identified "desire lines" (described in Chapter 2 – Existing Conditions) as commonly used paths between important destinations in the study area. Paths were ranked based on their pedestrian and bicycle facilities using the following points system: Sidewalks – 1, Bike lanes – 1, Sharrows – 0.5.

1.2.2. Ability to change mode share – Looks at the degree to which walking and/or biking facilities meet a primary desire line in the study area between Broadway and the Twin City Mall. 1.2.2 uses the same scoring system as 1.2.1.

1.2.3. Sidewalk connectivity – Compares average block length for each alternative as a measure of the density and coverage of the sidewalk network in the study area. Shorter block lengths and a more connected sidewalk network mean that pedestrians have more direct access – shorter walks – to locations around and across the corridor.

1.2.4. Environmental data metrics – Using CTPS model output, compares environmental pollutant amounts for all alternatives. These pollutants include Particulate Matter up to 10 micrometers in size(PM10), carbon dioxide (CO_2) emission in winter, mono-nitrogen oxides NO and NO_2(NOx), volatile organic compounds (VOC), and Particulate Matter up to 2.5 micrometers in size(PM 2.5).

1.3. Facilitate multimodal transportation opportunities

1.3.1. Assessment of all modes – Using a more focused study area and CTPS model outputs, compares mode splits for all alternatives.

1.3.2. Impacts on all vehicular travelers – Uses CTPS model outputs that specifically focus on traffic volumes at the "gateways" to the study area. The "gateways" relate to the trip link analysis where vehicles enter the study area. This measure is intended to analyze the effect that changes to vehicular capacity along the McGrath corridor will have on the regional flow of vehicular traffic entering and exiting the study area, and uses the 3-hour PM peak volumes.

2. <u>PROMOTE CONNECTIVITY – IMPROVE THE COHESION OF ABUTTING NEIGHBORHOODS FOR THE SAKE OF COMMUNITY, PLACEMAKING, AND ECONOMIC DEVELOPMENT.</u>

2.1. Identify new connections

2.1.1. Multimodal connections – The number of sidewalks that cross the corridor. This metric analyzes new links between the neighborhoods and facilities on the east and west side of the McGrath corridor.

2.2. Improving urban form/ places

2.2.1. Impacts of traffic, congestion, or character on/to adjacent districts – A ratio of Synchro queue lengths to the CTPS modeled vehicle speeds on select neighborhood paths, i.e. (average queue length/average vehicle speeds) for each scenario. Longer queue lengths at intersections and lower speeds on paths mean that traffic will generally be slower and the corresponding ratio higher. These conditions can help foster a more lively and inviting pedestrian and bicycle environment in neighborhoods in the study area.

2.2.2. Buffers between travel lanes and communities – Calculates a ratio of sidewalk, parking, median or other non-travel lane width to that of travel lanes for McGrath highway. A higher number indicates that the buffer between vehicles travelling on the McGrath corridor and surrounding neighborhoods is greater.

2.2.3. Appropriate scale, massing, and form for new development – Assumes that a lot size of 20,000 square feet is the minimum for development with the capacity for multiple uses, and calculates the number of areas created that could be used for such development in each alternative.

2.2.4. View corridors and incorporation into placemaking – Streets provide an important visual connection between neighborhoods. This metric counts streets that provide that link by crossing McGrath at-grade.

2.3. Improve access to open space

2.3.1. Acreage of open space – Analyzes the amount of new open space that the alternatives would provide in neighborhoods that abut McGrath.

2.3.2. Sidewalk space – Uses Computer-Aided Design (CAD) and Google Earth analyses to determine the acreage of sidewalk space in the corridor study area.

2.3.3. Pedestrian connections to open space – Measures the average pedestrian distance from major intersections in the corridor to open space in the corridor study area.

2.3.4. Roadway width crossing – Analyzes the change in the average width of travel lanes that pedestrians must traverse to get across McGrath. Longer widths can be physical and/or mental barriers to access.

2.4. Support and/ or generate economic development – Long term economic implications

2.4.1. Real estate: Vacancy rates, property values, lease rates – Uses qualitative metrics such as street width and retail street frontage to rank the alternatives based on potential real estate values.

2.4.2. Economic Activity: Employment sales, revenues– Uses qualitative metrics such as street width and retail street frontage to rank the alternatives based on potential economic activity.

2.4.3. Financial Impact: Transportation Access – Portions of McGrath that will add on-street parking are assumed to be those that will provide access to retail outlets. Thus, this metric looks at the volume of traffic in those areas as a proxy for access to local markets.

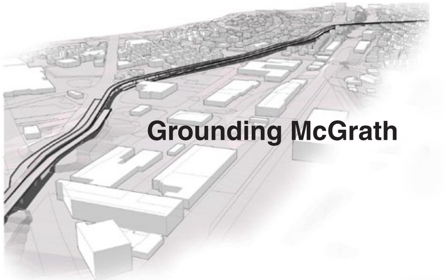
2.4.4. Financial Impact: User Cost – The Texas Transportation Institute's (TTI) Annual Urban Mobility Report estimates hours lost per year due to congestion in the Boston Area at 117,234,000. The report calculates the financial cost of those hours to be $2,393,000,000 using person hours and excess fuel consumed. This estimate can thus be converted to cost per second of delay, which works out to $0.006 in the Boston metropolitan area. This Financial Impact measurement uses Synchro aggregate AM and PM peak delay outputs for intersections in the McGrath corridor study area multiplied by TTI delay costs/seconds of delay to estimate the cost of congestion for each alternative.

3. <u>IMPROVE AND BALANCE FUNCTIONALITY – ENSURE COST EFFECTIVE AND EFFICIENT USE OF MANY MODES</u>

3.1. Enhance safety for all modes

3.1.1. Vehicle Speeds – This metric compares CTPS model output of AM and PM peak period speeds for each alternative in the study area neighborhoods.

3.1.2. Vehicle speeds at "gateway" links – The study team identified common vehicular paths and



used CTPS to model travel speeds as well as times on those paths. This provides an insight focused on roads around the McGrath corridor, rather than the corridor itself.

3.2. Maintain regional travel capacity

3.2.1. Travel time delay at key intersections and links – Uses Synchro outputs for intersections on the McGrath corridor and the aggregate time devoted to pedestrians in cycle timing as compared to overall signal cycle time. This provides some insight into delay due to signals rather than traffic volumes.

3.2.2. Enhance mobility by making corridor operations more predictable – Compares queue length and intersection capacity utilization using Synchro outputs for the corridor. These indicators not only describe potential delay in the corridor, they also provide insight into the potential operations at each intersection.

3.3. Impacts on surrounding roadways

3.3.1. Functional capacity of neighborhood roadways – Uses CTPS travel demand outputs to compare vehicular volume on streets that cross the corridor.

3.3.2. New or improved connections – Uses CTPS travel demand outputs to compare vehicular volumes on the McGrath corridor and the streets that cross it.

3.3.3. Parking and loading access – Compares the length of McGrath corridor segments with parking for each alternative. This metric is a way to analyze beginning and end of trip vehicle capacity.

4. <u>PROVIDE ACCOUNTABILITY – ADVANCE A DESIGN THAT IS SENSITIVE TO THE NEEDS AND DESIRES OF STAKEHOLDERS</u>

4.1. Share benefits and burdens of changes

4.1.1. Vehicle hours traveled in the region – Compares CTPS travel demand model outputs of the vehicle hours travelled (VHT) in each focus area neighborhood to ensure that benefits and burdens of changes are shared.

4.1.2. Impacts on Environmental Justice populations – Compares CTPS travel demand model outputs of VHT in each focus area neighborhood and the percentage of each neighborhood that qualifies as Environmental Justice populations to analyze EJ populations affected by vehicles traveling through the study area.

4.2. Limit impact to environment

4.2.1. Air quality/carbon footprint (Vehicle Miles Traveled (VMT) and Greenhouse Gases (GhG)) – Compares the CTPS summary of CO2 emission results for each alternative.

4.2.2. Stormwater impacts (flooding and runoff) – Compares the square footage of green space in the corridor to calculate the amount of pervious surface each alternative will add.

4.2.3. Other environmental resources to be impacted – A count of removed trees, new trees, and green space acreage for each alternative. Count partially generated using an assumed 20 Elm and/or Plum trees per acre of green space in the Boston area.

4.3. Ensure long-term corridor maintainability

4.3.1. Feasible maintenance plan for corridor– Ensure a sustainable maintenance program. Compares the average annual maintenance costs per mile versus the MassDOT urban roadway average.

4.3.2. Fiscal impacts of alternatives – Compares MassDOT, market and census data to cacluate a return on investment calculation.

4.3.3. Cost to construct – Uses several assumptions, detailed in the cost analysis section of this chapter to calculate life cycle cost estimates for maintaining McGrath as well as the alternatives.

Evaluation by Topic Area

The Evaluation Matrix in Table 5-1 and described previously, is based on the goals and objectives of the study. This section describes some of the specific analysis elements that served as the inputs to the matrix.

Mobility Analysis

Mobility relates to the highway, transit, bicycle and pedestrian systems. Three of the four major goals for the Grounding McGrath study address mobility to some degree, and are therefore included in the Evaluation Matrix.

Vehicles

As noted previously, estimating the changes in vehicle travel patterns that are the basis for the mobility analysis require consideration of the physical changes included in each of the alternatives, the CTPS travel demand model, and micro-simulation analysis. This section describes how the CTPS model results were coordinated with micro-simulation for vehicular traffic flow, and the resulting outputs that were then considered in the Evaluation Matrix.

The Grounding McGrath project team worked in close collaboration with CTPS to evaluate the alternatives in the context of the regional model. The approaches were coordinated and the team received concurrence from CTPS as each step of the process proceeded.

Estimating the changes in vehicle travel patterns started with an initial capacity analysis using Synchro 7.0 software for the 2035 No Build scenario and for the 2035 potential Build scenarios developed through the Alternatives Development process (see Chapter 4):

- Boulevard
- U-Turn/Rotary Hybrid
- Linwood Access Road

Initial Synchro networks depicting the three future build alternatives were provided to CTPS to use as the basis for the regional model runs. Each alternative assumed the 2035 No Build volumes generated by CTPS, and no changes were made to trip distributions prior to submittal to CTPS.

The preliminary Synchro models were then transferred to CTPS to advise them on the lane configurations and resulting capacity proposed under each of the potential Build scenarios. The CTPS regional travel demand model was then able to estimate the traffic volumes on selected roadway links for each alternative based on the changes in intersection and roadway capacity, the expected congested speeds and the presence of additional links created via new connections proposed in the alternatives. The general methodology used to convert the CTPS link volumes to intersection turning movements is provided in Appendix H of this report. It is important to note that the CTPS analysis is based on a 3-hour peak period, while the Synchro analysis is based on 1-hour peak periods. Conversion rates of 0.4 in the AM and 0.36 in the PM were used to convert the CTPS outputs from a 3-hour peak period to an equivalent 1-hour peak for the capacity analysis in Synchro.

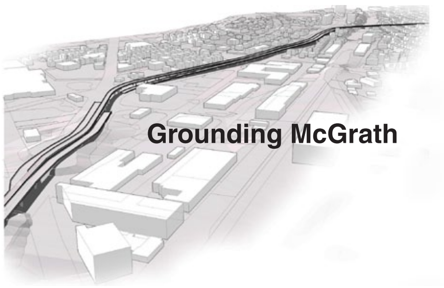
The summary table of traffic volumes produced through the CTPS regional model is included in Appendix I. The intersection capacity analysis summaries are included for each alternative with more detailed summaries of vehicular Level of Service (LOS), queue lengths and delay provided in Appendix E. The CTPS regional travel demand model is a tool to analyze regional traffic and is not intended for micro-analysis. The model is based on link capacity and speed, while the Synchro capacity analysis is based upon the turning movements at a specific intersection.

With the implementation of reduced capacity and the speed changes due to potential congestion for the modeled alternatives, the CTPS regional travel demand model indicated a significant reduction in volumes along the McGrath corridor. As a result of this reduction in traffic volumes, the implementation of a narrower north/south cross section may be feasible. However, it should be noted that this feasibility is based on the assumption that a number of vehicles which currently travel along the McGrath corridor will not do so in the future, and the potential impact of those diverted trips should be considered by the impacted communities. Additionally, vehicular movements that are currently grade separated with free-flow movement will be difficult to process at the new at-grade signals along the corridor, due to the resulting turning movements and corresponding delay. All three of the future Build alternatives have the following issues and challenges in common:

- Some traffic volume is diverted from the McGrath corridor to other roadways in the region. The trip diversions predicted by the CTPS regional travel

No.	Goal & Objective	Description	Criteria	Geography	Inputs	Methodology/Details
			WORSE ○ ◔	SAME ◑ ◕	BETTER ●	Compared to 2035 No Build
1	**IMPROVE ACCESS AND MOBILITY**	To move people efficiently by all modes along and across the corridor on all local and regional desire line				
1.1	**Improve regional and local travel time**					
1.1.1	*Balance of regional and local access needs*	Share of auto trips attributed to regional and local purposes.	Change in share of regional versus local auto trips	Study Area Neighborhoods: Central Davis E. Cambridge E. Medford E. Somerville Fresh Pond Harvard Inner Belt/Brickbottom Kendall/MIT Medford Hillside North Cambrdige North Medford South Medford Spring Hill Union Square West Medford/Medford Square Winter Hill	CTPS Model Output: Subarea Traffic Summary	Ratio of aggregate AM & PM local trips to regional trips. For non-auto trips, see 1.3
1.1.2	*Access to and around corridor*	Preserve opportunities to access the corridor and move within it	Change in number of intersection valences	Corridor Study Area - "Corridor Map"	Valences (Intersection Approaches -- see Corridor Map tab)	All intersecting roadways are assumed to be multi-modal. No dedicated non-motorized connections are considered for this measure.
1.1.3	*Travel time*	Travel times for all modes for regional v. local origin-destinations pairs served by the corridor	Proportional change in travel time by destination (regional v. local)	Study Area Neighborhoods: Central Davis E. Cambridge E. Medford E. Somerville Fresh Pond Harvard Inner Belt/Brickbottom Kendall/MIT Medford Hillside North Cambrdige North Medford South Medford Spring Hill Union Square West Medford/Medford Square Winter Hill	CTPS Model Output: Average Travel Time for Trips Leaving from and Arriving at Selected Neighborhoods by Auto and by Transit	Ratio of aggregate AM & PM local AUTO trip times to regional trips. Ratio of aggregate AM & PM local TRANSIT trip times to regional trips.
1.2	**Improve health of residents**					
1.2.1	*Comprehensiveness of pedestrian and cycling network*	Accommodate walking and biking facilities along all desire lines	Degree to which dedicated walking or biking facilities meet identified desire lines.	Corridor Study Area - "Corridor Map"	Sidewalks: 1 Bike lanes: 1 Sharrows: 0.5	Each "link" (intersection to intersection) in the study area analyzed by whether it has sidewalks, bike lanes, or sharrows. Desire lines identified as paths between activity centers in the corridor study area.
1.2.2	*Ability to change mode share*	Presence of alternative modal connections to accommodate a mode choice shift	Degree to which dedicated walking or biking facilities meet primary desire line	Corridor Study Area - "Corridor Map"	Sidewalks: 1 Bike lanes: 1 Sharrows: 0.5	Uses Broadway-Twin City Mall O-D pair as proxy for others.
1.2.3	*Sidewalk connectivity*	Ability for existing cross-corridor sidewalks to connect	Average block length in corridor (ft)	Corridor Study Area - "Corridor Map"	Block length in corridor area	

2035 No Build	Boulevard			Access Road			Hybrid U-Turn/Rotary			Boulevard & Inner Belt Rd		
Value	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change
S												
0.3778	◑	0.3781	0.0003	◑	0.3780	-0.0002	◑	0.3782	-0.0004	◑	0.3780	0.0001
69	◑	69	0	◑	73	4	●	77	8	◑	69	0
1.0627	◑	1.0605	-0.0021	◑	1.0633	0.0006	◑	1.0619	-0.0008	◑	1.0605	-0.0021
0.9405	◑	0.9422	0.0017	◑	0.9417	0.0012	◑	0.9410	0.0005	◑	0.9423	0.0018
60	●	101	41	●	101	41	●	101	41	●	101	41
11	●	26	15	◕	26	13	◕	26	13	●	26	15
504.52 ft	◕	496.73 ft	-7.79 ft	◔	516.42	11.90 ft	●	477.63 ft	-26.89 ft	◕	496.73 ft	-7.79 ft



No.	Goal & Objective	Description	Criteria	Geography	Inputs	Methodology/Details
			WORSE	SAME	BETTER	Compared to 2035 No Build
1.2.4	*Environmental data metrics*	Neighborhood pollutants	Summary of air quality measures in study area.	Study Area Neighborhoods: Central Davis E. Cambridge E. Medford E. Somerville Fresh Pond Harvard Inner Belt/Brickbottom Kendall/MIT Medford Hillside North Cambrdige North Medford South Medford Spring Hill Union Square West Medford/Medford Square Winter Hill	CTPS Model Output: Summary of Air Quality Results. Sum of AM&PM Peak 3-hour time period results.	PM10 CO Emission (in winter) NO_x Comparison VOC Comparison CO2 PM2.5 Noise
1.3	**Facilitate multimodal transportation opportunities**					
1.3.1	*Assessment of all modes*	Create multi-modal options in corridor.	Comparison of corridor mode shares for alternatives. Extent of study area defined specifically for this analysis.	Aggregate of neighborhoods listed below	CTPS Model Output: Mode Split AM & PM Peak Period	Auto Transit Walk/Bike
				Inner Belt/Brick Bottom		Auto Transit Walk/Bike
				East Cambridge		Auto Transit Walk/Bike
				East Somerville		Auto Transit Walk/Bike
				Kendall/MIT		Auto Transit Walk/Bike
				Spring Hill		Auto Transit Walk/Bike
				Union Square		Auto Transit Walk/Bike
				Winter Hill		Auto Transit Walk/Bike
1.3.2	*Impacts on all vehicular travelers*	Assess change in vehicle trips in study area relative to local and regional need.	Measure of vehicle trips displaced to other roads within study area.	Study Area Neighborhoods: Central Davis E. Cambridge E. Medford E. Somerville Fresh Pond Harvard Inner Belt/Brickbottom Kendall/MIT Medford Hillside North Cambrdige North Medford South Medford Spring Hill Union Square West Medford/Medford Square Winter Hill	CTPS Model Output: Changes of Link Volume at Gates of Select Area [PM]	Aggregate vehicle trips at "gates" of study area at PM peak three hours.

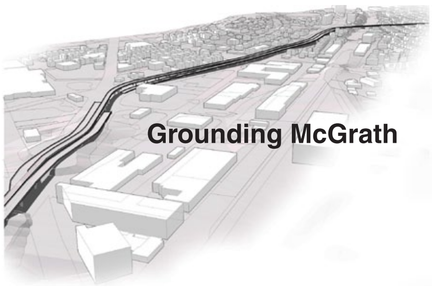
2035 No Build	Boulevard			Access Road			Hybrid U-Turn/Rotary			Boulevard & Inner Belt Rd		
Value	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change
33.2 kg	◑	32.9 kg	-0.3 kg	◑	33 kg	0 kg	◑	33.0 kg	-0.2 kg	◑	33 kg	0 kg
10718 kg	◕	10661 kg	-57 kg	◕	10674 kg	-44 kg	◕	10671 kg	-47 kg	◕	10660 kg	-58 kg
203 kg	◑	201 kg	-2 kg	◑	203 kg	0 kg	◑	201 kg	-2 kg	◑	201 kg	-2 kg
268 kg	◑	267 kg	-1 kg	◑	268 kg	0 kg	◑	267 kg	-1 kg	◑	267 kg	-1 kg
See 4.4.1												
15.2 kg	◑	15.0 kg	-0.2 kg	◑	15 kg	0 kg	◑	15.0 kg	-0.2 kg	◑	15 kg	0 kg
	◕			◕			◕			◕		
44.5%	◑	44.5%	0.0%	◑	44.5%	0.0%	◑	44.5%	0.0%	◑	44.5%	0.0%
23.8%	◑	23.8%	0.0%	◑	23.8%	0.0%	◑	23.8%	0.0%	◑	23.8%	0.0%
31.8%	◑	31.8%	0.0%	◑	31.8%	0.0%	◑	31.8%	0.0%	◑	31.8%	0.0%
55.3%	◑	55.3%	0.0%	◑	55.3%	0.0%	◑	55.3%	0.0%	◑	55.3%	0.0%
19.8%	◑	19.8%	0.0%	◑	19.8%	0.0%	◑	19.8%	0.0%	◑	19.8%	0.0%
24.8%	◑	24.8%	0.0%	◑	25.0%	0.3%	◑	24.8%	0.0%	◑	24.8%	0.0%
27.3%	◑	27.5%	0.3%	◑	27.3%	0.0%	◑	27.3%	0.0%	◑	27.3%	0.0%
29.8%	◑	29.8%	0.0%	◑	29.8%	0.0%	◑	29.8%	0.0%	◑	29.8%	0.0%
42.8%	◑	42.8%	0.0%	◕	43.0%	0.2%	◑	42.8%	0.0%	◑	42.8%	0.0%
52.8%	◑	52.8%	0.0%	◑	52.8%	0.0%	◑	52.8%	0.0%	◑	52.8%	0.0%
26.5%	◑	26.5%	0.0%	◑	26.5%	0.0%	◑	26.8%	0.3%	◑	26.5%	0.0%
20.8%	◑	20.8%	0.0%	◑	20.8%	0.0%	◑	20.8%	0.0%	◑	20.8%	0.0%
29.5%	◑	29.5%	0.0%	◑	29.5%	0.0%	◑	29.5%	0.0%	◑	29.5%	0.0%
27.5%	◑	27.5%	0.0%	◑	27.5%	0.0%	◑	27.5%	0.0%	◑	27.5%	0.0%
43.0%	◑	43.0%	0.0%	◑	43.0%	0.0%	◑	43.0%	0.0%	◑	43.0%	0.0%
53.8%	◑	53.8%	0.0%	◑	53.8%	0.0%	◑	53.8%	0.0%	◑	53.8%	0.0%
19.0%	◑	19.0%	0.0%	◑	19.0%	0.0%	◑	19.0%	0.0%	◑	19.0%	0.0%
27.8%	◑	27.8%	0.0%	◑	27.8%	0.0%	◑	27.8%	0.0%	◑	27.8%	0.0%
46.5%	◑	46.5%	0.0%	◑	46.8%	0.2%	◑	46.5%	0.0%	◑	46.5%	0.0%
20.8%	◑	20.8%	0.0%	◑	20.8%	0.0%	◑	20.8%	0.0%	◑	20.8%	0.0%
32.8%	◑	32.8%	0.0%	◑	33.3%	0.5%	◑	32.8%	0.0%	◑	32.8%	0.0%
53.8%	◑	53.8%	0.0%	◑	53.8%	0.0%	◑	53.8%	0.0%	◑	53.8%	0.0%
17.3%	◑	17.3%	0.0%	◑	17.3%	0.0%	◑	17.5%	0.3%	◑	17.3%	0.0%
29.0%	◑	29.0%	0.0%	◕	29.3%	0.3%	◑	29.3%	0.3%	◑	29.0%	0.0%
165,628	◔	166,212	584	◑	165,731	103	◔	166,023	395	◔	166,115	487

No.	Goal & Objective	Description	Criteria	Geography	Inputs	Methodology/Details
			WORSE / SAME / BETTER			Compared to 2035 No Build
2	**PROMOTE CONNECTIVITY**	To improve the cohesion of abutting neighborhoods for the sake of community, placemaking, and economic development.				
2.1	**Identify new connections**					
2.1.1	*Multimodal connections*	To increase connections by all modes and remove connectivity barriers.	Change in number of multi-modal connections across corridor.	Corridor Study Area - "Corridor Map"	Sidewalks that cross corridor.	
2.2	**Improving urban form/places**					
2.2.1	*Impacts of traffic, congestion, or character on/to adjacent districts*	Reduce potential negative impacts of traffic on adjacent neighborhoods	Average vehicle speed of abutting corridor travel lane AND average volume of queued cars during peak and non-peak periods	Select paths in study area	CTPS AM & PM Peak Speeds for select neighborhood paths and Synchro queue lengths for key intersections	Ratio of average of queue lengths to AM & PM Peak Speeds
2.2.2	*Buffers between travel lanes and communities.*	Buffers between travel lanes and communities.	Ratio of travel lanes to non-travel lanes in the corridor.	McGrath highway	Cross section at A-A	A ratio of footage of sidewalk, parking, median, etc as compared to travel lanes in the corridor
					Cross section at B-B	A ratio of footage of sidewalk, parking, median, etc as compared to travel lanes in the corridor
2.2.3	*Appropriate scale, massing, and form for new development*	Potential blocks for new development	Potential blocks of 20,400 sf each.	Corridor Study Area - "Corridor Map"	CAD	20,000 ft^2 assumed to be minimum lot size for greater development - allows for capacity of multiple alternate uses.
2.2.4	*View corridors and incorporation into placemaking*	Visual connections across corridor	Count of streets that cross McGrath at grade -- they provide a visual connection between neighborhoods.	McGrath Highway	View corridors defined as streets that cross McGrath at grade.	Count of streets that cross McGrath at grade.
2.3	**Improve access to open space**					
2.3.1	*Acreage of open space*	Potential new open space.	Acreage of potential open space.	Neighborhoods that abut corridor: East Somerville Prospect Hill Ten Hills Union Square/Beacon Street Winter Hill East Cambridge	GIS network analysis: CAD drawings	Change reflects new green space on corridor.
2.3.2	*Sidewalk space*	Potential sidewalk space	Acreage of sidewalk	Corridor Study Area - "Corridor Map"	CAD	Acreage of sidewalks in the corridor area.
2.3.3	*Pedestrian connections to open space*	Increase corridor neighborhoods' access to open space	Corridor residents' access to open space.	Corridor Study Area - "Corridor Map"	Network analysis	Average distance from major intersections in corridor to open space (defined as 8' wide or greater) in focus area.
2.3.4	*Roadway Width Crossing*	Improve pedestrian access amenities	Change in average width of travel lane crossing; crossings identified in 2.1.1	McGrath highway	CAD drawings & analysis	Estimated linear feet of active travel lanes that pedestrians must cross to get across McGrath.

2035 No Build	Boulevard			Access Road			Hybrid U-Turn/Rotary			Boulevard & Inner Belt Rd		
Value	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change
7	◕	9	2	◔	6	-1	◑	7	0	◕	9	2
10.0	◔	11.9	1.8	◕	5.2	-4.8	◕	6.0	-4.0	◕	7.6	-2.5
0.55 ft	◕	1.56 ft	1.02 ft	◕	1.61 ft	1.06 ft	◕	1.19 ft	0.65 ft	◕	1.56 ft	1.02 ft
0.44 ft	◕	0.58 ft	0.14 ft	◕	0.60 ft	0.16 ft	◕	0.61 ft	0.17 ft	◕	0.58 ft	0.14 ft
0	●	16	16	◕	15	15	◕	15	15	●	16	16
4	◕	6	2	◑	4	0	◑	4	0	◕	6	2
37.52 acres	●	39.56 acres	2.04 acres	●	39.93 acres	2.41 acres	◕	39.12 acres	1.60 acres	●	39.56 acres	2.04 acres
4.47 acres	◕	4.85 acres	0.38 acres	◕	4.88 acres	0.41 acres	◕	4.96 acres	0.49 acres	◕	4.85 acres	0.38 acres
965.31 ft	●	156.15 ft	-809.15 ft	●	162.00 ft	-803.31 ft	◕	322.54 ft	-642.77 ft	●	156.15 ft	-809.15 ft
84.92 ft	◕	76.60 ft	-8.32 ft	◔	91.00 ft	6.08 ft	◕	76.50 ft	-8.42 ft	◕	76.60 ft	-8.32 ft

No.	Goal & Objective	Description	Criteria	Geography	Inputs	Methodology/Details
			WORSE	SAME	BETTER	Compared to 2035 No Build
2.4	**Support and/or generate economic development**					
2.4.1	***Long-term economic development implications***					
2.4.1.1	*Real Estate: Vacancy rates, Property values, Lease Rates*	Improve quality of real estate investments	Change in vacancy rates, property values, and lease rates	Study Area Neighborhoods: Central Davis E. Cambridge E. Medford E. Somerville Fresh Pond Harvard Inner Belt/Brickbottom Kendall/MIT Medford Hillside North Cambrdige North Medford South Medford Spring Hill Union Square West Medford/Medford Square Winter Hill	Market analysis & GIS	Ranked on a scale of 1-10, based on travel times, visibility, access and environmental quality. For detailed methodology, please see tab marked 2.4.1.1-2.4.1.4
2.4.1.2	*Economic Activity: Employment, Sales, Revenues*	Improve economic opportunity	Change in jobs, sales receipts, propety taxes		Market analysis & GIS	
2.4.1.3	*Financial Impact: Transportation access*	Improving corridor access to/from markets	Volume of trips on McGrath portions with on-street parking	McGrath highway	CTPS: Volume Summary & Street Diagram.	Sum of peak period volumes on McGrath portions that will add parking. (See 3.3.3 for parking)
2.4.1.4	*Financial Impact: User cost*	Reducing transportation costs for all users	Change in gross user delay	McGrath intersections - Rt 28 & Somerville, & Medford, & Washington Street.	Synchro output, TTI info	Delay in corridor per day (aggregate Synchro AM & PM peak hour) quantified by cost of delay in Boston.

2035 No Build	Boulevard			Access Road			Hybrid U-Turn/Rotary			Boulevard & Inner Belt Rd		
Value	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change
4	●	9	5	◔	5	-1	◕	8	4	●	9	5
2	●	9	7	◔	5	-3	◕	8	6	●	9	7
29,528	◔	20,572	-30.33%	◔	25,341	-14.18%	◔	21,834	-26.06%	◔	19,449	-34.13%
$27.59	◕	$17.38	-$10.21	●	$7.00	-$20.59	●	$11.34	-$16.25	◕	$15.11	-$12.48



No.	Goal & Objective	Description	Criteria	Geography	Inputs	Methodology/Details
			WORSE	SAME	BETTER	Compared to 2035 No Build
3	**IMPROVE AND BALANCE FUNCTIONALITY**		Ensure cost-effective and efficient use of many modes			
3.1	**Enhance safety for all modes**					
3.1.1	*Vehicle speeds*	Reduce injuries and fatalities in corridor	Change in average vehicular speed	Study Area Neighborhoods	CTPS Model Output: Summary of Average Speed	Average of AM & PM peak period speeds
3.1.2	*Vehicle speeds at "gateway" links*	Reduce injuries and fatalities in corridor through reduction in vehicle speeds	Change in average vehicular speed on roads around corridor	Select paths around corridor selected -- see attached for map/analysis.	CTPS Travel Time Summary	Average of AM & PM Peak period speeds Average of AM & PM Peak period travel times on select paths
3.2	**Maintain regional travel capacity**					
3.2.2	*Travel time delay at key intersections and links*	Reduce corridor delays by mode	Time devoted to pedestrians in signal cycle timing.	McGrath intersections - see list on 3.2.3 sheet	Synchro output for LOS (PM Peak) by intersection	(Average pedestrian time in signal cycle)/(Average signal cycle time)
3.2.3	*Enhance mobility by making corridor operations more predicatable*	Monitor congestion duration and consistency.	Change in intersection capacity utilization	McGrath intersections - see list on 3.2.3 sheet	Synchro Intersection Output PM Peak hour	Average intersection capacity utilization in corridor
			Median queue length		Synchro Intersection Output AM&PM Peak hour	50th percentile queue length
			90th percentile queue length		Synchro Intersection Output AM&PM Peak hour	90th percentile queue length
			Difference between average and longest queue		Synchro Intersection Output AM& PM Peak hour	Difference between 50th percentile and 90th percentile queue length
3.3	**Impacts on surrounding roadways**					
3.3.1	*Functional capacity of neighborhood roadways*	Consider ~~Preserve or enhance~~ capacity of roads crossing corridor	Measure of capacity change on streets that cross corridor	Streets in Corridor Study Area (see tab marked "Corridor Map"): Cross, Medford, Linwood, Somerville, Washington	CTPS "Volume Summary"	Peak AM & PM period aggregated
3.3.2	*New or improved connections*		Total volume of all roadways that travel completely through or across the corridor	3.3.1 and McGrath Highway	CTPS "Volume Summary"	Peak AM & PM period aggregated
3.3.3	*Parking and loading access*	Improve beginning and end of trip capacity	Parking on McGrath	McGrath highway	Additional parking on McGrath	Length of Boulevard segments with parking (ft). Measured from Utile renderings.

2035 No Build	Boulevard			Access Road			Hybrid U-Turn/Rotary			Boulevard & Inner Belt Rd		
Value	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change
22.2 mph	◑	22.0 mph	-0.1 mph	◑	22.0 mph	-0.1 mph	◑	22.1 mph	-0.1 mph	◑	22.0 mph	-0.1 mph
19.5 mph	◑	17.9 mph	1.6 mph	◑	18.0 mph	1.5 mph	◑	18.0 mph	1.5 mph	◑	18.0 mph	1.5 mph
2.21 secs	◑	2.38 secs	0.18 secs	◑	2.46 secs	0.26 secs	◑	2.37 secs	0.16 secs	◑	2.36 secs	0.15 secs
0.31	◕	0.54	0.23	●	0.91	0.60	●	0.73	0.42	◕	0.54	0.23
74.15 %	◔	79.40 %	5.25 %	◕	64.00 %	-10.15 %	●	56.27 %	-17.88 %	◕	63.06 %	-11.09 %
196 ft	◔	212 ft	17 ft	●	94 ft	-102 ft	◕	108 ft	-87 ft	◕	136 ft	-59 ft
262 ft	◑	271 ft	9 ft	●	159 ft	-103 ft	●	161 ft	-100 ft	◕	182 ft	-80 ft
66 ft	◑	58 ft	8 ft	◑	65 ft	-1 ft	◑	53 ft	-13 ft	◑	65 ft	-1 ft
12,420	◕	11,744	-676	○	14,951	2,531	◔	13,550	1,130	○	15,784	3,364
62,250	●	48,069	-14,181	◕	55,977	-6,273	●	51,672	-10,578	●	51,113	-11,137
1,804 ft	●	2,348 ft	544 ft	●	2,612 ft	808 ft	◔	1,755 ft	-49 ft	●	2,348 ft	544 ft

No.	Goal & Objective	Description	Criteria	Geography	Inputs	Methodology/Details
			WORSE	SAME	BETTER	Compared to 2035 No Build
4	**PROVIDE ACCOUNTABILITY**	Advance a final design that is sensitive to the needs and desires of stakeholders				
4.1	**Share benefits and burdens of changes**					
4.1.1	*Vehicle hours traveled in the region*	Potential for corridor mobility to benefit as many people as possible	Change in VHT by neighborhood	Focus Area Neighborhoods: East Cambridge East Somerville Inner Belt/Brickbottom Kendal/MIT Union Square Winter Hill	CTPS model / GIS analysis	VHT by neighborhood from CTPS Air Quality Results - for neighborhoods in "focus area"
4.1.2	*Impacts on Environmental Justice populations*	Specifically analyzing impacts on EJ populations	EJ populations affected by vehicles traveling through the study area		GIS network analysis	VHT by neighborhood*Percentage of population that is EJ
4.2	**Limit impact to environment**					
4.2.1	*Air quality/carbon footprint (VMT and GhG)*	Effect no change or improve greenhouse gas emissions	Change in corridor CO2	Study Area Neighborhoods: Central Davis E. Cambridge E. Medford E. Somerville Fresh Pond Harvard Inner Belt/Brickbottom Kendall/MIT Medford Hillside North Cambrdige North Medford South Medford Spring Hill	CTPS Summary of Air Quality Results	Aggregate AM & PM Peak
4.2.2	*Stormwater impacts (flooding and runoff)*	Potential pervious surface	Square footage of open space in corridor	Neighborhoods that abut corridor: East Somerville Prospect Hill Ten Hills Union Square/Beacon Street Winter Hill East Cambridge	Green space numbers from Utile CAD drawings, exisiting conditions report.	Open space minimum 8 ft wide.
4.2.3	*Other environmental resources to be impacted*	Effect no net impact on native species and green space	Count of removed trees, new trees, and green space acreage from 2.3.1	Neighborhoods that abut corridor: East Somerville Prospect Hill Ten Hills Union Square/Beacon Street Winter Hill East Cambridge	GIS network analysis	Uses general rule of thumb: Mix of Elm & Plum trees = 20 trees/acre Multiplied by acres of green space from 2.3.1
4.3	**Ensure long-term corridor maintainability**					
4.3.1	*Feasible maintenance plan for corridor*	Ensure a sustainable maintenance program	Average annual maintenance costs per mile versus MassDOT urban roadway average		MassDOT analysis	
4.3.2	*Fiscal impacts of alternatives*	Ensure investment is outweighed by economic gain	Sustainable ROI calculation		MassDOT, market & Census data	
4.3.3	*Cost to construct*			McGrath viaduct	Cost Analysis	Appendix N

SUMMARY OF RANKINGS

2035 No Build	Boulevard			Access Road			Hybrid U-Turn/Rotary			Boulevard & Inner Belt Rd		
Value	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change	Ranking	Value	Change
15,312 VHT	◕	15,140 VHT	-172 VHT	◑	15,278 VHT	-34 VHT	◕	15,201 VHT	-111 VHT	◕	15,138 VHT	-174 VHT
14,430 VHT	●	14,285 VHT	-144 VHT	◑	14,426 VHT	-3 VHT	◕	14,346 VHT	-83 VHT	●	14,292 VHT	-138 VHT
692,843 kg	◕	688,390 kg	-4,453 kg	◕	689,347 kg	-3,496 kg	◕	689,097 kg	-3,746 kg	◕	688,596 kg	-4,247 kg
1,634,371 sf	◕	1,723,301 sf	88,930 sf	●	1,739,486 sf	105,115 sf	◕	1,703,959 sf	69,588 sf	◕	1,723,301 sf	88,930 sf
750 trees	◕	791 trees	41 trees	◕	799 trees	48 trees	◕	782 trees	32 trees	◕	791 trees	41 trees
	◕			◕			◕			◕		
	◕			◕			◕			◕		
	◕			◕			◕			◔		
	36 ● Boulevard			29 ◕ Access Road			36 ● Hybrid U-Turn/Rotary			38 ● Boulevard & Inner Belt Road		

demand model are presented in Appendix J, and provided sufficient information regarding the extent of these diversions for them to be qualitatively considered in the Evaluation Matrix. However, understanding the full impacts of diverted trips on intersections and roadways outside of the study area will require additional consideration from a capacity and public policy perspective if a selected alternative advances to conceptual design.

- No alternative completely solves the vehicular traffic issues throughout the McGrath corridor. Modifying the McGrath corridor to an at-grade roadway from a grade-separated highway introduces added traffic to the corridor intersections. As discussed previously, the alternatives were selected primarily to help make the McGrath corridor more livable in terms of serving multiple modes of transportation users and giving less priority to the speed and efficiency of vehicular traffic.
- Some alternatives have significant queuing at intersections, with a potential for spill back that could lead to unacceptable conditions. Additional evaluation of these intersections is warranted if an alternative proceeds to preliminary design.

The key issues and opportunities from a vehicular circulation perspective for each alternative are provided below:

Boulevard Alternative

A summary of the capacity analysis for the Boulevard Alternative is provided in Table 5-2.

Opportunities

- The alternative would result in improved or maintained overall traffic operations compared to the No Build at the following existing intersections with the McGrath corridor:
  - » Blakeley Avenue
  - » Broadway
  - » Pearl Street
  - » Medford Street/Highland Avenue
  - » Medford Street at Somerville Avenue
  - » Rufo Road
  - » Land Boulevard/Austin Street
- Besides the Washington Street intersection, this alternative provides "normalized" intersection operations at reconfigured at-grade intersections by implementing conventional intersection designs. A "normalized" intersection configuration would include straightforward and simple vehicular movements as well as simplified signal phasing, eliminating potential confusion to vehicles traveling within the McGrath corridor. The Boulevard alternative would provide vehicles traveling along the McGrath corridor and its intersecting roadways with the ability to more easily and directly navigate the newly configured intersections, rather than the somewhat confusing existing and No Build configurations of ramps, surface roads, and underpasses.
- Would allow for full access between the McGrath corridor, Somerville Avenue and Poplar Street that is not permitted under existing conditions.
- The following assumptions and improvements would likely provide additional capacity and better traffic operations for the proposed Boulevard Alternative:
  - » Trip diversions from Washington Street may be possible with potential new Inner Belt connections.
  - » Additional eastbound and westbound through lanes.
  - » Adding exclusive, channelized right turn lanes on the northbound and southbound approaches, rather than a shared right-turn and through lane.

Issues

- Trip diversions to other area roadways are assumed as a result of the reduced capacity on the McGrath corridor. Due to the change in vehicle capacity along the McGrath corridor and the resulting reduction in congested travel speed, the CTPS regional travel demand model indicates that some vehicles may seek alternate routes in order to travel on roads with more available capacity. As a result, volumes are projected to increase on Broadway and Land Boulevard, which have impacts on the cross streets with these roadways. The increases on Land Boulevard and Broadway indicate that vehicles may be expected to travel along Rutherford Avenue and other regional roadways instead of the McGrath corridor in order to reach their destinations.

Table 5-2: Boulevard Capacity Analysis

Location	Peak Hour		2011 Existing LOS[1]	2011 Existing Delay[2]	2011 Existing V/C[3]	2035 No Build LOS	2035 No Build Delay	2035 No Build V/C	Boulevard 2035 LOS	Boulevard 2035 Delay	Boulevard 2035 V/C
Route 28 at Land Boulevard/Austin Street	AM	Overall	F	89.4	1.78	E	68.0	1.10	E	76.0	1.07
	PM	Overall	F	94.3	1.32	F	90.4	1.2	F	92.6	1.26
Route 28 at Land Cambridge Street/East Street	AM	Overall	B	18.4	0.74	B	15.5	0.7	C	26.1	0.59
	PM	Overall	C	23.1	0.73	B	17.5	0.56	C	20.1	0.4
Route 28 at Third Street	AM	Overall	C	24.8	0.85	C	28.5	0.68	A	9.6	0.57
	PM	Overall	C	30.2	0.86	C	33.8	0.94	C	27	0.85
Route 28 at Rufo Street	AM	Overall	C	23.8	0.71	C	28.5	0.68	A	8.8	0.66
	PM	Overall	D	40.7	1.41	D	35.8	0.93	C	28.3	0.9
Medford Street at Somerville Avenue	AM	Overall	C	31.3	0.76	C	34.4	0.82	C	32.6	0.83
	PM	Overall	D	47.4	1.04	E	72	1.28	D	36.8	0.89
Route 28 at Somerville Avenue/Poplar Rd	AM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	C	23.7	0.83
	PM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	D	49.3	0.89
Route 28 at Washington Street	AM	Overall	C	29.7	0.88	E	57.4	1.24	F	210.5	1.33
	PM	Overall	E	57.1	0.88	E	75	2.36	F	116.4	1.32
Route 28 at Medford Stret/Highland Street	AM	Overall	F	84.8	1.26	F	101.2	1.31	C	22.3	0.91
	PM	Overall	D	45.4	1.19	E	56.2	1.14	C	27	0.92
Route 28 at Pearl Street	AM	Overall	C	30.3	0.86	E	55.8	1.08	C	30.1	0.86
	PM	Overall	D	42.9	0.87	D	43.5	0.98	B	19.7	0.83
Route 28 at Broadway	AM	Overall	D	51.9	1.22	E	69.9	1.06	D	42.9	0.91
	PM	Overall	D	48.2	0.96	D	52	0.98	D	42.9	0.91
Route 28 at Blakeley Avenue	AM	Overall	A	6.6	0.54	A	7.9	0.64	A	5.5	0.55
	PM	Overall	A	8.9	0.62	A	9.2	0.68	A	8.2	0.72

1 Level-of-Service

2 Average delay in seconds per vehicle

3 Volume to capacity ratio

Table 5-3: U-Turn/Rotary Hybrid Analysis

Location	Peak Hour		2011 Existing LOS[1]	2011 Existing Delay[2]	2011 Existing V/C[3]	2035 No Build LOS	2035 No Build Delay	2035 No Build V/C	Uturn/Rotary 2035 LOS	Uturn/Rotary 2035 Delay	Uturn/Rotary 2035 V/C
Route 28 at Land Boulevard/Austin Street	AM	Overall	F	89.4	1.78	E	68.0	1.10	E	70.5	1.05
	PM	Overall	F	94.3	1.32	F	90.4	1.2	F	92.50	1.26
Route 28 at Land Cambridge Street/East Street	AM	Overall	B	18.4	0.74	B	15.5	0.7	C	29.7	0.61
	PM	Overall	C	23.1	0.73	B	17.5	0.56	B	23.00	0.85
Route 28 at Third Street	AM	Overall	C	24.8	0.85	C	28.5	0.68	B	11.8	0.64
	PM	Overall	C	30.2	0.86	C	33.8	0.94	C	30.50	0.90
Route 28 at Rufo Street	AM	Overall	C	23.8	0.71	C	28.5	0.68	B	13.8	0.56
	PM	Overall	D	40.7	1.41	D	35.8	0.93	C	33.10	0.91
Medford Street at Somerville Avenue	AM	Overall	C	31.3	0.76	C	34.4	0.82	n/a	n/a	n/a
	PM	Overall	D	47.4	1.04	E	72	1.28	n/a	n/a	n/a
Route 28 at Southern Rotary/Access Road	AM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	B	15.4	0.87
	PM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	B	17.6	0.81
Route 28 at Northern Rotary/Access Road	AM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	B	11.4	0.87
		WB T	n/a	n/a	n/a	n/a	n/a	n/a	D	45.2	0.52
Poplar Street at Rotary/Access Rd	AM	WB R	n/a	n/a	n/a	n/a	n/a	n/a	B	11.6	0.14
	PM	WB R	n/a	n/a	n/a	n/a	n/a	n/a	B	14.5	0.22
Somerville Avenue at Rotary/Access Rd	AM	EB R	n/a	n/a	n/a	n/a	n/a	n/a	F	82.6	0.92
	PM	EB R	n/a	n/a	n/a	n/a	n/a	n/a	F	191.80	1.35
Medford Street at Rotary/Access Rd	AM	NB TR	n/a	n/a	n/a	n/a	n/a	n/a	F	105	1.07
	PM	NB TR	n/a	n/a	n/a	n/a	n/a	n/a	F	191.80	1.35
Route 28 at Linwood Street	AM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	C	20.7	0.87
	PM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	C	32.6	0.91
Route 28 at Northern U-Turn	AM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	A	7.2	n/a
	PM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	B	10.3	0.78
Route 28 at Washington Street	AM	Overall	C	29.7	0.88	E	57.4	1.24	C	20.4	0.78
	PM	Overall	E	57.1	0.88	E	75	2.36	C	20.90	0.88
Route 28 at Medford Stret/Highland Street	AM	Overall	F	84.8	1.26	F	101.2	1.31	B	15.7	0.93
	PM	Overall	D	45.4	1.19	E	56.2	1.14	A	18.60	0.76
Route 28 at Pearl Street	AM	Overall	C	30.3	0.86	E	55.8	1.08	D	46.7	1.1
	PM	Overall	D	42.9	0.87	D	43.5	0.98	D	43.30	1.23
Route 28 at Broadway	AM	Overall	D	51.9	1.22	E	69.9	1.06	D	44.9	0.91
	PM	Overall	D	48.2	0.96	D	52	0.98	D	43.30	0.88
Route 28 at Blakeley Avenue	AM	Overall	A	6.6	0.54	A	7.9	0.64	D	35.30	0.82
	PM	Overall	A	8.9	0.62	A	9.2	0.68	A	8.90	0.59

1 Level-of-Service

2 Average delay in seconds per vehicle

3 Volume to capacity ratio

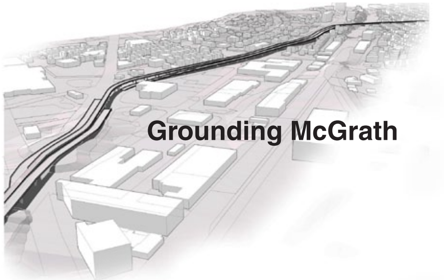
- To improve intersection operations, the northbound and southbound left-turns from the McGrath corridor to Washington Street are prohibited in this alternative. The existing conditions show that there is a relatively low demand for these turns. Restricting the left turns will require vehicles to seek alternate routes within the study area to travel to their destinations. Northbound vehicles traveling towards Union Square would be required to turn left onto Somerville Avenue (at the new signalized location) and travel northwest to reach their destination. Southbound vehicles wishing to travel eastbound on Washington Street towards Sullivan Square would need to turn left onto Poplar Street (at the new signalized location) and travel north to turn right onto Washington Street and continue to the east.
- The intersection of the McGrath corridor and Washington Street would operate at an overall LOS F with many approaches operating over-capacity including the eastbound and westbound Washington Street approaches during both analyzed peak hours. The southbound McGrath corridor approach is shown to operate at LOS F during the weekday morning peak hour while the northbound McGrath corridor approach is shown to operate at LOS D during the weekday afternoon peak hour. Additional capacity analysis results can be found in Appendix E.
- Providing an acceptable LOS (LOS D or better) would require capacity changes at the intersection of the McGrath corridor and Washington Street. This added capacity would increase the pavement cross-section and run counter to the “Road Diet” and Complete Streets approach that are the basis of the Working Group’s request to explore this alternative. Therefore, modifications to increase capacity at the intersection were not further analyzed.
- The proximity of the signalized intersections on the McGrath corridor at Washington Street and at Linwood Street would result in queuing issues, specifically the northbound approach at Washington Street during the weekday afternoon peak hour when queue lengths are projected to extend back into the Linwood Street intersection. This situation would result in gridlock that would potentially block vehicles exiting and entering Linwood Street, further degrading traffic operations.
- Under the Boulevard alternative, the McGrath corridor/Somerville Ave/Medford Street/Poplar Street intersection presents a number of challenges with the coordination of the two closely spaced signals, including the following:
    - » Minimal vehicle queue storage between the two coordinated traffic signals (Somerville Avenue at Medford Street and McGrath corridor at Poplar Street). The two signals would essentially need to operate as one in order to eliminate the possibility of vehicles queuing in the eastbound and westbound directions between the signals. The configuration of the two intersections requires complex signal and roadway design in order to ensure safe and efficient operations and to limit potential driver confusion.
    - » Potentially high volume of eastbound left turns from Somerville Avenue to the McGrath corridor northbound would further complicate the inability to store vehicles between the two intersections. The eastbound left turn is also expected to operate at LOS F with a queue length in excess of 500 feet during the weekday afternoon peak hour. Additional details of the capacity analysis including level of service, delay, capacity and queuing can be found In Appendix E.

U-turn/Rotary Hybrid Alternative

A summary of the capacity analysis for the U-turn/Rotary Hybrid Alternative is provided in Table 5-3.

Opportunities

- This alternative would provide new roadway connections between the McGrath corridor and Inner Belt/Brickbottom, Somerville Avenue, Union Square, as well as additional pedestrian connections across the McGrath corridor not possible today.
- As noted previously, all alternatives assume that there would be some level of traffic diversion compared to the No Build condition, as indicated through the use of the CTPS regional travel demand model. During the weekday morning analysis, the southbound McGrath corridor traffic volumes show less of a decrease along the entire corridor than under the Boulevard alternative. This smaller decrease in traffic volumes under the U-turn/ Rotary Hybrid Alternative is due to some level of



improvement on both capacities and speed at the intersections and rotary compared to the Boulevard Alternative.

- Attaining an acceptable operational traffic LOS during the weekday morning and weekday afternoon peak hours at the McGrath corridor and Washington Street intersection is possible with the use of a simplified two phase traffic signal. This would maintain through access of eastbound and westbound Washington Street approaches and streamline vehicular operations at this intersection.
- Acceptable traffic operations at the new signalized rotary intersections would be expected. However, 95th percentile queues would slightly exceed the maximum storage length available, but could potentially be addressed through more advanced design in the future if this is the preferred alternative.
- There would be a slight decrease in the traffic volumes on Medford Street in the vicinity of Somerville Avenue, compared to the Boulevard Alternative during the weekday morning and weekday afternoon peak hours. This may be attributed to the combination of improved traffic flow on the McGrath corridor and the increased travel time to access Medford Street via the rotary. Vehicles are more likely to remain on the McGrath corridor instead of using Medford Street as an alternative route.
- Compared to the No Build, this alternative would combine the intersection of the McGrath corridor and Linwood Street and the southbound McGrath corridor U-turn.
    - » Linwood Street right-out exiting and full access entering would be allowed
    - » Would eliminate a potential additional traffic signal along the McGrath corridor
    - » Would create an opportunity for a pedestrian crossing that could run concurrently with the southbound U-turn
- Compared to the No Build, this alternative would improve or maintain overall traffic operations at the following existing intersections with the McGrath corridor:
    - » Blakeley Avenue
    - » Broadway
    - » Medford Street/Highland Avenue
    - » Would improve the LOS due to elimination of the eastbound Medford Street left turn, which would result in a number of vehicles diverting from the intersection.
    - » Rufo Road
    - » Third Street
    - » Land Boulevard/Austin Street

Issues

- The left-turn restriction from Medford Street/Highland Avenue to the northbound McGrath corridor would force a significant number of vehicles to shift to the eastbound movement of Pearl Street at its intersection with the McGrath corridor. This diversion would have an impact on both Medford Street, Pearl Street, and the northbound McGrath corridor (north of Medford Street/Highland Avenue). Most notably, this would cause delay at the intersection of Pearl Street and the McGrath corridor. In addition, trips destined to the north may seek alternative routes to avoid McGrath intersections, as reflected in the relatively lower volumes for the northbound approach to Blakely Avenue (as shown in the CTPS results in Appendices I and J) when compared to the No Build and Boulevard alternatives. These diversionary trips would likely have impacts on streets north of Medford Street that need to be considered from a regional perspective.
- Under this alternative, the new signalized U-turn intersection at Cross Street would include a configuration that allows dual U-turn movements where northbound and southbound vehicles would complete their reverse-movement turns at the same time under a protected signal phase. This dual U-turn configuration would improve the operations at the McGrath corridor intersection with Somerville Avenue and Highland/Medford Street. However, providing the dual U-turn configuration complicates the pedestrian crossings at the intersection because they could not run concurrently with the U-turns without additional geometric changes to the intersection. For example, a “slip lane” could be created for the U-turn, providing a small area of median between turning vehicles and pedestrian crossings. However, this would lengthen the overall intersection and sight lines would need to be considered. Additionally, an exclusive pedestrian

phase at the U-turn intersection would cause the intersection to exceed capacity during both the weekday morning and weekday afternoon peak periods. Specific design details regarding the configuration and interaction between vehicles and pedestrians at this new signalized intersection would require further exploration if the alternative proceeds to design.
- The CTPS regional travel demand model showed that during the weekday afternoon peak period, traffic volumes on the southbound McGrath corridor between Medford Street/Highland Avenue and Washington Street are much higher than traffic volumes for the same segment in the Boulevard Alternative. The provision of a southbound left-turn pocket lane between Medford/Highland and Washington Street is viewed by the CTPS model as the equivalent of an additional lane of capacity. Adding the left-turn pockets allows slightly higher congested travel speeds on the through lanes compared to the Boulevard Alternative, which would attract trips using this portion of roadway.
- Signalized intersections along the McGrath corridor at Washington Street, Linwood Street and median U-turns would be closely spaced, and projected to result in spillback issues for vehicle queues into adjacent intersections. This situation would result in gridlock that would potentially block vehicles exiting and entering the side streets, further degrading traffic operations.
- The Somerville Avenue and Medford Street yield controlled approaches to the rotary would operate at LOS F during the weekday morning and weekday afternoon peak hour. The projected queue lengths for a yield approach would likely exceed the capacity of the intersection. Widening each of these approaches to include two travel lanes is expected to improve operations, but would require additional roadway width.
- Some of the yield approaches to the signalized rotary would operate with significant delay and queuing.
    - » Medford Street would operate at LOS F during the weekday morning and weekday afternoon peak hours.
    - » The Somerville Avenue approach would operate at LOS F during the weekday morning peak hour.

Linwood Access Road

A summary of the capacity analysis for the Linwood Access Road Alternative is provided in Table 5-4.

Opportunities

- Compared to the No Build, this alternative would result in acceptable operations at both signalized and unsignalized access road intersections, with the exception of Medford Street during the weekday afternoon peak.
- Compared to the No Build, this alternative would improve capacity for through movements on the McGrath corridor due to the consolidation of conflict points with traffic from intersection roadways.
- Compared to the No Build, this alternative would improve or maintain overall traffic operations at the following existing intersections with the McGrath corridor:
    - » Blakeley Avenue
    - » Broadway
    - » Medford Street/Highland Avenue
    - » Rufo Road
    - » Third Street
    - » Land Boulevard/Austin Street
- A northbound access road would be incorporated through existing Brickbottom roadways, improving access and connectivity to local roadways in the area.

Issues

- Washington Street eastbound/westbound through movements would be circulated through the access road.
    - » The new alignment requires eastbound Washington Street through movements to be circuitously routed a longer distance through three signals, an addition of almost 0.5 miles to this movement compared to existing conditions and the No Build.
    - » May divert additional eastbound traffic to

Table 5-4: Linwood Access Road Capacity Analysis

Location	Peak Hour		2011 Existing LOS[1]	Delay[2]	V/C[3]	2035 No Build LOS	Delay	V/C		Access Rd 2035 LOS	Delay	V/C
Route 28 at Land Boulevard/Austin Street	AM	Overall	F	89.4	1.78	E	68.0	1.10	Overall	E	77.4	1.18
	PM	Overall	F	94.3	1.32	F	90.4	1.2	Overall	F	90.00	1.20
Route 28 at Land Cambridge Street/East Street	AM	Overall	B	18.4	0.74	B	15.5	0.7	Overall	B	19.1	0.58
	PM	Overall	C	23.1	0.73	B	17.5	0.56	Overall	B	19.80	0.48
Route 28 at Third Street	AM	Overall	C	24.8	0.85	C	28.5	0.68	Overall	B	0.64	1.71
	PM	Overall	C	30.2	0.86	C	33.8	0.94	Overall	B	27.50	0.87
Route 28 at Rufo Street	AM	Overall	C	23.8	0.71	C	28.5	0.68	Overall	B	12.2	0.63
	PM	Overall	D	40.7	1.41	D	35.8	0.93	Overall	C	33.00	0.91
Medford Street at Somerville Avenue	AM	Overall	C	31.3	0.76	C	34.4	0.82	Overall	n/a	n/a	n/a
	PM	Overall	D	47.4	1.04	E	72	1.28	Overall	n/a	n/a	n/a
Route 28 at Somerville Avenue/Poplar Rd	AM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	Overall	n/a	n/a	n/a
	PM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	Overall	n/a	n/a	n/a
Route 28 at Southern Rotary/Access Road	AM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	Overall	B	15.1	0.79
	PM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	Overall	B	16.5	0.84
Route 28 at Northern Rotary/Access Road	AM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	Overall	B	17.6	0.97
	PM	Overall	n/a	n/a	n/a	n/a	n/a	n/a	Overall	C	26.8	0.95
Poplar Street at Rotary/Access Rd	AM	WB R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	B	11.3	0.13
	PM	WB R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	C	15.8	0.25
Somerville Avenue at Rotary/Access Rd	AM	EB R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	D	33.9	0.71
	PM	EB R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	E	43	0.85
Medford Street at Rotary/Access Rd	AM	EB R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	B	13	0.34
	PM	EB R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	F	55.10	0.91
Route 28 at Washington Street	AM	Overall	C	29.7	0.88	E	57.4	1.24	Overall	n/a	n/a	n/a
	PM	Overall	E	57.1	0.88	E	75	2.36	Overall	n/a	n/a	n/a
Washington Street WB at Rotary/Access Rd	AM	WB R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	C	17.4	0.65
	PM	WB R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	D	32.4	0.85
Washington Street EB at Rotary/Access Rd	AM	EB R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	C	18.9	0.39
	PM	EB R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	C	19.4	0.49
Route 28 at Medford Stret/Highland Street	AM	Overall	F	84.8	1.26	F	101.2	1.31	Overall	D	37	1
	PM	Overall	D	45.4	1.19	E	56.2	1.14	Overall	C	26.50	0.88
Route 28 at Pearl Street	AM	Overall	C	30.3	0.86	E	55.8	1.08	Overall	C	28.4	0.9
	PM	Overall	D	42.9	0.87	D	43.5	0.98	Overall	D	37.80	0.82
Route 28 at Broadway	AM	Overall	D	51.9	1.22	E	69.9	1.06	Overall	D	54.2	0.99
	PM	Overall	D	48.2	0.96	D	52	0.98	Overall	E	49.20	0.95
Route 28 at Blakeley Avenue	AM	Overall	A	6.6	0.54	A	7.9	0.64	Overall	A	5.70	0.52
	PM	Overall	A	8.9	0.62	A	9.2	0.68	Overall	A	8.80	0.58

1 Level-of-Service

2 Average delay in seconds per vehicle

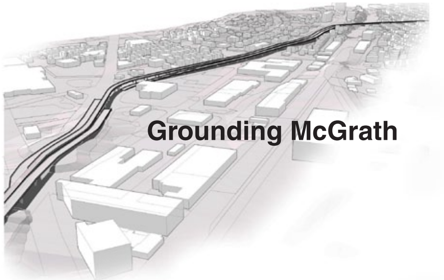
3 Volume to capacity ratio

Somerville Avenue in order to shorten the length of the trip to travel eastbound on Washington Street.
- There is some trip diversion shown in the CTPS regional travel demand model for traffic that would originally be using Washington Street eastbound and shifting to Highland Avenue/Medford Street eastbound in order to travel northbound on the McGrath corridor. This would impact local roadways west of McGrath and would need to be considered from a regional perspective.
- Locating the pedestrian crossings at the signalized access road intersections would prevent direct pedestrian access along Washington Street or from Somerville Avenue to the Inner Belt/Brick Bottom area.
- Eastbound queuing at the southern access road intersection near Somerville Avenue, and westbound 95th percentile queuing at the northern access road intersection near Washington Street would extend beyond the available storage length. Slight improvements could be possible with a reconfiguration of the access road geometry, but would have impacts on adjacent properties.
- For this alternative, the smallest amount of traffic is diverted from along the McGrath corridor and greatest amount of traffic is diverted from Washington Street when compared to the other alternatives.
- The travel to and from McGrath to the intersecting east/west streets increases under this alternative, therefore increasing overall travel time for local trips.

Summary of Pedestrian and Bicyclist Issues

Mobility for pedestrians and bicycles are included in the Evaluation Matrix through a variety of measures.

- All alternatives improve the comprehensiveness of the pedestrian and cycling network compared to the No Build. All Build alternatives are assumed to include facilities such as sidewalks, bicycle lanes or shared lane markings between activity centers along the McGrath corridor.
- The presence of alternative modal connections would be the greatest for the Boulevard and IBBB options, although the Linwood Access Road and U-turn/Rotary alternatives would also provide improvements compared to the No Build condition. The ability to change mode share is based on cost and convenience, and these alternatives facilitate transfers with improved connections.
- In terms of sidewalk connectivity, the average block length would decrease slightly for the Boulevard Alternative and more significantly for the U-turn/Rotary Alternative, and therefore rates more favorably when compared to the No Build. The Linwood Access Road Alternative would not decrease as significantly, which is due to long block lengths expected in this alternative. The decrease for the U-turn/Rotary Alternative may be due, in part, to new “blocks” forming around the Poplar Street intersection.
- No significant change in travel mode share was evident among the alternatives based on the CTPS regional travel demand model (see Appendix K). The CTPS regional travel demand model shows vehicle trip diversions to outside of the McGrath corridor, but it does not appear that there was a shift to non-vehicular travel. Therefore, all alternatives are comparable to the No Build condition in terms of mode shares. It is important to note that planned transit improvements, such as the GLX, are included in the No Build Alternative which contributes significantly to why there were no substantial mode-shifts in the alternatives.
- All alternatives would increase the ratio of “buffers” between travel lanes and communities (i.e. parking, sidewalks, bike lanes, green space) to travel lanes. The U-turn/Rotary does not rank as well as the other alternatives for the sample cross sections shown previously due to the wider cross-sections at signalized intersections, but otherwise all alternatives are comparable in this regard.
- All alternatives would provide significantly better neighborhood connections to open space, than compared to the No Build condition. The barrier created by an elevated McGrath corridor is removed for the alternatives, improving pedestrian crossings to access the parks and playgrounds adjacent to the McGrath corridor.
- Based on the estimated linear feet of active travel lanes that pedestrians must walk to get across the



McGrath corridor, the Boulevard Alternative performs best for the roadway width crossing criterion. While both the Boulevard and U-turn/Rotary alternatives would decrease roadway crossing by a little less than one lane, the Linwood Access Road Alternative increases the average width of active travel lanes that pedestrians must cross over the No Build.

Summary of Safety Impacts

The safety analysis includes the examination of impacts on vehicular, bicycle and pedestrian movements in the study area. Vehicular speeds, as a measure of safety for modes of travel, are evaluated for each alternative in section 3.1 of the Evaluation Matrix. Injuries and fatalities can be reduced through reduction in vehicular speeds. The average speed in the No Build Alternative is 19.5 mph, while the three alternatives are all about 18 mph. This does not represent a significant difference in speeds, and therefore no substantial change in safety in terms of vehicular speed.

The existing crash rates identified as part of the existing conditions analysis (see Chapter 2), will likely be influenced by the reconfiguration of the McGrath corridor from an elevated roadway to an at-grade corridor. Congested conditions may lead to additional crashes, particularly rear-end crashes. However, with slightly lower vehicular speeds at key intersections along the McGrath corridor, the severity of these crashes may diminish.

Crash data for existing conditions is presented in Chapter 2. The at-grade alternatives for Grounding McGrath will create new intersections that must be carefully designed to reduce the probably of crashes, particularly the angle type rear-end and bicycle crashes that occur at key intersections.

Potential short-term improvements that could be made to enhance safety for the No Build or any of the Build alternatives include:

- Signal timing adjustments
  - » Extend clearance intervals
  - » Provide additional green time to critical movements
  - » Provide protected signal phasing for critical movements such as left turns
  - » Improve signal coordination
- Lane Restriping
  - » Clearly indicate exclusive movements
  - » Modify intersection configuration to improve capacity
- Roadway Improvements
  - » Repave for non-skid resistance
  - » Improve access management by reducing conflict points
  - » Provide channelization or turn lanes
  - » Improve sight distance

Summary of Environmental Effects

Environmental impacts of alternatives are evaluated through metrics to improve the health of residents through increased pedestrian and bicycling opportunities, access to open space, vehicle hours travelled, and overall impacts to the environment, as noted in the Evaluation Matrix.

All three alternatives are expected to improve carbon monoxide (CO) emissions in the winter, compared to the No Build alternatives. Otherwise, there is no significant difference in air quality measures, based on the data available through the CTPS model Air Quality Results. The *Health Impact Assessment of the Massachusetts Department of Transportation (MassDOT) Grounding McGrath Study* (HIA Study)[1] evaluated air quality within proximity of 200 meters of the roadway (for indirect measure of ultrafine particles and higher gradient of vehicle emissions), using contour maps of the density of vehicle miles travelled (VMT). The findings concluded "All future project alternatives, including the 2035 No Build, will result in significant reductions in traffic-related air pollution largely attributed to advancements in vehicle emissions standards and technologies." The HIA Study goes on to state that, "De-elevation of the highway structure is anticipated to result in an increase in ground-level exposure to traffic-related air pollutant emissions (i.e. criteria pollutants, hazardous air pollutants, ultrafine particles). Thus, implementation of mitigation measures (e.g., locating sidewalks and bike paths further away from the roadway, installation of barriers, planting of

1 April 4, 2013 McGrath Working Group presentation by the Massachusetts Department of Public Health

trees) based on more comprehensive assessment of air pollution impacts should be explored where possible to reduce exposure to traffic related air pollutants."

Noise impacts are a function of distance of noise receptors from the roadway, traffic displacement, vehicular speed, and similar measures. Generally speaking, it can be assumed that an elevated roadway (existing conditions and No Build) will generate more noise than at-grade roadways. Noise is generated by the structure itself as vehicles travel over joints and similar features. In addition, noise is directly affected by line of sight which will extend further for an elevated structure than for at-grade roadways. Finally, the types of barriers on the structure and adjacent land uses also impact noise levels.

The Massachusetts Department of Transportation's Highway Division Type I and Type II Noise Abatement Policy and Procedures (MassDOT Noise Policy) complies with Codified Federal Regulations and have been approved by the Federal Highway Administration (FHWA). The Policy defines two types of highway noise projects , the first of which will be required for any alternative:[2]

- A Type I Noise Barrier is a noise barrier considered as part of new highway construction or when there is a substantial change in the capacity or alignment of an existing highway. Examples of Type I projects include: new highway, substantial horizontal or vertical alignment, addition of a full travel lane and the addition or relocation of interchange ramps.
- The Type II Noise Program addresses highway traffic noise in locations where a Type I project is not planned. The Type II Noise Program is a voluntary program. Type II noise barriers compete for funding with other projects that increase highway safety such as the replacement of structurally deficient bridges, the reconstruction of deteriorated and substandard roadways, and the reconstruction of intersections that are known to be high accident locations.

2 Information from MassDOT's Noise Barrier Brochure, 2013. http://www.mhd.state.ma.us/downloads/environ/noisebarrier2012/NoiseBarrierBrochure2013.pdf

A review of existing environmental conditions, presented in Chapter 2, indicates that there is not anticipated to be any change in impacts from the No Build and the alternatives for wetlands and waterways, Areas of Critical Environmental Concern (ACEC), hazardous materials sites, historic, cultural and archaeological resources.

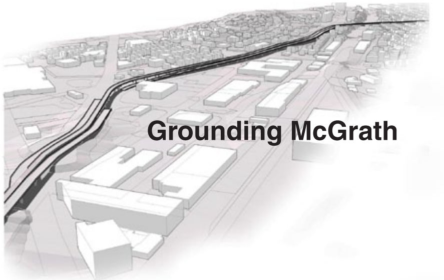
Environmental effects are further analyzed through the separate HIA Study. Generally speaking, most environmental impacts associated with the Build alternatives are positive when compared to the No Build. Thresholds for environmental review under the Massachusetts Environmental Policy Act (MEPA) and National Environmental Policy Act (NEPA) may not be triggered, with the exception of overall acreage of the project area and potential changes in alignment of Poplar Street. The project is primarily in the MassDOT right-of-way, with the exception of the potential Poplar Street re-alignment. The City of Somerville has indicated a willingness to work with MassDOT to secure additional right-of-way associated with the Boulevard Alternative (see Appendix L).

Land Use and Economic Development

The potential implications of the alternatives on economic development are included in section 2.4 of the Evaluation Matrix. The key issues considered in the evaluation are described below. Population and employment projections are included in the 2035 No Build condition.

Generally speaking, the Build alternatives will influence land use and economic development in the McGrath corridor:

- New properties would be created by grounding the overpasses, including some public land. A land bank could be maintained for needed uses such as affordable housing.
- Careful planning of the traffic network, including potential land swaps with neighboring properties for grounding the structures, could yield new redevelopment potential.
- Infrastructure costs required to create attractive development may be expensive. With careful



planning, Tax Increment Financing, Infrastructure Investment Incentive (I-3) or related district financing could make sure that sources exist for infrastructure costs.

- Speculation on property could be an unwelcome part of the impacts as developers assemble land for larger development, and could reduce the speed of redevelopment.
- There may also be a run-up in prices on residential and commercial stock resulting from this speculation in the area which could lead to pricing out some current residents and businesses. Gentrification could be felt by some residents unless planned for in advance.

No Build

If the No Build condition provides faster travel times between Boston/Cambridge than the other alternatives it will have positive impacts on property values and lease rates in the suburbs north of the project area. These impacts will be very small in dollar value for any individual property owner and will only be felt at significant distances from the site; but there is a benefit to them. However, the elevated highway has a significant negative impact on the properties immediately adjacent to the McGrath corridor. It degrades their character and image in the marketplace and visibility and access. It is difficult to say that the No Build has any significant benefit to employment, sales or revenues, as its impact to the communities to the north of the study area, or in Boston and Cambridge is very small.

Boulevard

This alternative would improve the character of the area for commercial and residential property owners more than other alternatives. It would improve visibility to properties on both sides of the previously elevated section, provides for more of a sense of boulevard along the McGrath corridor as well as Washington Street east of the McGrath corridor, Linwood Street, and Medford Street. This alternative would improve the quality and image of the environment in front of many of the properties in the area. The buffers on the east side of the McGrath corridor would be beneficial for the residential uses, but less so for the commercial, as it would restrict access for businesses fronting on the McGrath corridor to Linwood, Poplar or Washington Streets. Businesses typically would prefer to have access and frontage abutting the major street. The impact of new streets and realignment would be generally good relative to creating parcels for development. This alternative should see an upgrade to businesses and property values in the immediate area, as well as those factors considered in 2.4.1.4 of the Evaluation Matrix. The only other drawback is that slower travel times to and from northern suburbs would have a marginally negative impact on their property values.

U-turn/Rotary Hybrid

The impacts of this alternative would be very similar to the Boulevard Alternative. Some of the reasons that it may provide slightly less benefit relative to the Boulevard Alternative are:

- There is less “boulevard” throughout the focus area due to the increased pavement width associated with the rotary and U-turns.
- A rotary is less desirable in terms of frontage for real estate development due to the higher speed of vehicles and one-way circulation pattern.
- The Somerville Avenue/Medford Street intersection is less attractive for real estate development due to the more complicated during movements from the McGrath mainline.

Linwood Access Road

This alternative would provide some of the same advantages over the No Build as the other alternatives, in that it improves the visibility of parcels along the McGrath corridor. However, this alternative has several significant disadvantages relative to the other two alternatives:

- Washington Street and Somerville Avenue would not flow straight through the intersection in a clearly understandable way, which reduces the apparent connection. The lack of a direct connection degrades access and perceived access for commercial properties both in the immediate district and along the cross streets.
- The alternative has less of a high quality urban character and image, due to the circulating roadway system and potential difficulty accessing properties along the McGrath corridor.
- There is less of a sense of boulevard organization

since the McGrath corridor mainline favors the north/south through volumes. The street and "park/ median" would be very wide separating the two sections of Somerville.
- It would not convey an urban feeling as a place to live and do business; it will feel more like a large, elongated rotary.

Community Effects/Environmental Justice

CTPS completed an analysis of the potential impacts each alternative may have on Environmental Justice (EJ) populations. The methodology and summary of findings are provided below, while the summary data are provided in Appendix M.

Title VI of the 1964 Civil Rights Act states that "No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance." MassDOT's Office of Civil Rights states that:

Title VI of the Civil Rights Acts of 1964 ensures that no person in the United States shall on the grounds of race, color, national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance from the Federal Transit Authority (FTA) and Federal Highway Administration (FHWA) funded programs. Under additional Nondiscrimination statutes age, sex and disability are applicable to Federal programs in addition to programs receiving federal financial assistance due to the Civil Rights Restoration Act of 1987.[3]

The Federal Highway Administration (FHWA) in a memorandum dated October 7, 1999, indicates that the President's Executive Order on Environmental Justice, the U.S. DOT Order, and the FHWA Order further amplify Title VI by providing that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."[4]

EJ Neighborhood Definition

For the purpose of this study, an environmental justice transportation analysis zone (TAZ) is defined by the criteria in the Boston MPO's regional equity program (low income and minority population), together with one of the criteria from the Executive Office of Environmental Affairs (EOEA) definition (Limited English proficiency). The detailed criteria are:
- Low income - A low-income population TAZ was defined as having a median household income at or below 80 percent of the Boston MPO median household income. In 2010, the median household income in Boston MPO region is $70,831.
- Minority - A minority population TAZ was defined as having a percentage of minority population (nonwhite and Hispanic) in 2010 greater than 21.4 percent.
- Limited English Proficiency – A limited English language proficiency TAZ was defined as one where 25 percent or more of the residents are classified as lacking proficiency in the English language.

The EJ analysis for this project focused on the 17 neighborhoods in the vicinity of the McGrath corridor: Central Square, Davis Square, East Cambridge, East Medford, East Somerville, Fresh Pond, Harvard Square, Inner Belt/Brickbottom, Kendall/MIT, Medford Hillside, North Cambridge, North Medford, South Medford, Spring Hill, Union Square, West Medford/Medford Sq., and Winter Hill. Among the 179 TAZs that make up these 17 communities, 142 TAZs met one or more of the EJ thresholds described above. The results of the above analyses from the EJ areas near the study area were compared to those from the non-environmental justice areas.

3 http://www.massdot.state.ma.us/OfficeofCivilRights.aspx

4 http://www.fhwa.dot.gov/environment/environmental_justice/facts/ej-10-7.cfm

Performance Measures

Three categories of performance measures were adopted in the CTPS environmental justice analysis:

1. Analyses of accessibility to jobs and needed services, which focused on two measures:
    - The number of employment opportunities in three categories (basic, retail, and service), health care facilities (hospital beds), and higher education facilities, that can be reached within 20 minutes by car, or within 40 minutes by transit.
    - The average travel time to access the above employment opportunities, health care, and higher education institutions.
2. The mobility and congestion analysis compared the average door-to-door travel time for auto and transit trips travelling from and to the study areas between EJ and non-EJ TAZs.
3. The environmental impact analysis examined the volumes of emissions (CO and PM2.5) for roadway VMTs and roadway congested VMTs within the EJ area. Please note that the congested VMT is the average VMTs on the links under the congested condition (links with volume to capacity ratio greater than 0.75), as opposed to the standard VMTs.

Summary of Results

Environmental Impacts

In each build alternative, the EJ TAZs benefited from the reduction in vehicle-miles traveled, CO emissions, and fine particle matter pollution more than the non-EJ population zones.

Mobility

The average travel time (both highway and transit) from/to the TAZs in the study area was reduced in the Build alternatives. Although the travel from/to non-EJ TAZs decreased slightly more than the EJ TAZs, the difference was considered minimal. The absolute difference between percentage change of EJ and non-EJ communities was less than 0.6 %. These differences are statistically insignificant.

Accessibility

The accessibility analysis examined the number of jobs and services, health care facilities, and education institutions available within 20 minutes by car and within 40 minutes by transit, respectively from each neighborhood. It also summarizes the average travel time from EJ and non-EJ neighborhoods to these places.

The results indicated that in all Build alternatives, people will be able to access more jobs and services compared to the No Build condition. The travel time to jobs in the Build alternatives are slightly longer in most of the cases. The non-EJ TAZs will benefit slightly more than EJ TAZs, but again, the t-tests indicate they are statistically insignificant.

The number of available health facilities and education institutions and the average travel time to them remained very close in both the Build alternatives and the No Build conditions for both EJ and non-EJ populations.

Cost Analysis

Understanding the costs associated with different courses of action – both a Build alternative that changes the study area infrastructure and the No Build alternative that makes no new changes to the study area infrastructure – is essential to understanding the overall trade-offs involved in a study recommendation. These costs include not only near-term costs, but all costs incurred with a given course of action over a significant period of time.

Life cycle cost analysis considers all costs over the life of an asset – both capital and operating and maintenance (O&M) – to determine the overall lowest cost alternative. Capital costs are high-value projects incurred either to rehabilitate the transportation infrastructure or to change its configuration, while operating and maintenance costs are lower-value investments incurred to keep a transportation operating in good condition in its base configuration for use by the general public. The cost analysis approach employed here evaluates the costs of initial and future capital expenditures as well as continued maintenance to ensure that the capital investment remains useful to the public.

Order-of-magnitude, life cycle cost estimates were developed for each of the three Grounding McGrath study's Build alternatives, as well as the No Build alternative. It is important to note that each alternative has only been designed to a preliminary stage as part of this study. Estimating the true project cost of each constructed alternative at this stage of design is subject to uncertainty due to the possibility of unknown site conditions, changes in design as the project moves through the environmental permitting and final design process, and other unforeseen factors. To mitigate for this uncertainty in the final project cost, the cost estimates developed for each alternative as part of this analysis carry high "contingency" costs of 25 percent of the total project cost. The addition of "contingency" costs at this stage of project development is standard practice that follows both industry and FHWA recommendations.

As a general comparison, the capital costs for each of the three Build alternatives are higher than the No Build due to the initial costs involved in removing the structures and building the surface roadways. However, the overall life cycle costs of the Build alternatives are lower than the No Build due to the decreased costs of operating and maintaining an at-grade roadway versus elevated structures. Additionally, the estimates show that the life cycle costs associated with the three Build alternatives are very similar to one another. The primary comparison, therefore, is between the No Build alternative and any one of the three Build alternatives.

The costs shown below represent the costs of work that would be executed from the northerly abutment of the Squire's Bridge north along the McGrath corridor to the Lowell Line Bridge. The maintenance of the Squire's Bridge was not included in this analysis as the structure would be maintained in all four alternatives. The costs for work north of the Medford Street/Highland Avenue intersection are provided in the next section. All costs are in 2013 dollars, unless otherwise noted. The expected service life of the highway and structures is 75 years. Details of the cost estimates are provided in Appendix N.

Focus Area of Alternatives

Capital Costs

The capital costs shown in Table 5-5 reflect the initial major improvements being considered under each of the four alternatives. The costs for the McCarthy Viaduct repairs (MassDOT Project Number 605519) initiated in 2012 and the other interim improvements being conducted as part of that project through the MassDOT Accelerated Bridge Program are not included in this analysis because they are considered part of the existing conditions and they are being implemented, irrespective of the alternative selected.

It is assumed that these interim improvements are in place for approximately 10 years, at which time a long-term capital investment is made. The cost comparison of this long-term capital investment is between the No Build alternative, which would entail rehabilitation of the existing structures, and one of the Build alternatives, which would entail demolition of the existing structures and construction of a surface roadway. The capital costs for the No Build alternative include repairs to the substructure of the McCarthy Viaduct that would be needed for the structure to continue being used. For this estimation, it was assumed that those repairs will be conducted in the year 2026, at a cost of $23,250,000 (in 2013 dollars), or $38,713,000 in year of expenditure (2026) dollars.

The capital costs for the three Build alternatives include the cost to demolish the existing McCarthy Viaduct, and construct a new ramp structure between the Squire's Bridge and the Somerville Avenue/Poplar Street/Medford Street intersection with the McGrath corridor, in addition to the roadway improvements. It was assumed that the Build alternatives would be constructed in the year 2026. The capital costs for each alternative are shown in Table 5-5. Note that Table 5-5 shows capital costs expressed in two ways: in current 2013 dollars, and in year of expenditure 2026 dollars. The 2013 costs are what the infrastructure improvement project would cost if it were built today. However, the investment is not needed today; rather, it will be needed in 2026, at which point inflation will have increased costs. Consistent with FHWA guidance, a 4 percent inflation rate for project cost was assumed, which results in the 2026 year of expenditure costs shown in Table 5-5.

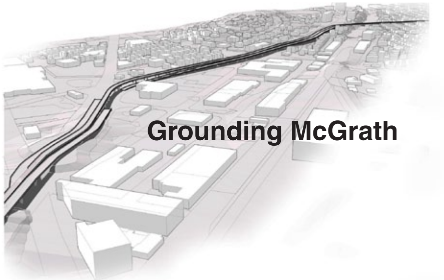


Table 5-5: Estimated Capital Costs (2013 and 2026 dollars)

Alternative	Present Day Capital Cost (2013 dollars)	Estimated Year of Expenditure Capital Cost (2026 dollars)
No Build	$23,250,000	$38,713,000
Boulevard	$41,132,800	$68,489,200
U-Turn	$41,797,100	$69,595,300
Access Road	$40,989.100	$68,249,900

Additionally, the following assumptions were made in estimating the capital costs for all four alternatives:

- The estimates do not include the cost of any right-of-way acquisition.
- Cost of adjusting utility structures to grade during pavement operations is included in the contingency.
- The cost for landscaping is based on estimates for loam and seeding, a very basic landscaping treatment. The cost will increase for additional landscaping, to be determined when an alternative advances to a conceptual design phase. These costs would likely be comparable for the three Build Alternatives.

Operating and Maintenance Costs

For the No Build alternative and the Build alternatives discussed in this report, operating and maintenance costs include roadway maintenance costs (pavement rehabilitation, pavement marking replacement) and basic structural upkeep costs (substructure and structural rehabilitation/repair, cleaning/painting structural steel). Table 5-6 provides a list of anticipated operating and maintenance costs and their anticipated year of expenditure.

The costs associated with the three Build alternatives are very similar to one another, not only for capital costs, but also for operating and maintenance costs. Therefore, the primary comparison is between the No Build alternative and the three Build alternatives. For the sake of a simpler comparison, the details of the operating and maintenance costs and corresponding 75 year life cycle costs of the Boulevard Alternative are compared to the No Build in the following tables and figures.

Pavement resurfacing includes costs of new pavement markings, pavement milling and overlay. In contrast, pavement rehabilitation is a more comprehensive improvement that includes full depth pavement reconstruction and sidewalk and curb replacement along the surface roads. The cost for pavement rehabilitation on a structure or ramp is included in the cost for deck replacement or deck overlay. Although the Boulevard Alternative is primarily at-grade, there will continue to be ramp structures to transition from the at-grade section to the Lowell Line and Squire's bridges that will require maintenance. A more detail breakdown of the operating and maintenance costs is shown in Appendix N.

Table 5-6: Operating and Maintenance Costs[5]

Year	No Build		Build	
	Actions	**Cost**	**Actions**	**Cost**
2026	Pavement Resurfacing	$1,419,375		
2046	Pavement Resurfacing, TranSystems Rehab – Option 3	$24,669,375	Pavement Resurfacing	$1,449,375
2051			Clean and Paint Structural Steel, Deck Overlay – Grind & Pave, Deck Joint Rehab/Repair	$3,352,050
2066	Pavement Resurfacing, Tunnel Repairs, Demolition of Structure, Bridge Replacement	$45,116,300	Pavement Resurfacing	$1,449,375
2076			Clean and Paint Structural Steel, Deck Overlay – Grind & Pave, Deck Joint Rehab/Repair, Substructure Rehab/ Repair, Structural Rehab/Repair, Bearing Rehab/Repair.	$9,163,300
2086	Pavement Rehabilitation, Tunnel Repairs, Clean and Paint Structural Steel, Deck Overlay – Grind & Pave, Deck Joint Rehab/Repair	$13,004,845	Pavement Rehabilitation	$3,735,625

Life Cycle Costs

The capital costs and operations and maintenance costs outlined above were then combined to determine the life cycle costs for each alternative. The analysis conducted for this study's alternatives shows that the life span costs of any of the three Build alternatives is lower than the No Build due to reduced costs of maintaining at-grade roadways compared to elevated structures.

Table 5-7: Total 75 Year Costs (in 2013 dollars)

Alternative	Capital Cost in 2013 dollars	O&M Cost in 2013 dollars	Total Cost Over 75 Years in 2013 dollars
No Build	$23,250,000	$84,209,900	$107,459,900
Boulevard	$41,132,800	$30,583,500	$71,716,300
U-turn/Rotary	$41,797,100	$30,387,900	$72,185,000
Linwood Access Road	$40,989,100	$30,583,500	$71,572,600

Figure 5-15 provides a summary of the when the major expenditures in Table 5-6 are expected to occur. Figure 5-16 shows the cumulative amount expected to be spent over the 75 year life of the alternative.

5 No Build Cost Estimate is based on TranSystems cost estimate for Option 3, plus 25 percent contingency, and is included in Appendix N

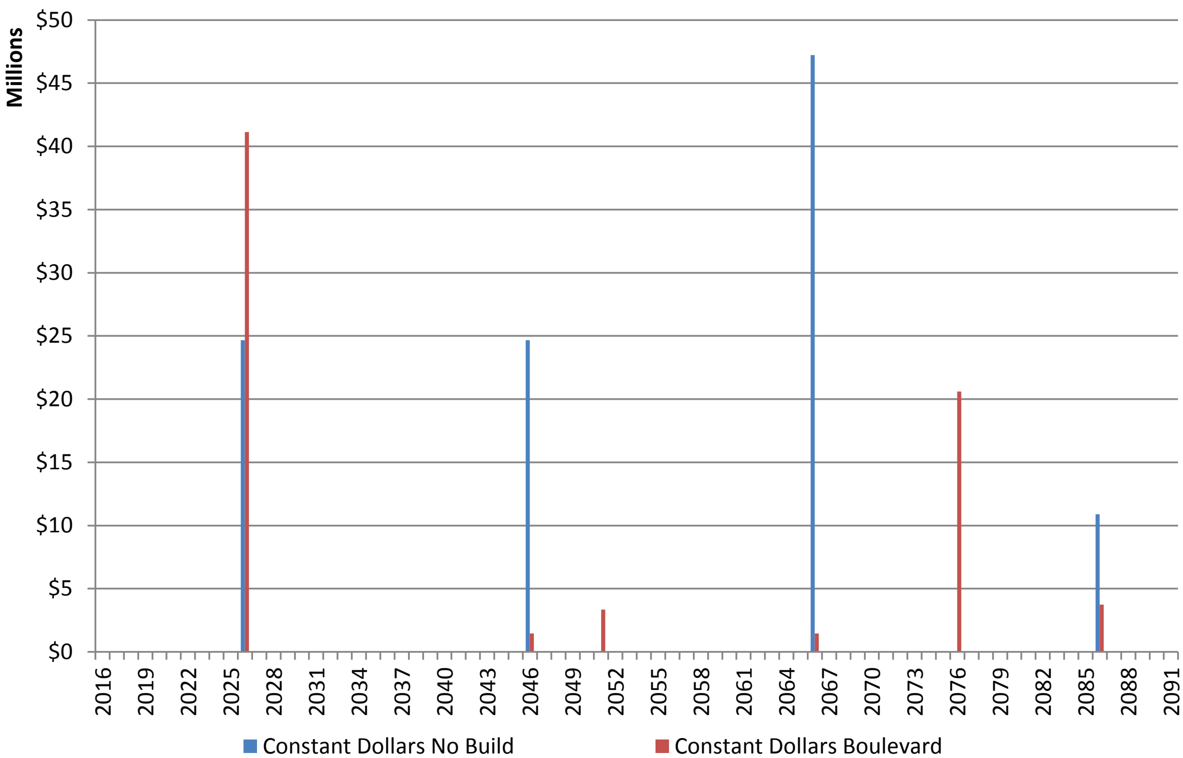


Figure 5-15: 75 Year Capital, Operating, and Maintenance Expenditures (in 2013 dollars)

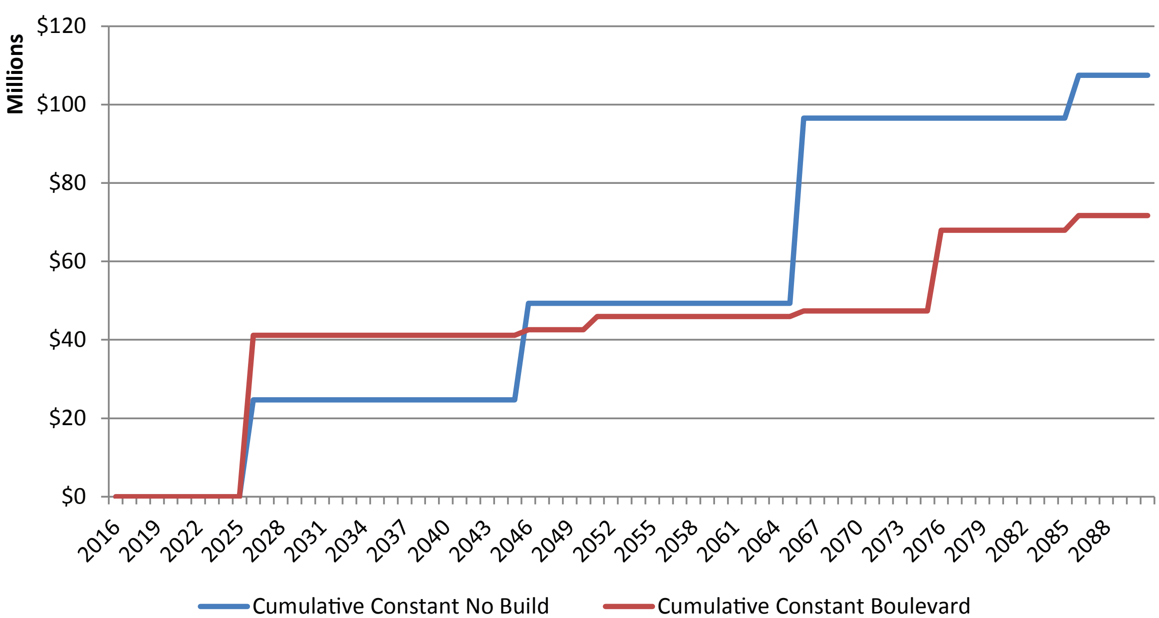


Figure 5-16: Cumulative Cost of the Alternatives over 75 Years

North of Lowell Line Bridge

The project team also prepared a cost estimate for two alternatives for highway work north of the Lowell Line Bridge (see Chapter 4). The first alternative provides a bicycle lane with parking. The project team estimated the cost of the first alternative at approximately $545,100. The second alternative included a cycle track north of the Lowell Line Bridge. The project team estimated the cost of the second alternative at approximately $1,441,600. These estimates are in 2013 dollars and do not include the cost of design.

Summary of Findings

Evaluation Matrix

The Evaluation Matrix in Table 5-1 was prepared as a tool for the Grounding McGrath study and the community to compare the developed alternatives and the No Build conditions. The Evaluation Matrix does not establish any preference or weighting of the importance of one objective to another. These preferences are part of the community and Working Group discussions.

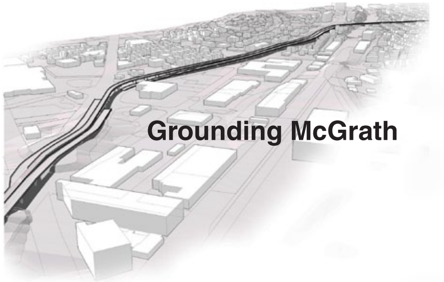
The Evaluation Matrix ranks each of the proposed alternatives based on the categories outlined under each goal. All of the proposed scenarios -- Boulevard, Access Road, Hybrid U-turn/ Rotary and Boulevard & Inner Belt Road, and the 2035 No Build -- were quantitatively scored based on their ability to meet each of the set criteria. Using these values, a qualitative type analysis was executed to compare each of the scenarios with a 2035 No Build scenario. The qualitative analysis provided a visual communication of the quantitative data garnered by each ranking and demonstrates the degree to which each scenario would be more or less beneficial compared to projected 2035 McGrath corridor No Build conditions.

The analysis showed that all grounded alternatives provide benefits based on the criteria evaluated. There are key differences between the alternatives, primarily related to traffic patterns and connections enabled by each alternative. For example, the Boulevard Alternative provides the most direct connections, but prohibits left-turns from the McGrath corridor to Washington Street. The Linwood Access Road Alternative provides some of the best traffic operations of the three alternatives analyzed, but at the expense of longer blocks and fewer direct connections.

As a result of the analysis, the study provides several broad conclusions:

- Build alternatives show an improvement over the No Build scenario.
- Build alternatives have similarities in achieving the project's goals.
- Build alternatives have challenges and traffic implications.
- Build alternatives improve community character and provide environmental, public health and Environmental Justice benefits.
- Build alternatives provide new real estate development opportunities.
- Build alternatives have lower 75-year life-cycle costs for the focus area than the No Build alternative.

Lastly, for each of the alternatives, the Grounding McGrath study identified traffic, operational, and other potential issues that have not been resolved. For example, a lack of sufficient traffic dispersion to other streets in the network, and the resulting capacity issues at several intersections are critical to understanding the overall context of each alternative as they are reviewed and advanced for further study.



MassDOT District 4 Short-Term Improvements

As a result of stakeholder involvement in the Grounding McGrath study, MassDOT District 4 began working with the City of Somerville and other stakeholders to make some short-term multimodal access and circulation changes through the existing construction contract for repairs to the McCarthy Viaduct. The proposed improvements were developed as a result of positive feedback on some of the potential alternatives identified through Grounding McGrath, such as improved connections between Somerville Avenue and the McGrath corridor. The alternatives were developed and analyzed separately from this study, and are summarized below for informational purposes.

The proposed short-term improvements include the closure of the southbound ramp north of the intersection of Somerville Avenue/Medford Street. This will require southbound vehicles destined to Somerville Avenue to exit McGrath at Washington Street and require an increase in green signal time for the McGrath off-ramp approach to Washington Street. In order to handle the vehicular demand between Washington Street and Somerville Avenue, it may be necessary to create two travel lanes along Medford Street, which would necessitate the elimination of some parking. There would also be additional geometric and signal equipment modifications.

A second aspect of this work is a proposed "punch-through" under the McCarthy Viaduct to allow direct access to the McGrath corridor (northbound) from Somerville Avenue/Medford Street. This proposal eliminates the need for the traffic from Somerville Avenue/Medford Street destined to McGrath northbound to use the tunnel under the McCarthy Viaduct to access the northbound ramps at Washington Street The punch through allows for traffic eastbound from Somerville Avenue, and northbound from Medford Street, to cross under the viaduct at Somerville Avenue and connect with the northbound McGrath traffic at-grade. It creates an opportunity for enhanced pedestrian and bicycle connections and accommodations, and the ability to upgrade signal operations. It is also expected to reduce congestion at Washington Street.

MassDOT District 4's short-term improvements for pedestrian crossings and circulation changes associated with the McCarthy Viaduct interim repairs provide an opportunity to assess new connections. The result of these potential changes can and should be incorporated in the project development for the future of the McGrath corridor.

Health Impact Assessment

The Commonwealth's Health Impact Assessment (HIA), led by the Department of Public Health (DPH), evaluated air quality, noise, safety, mobility, land use, pedestrian and bicycle friendliness of the alternatives. Factors such as projected housing and employment growth, economic development, mode shift as a result of the GLX, were incorporated in the assessment. Health factors such as asthma, hospitalization, obesity, diabetes, injury and fatality data were also considered.

The Department of Public Health's (DPH) Health Impact Assessment (HIA) of the Massachusetts Department of Transportation (MassDOT) Grounding McGrath Study, April 2013, (HIA report) supports an at-grade alternative for McGrath and provides the following conclusions:

- All Build alternatives (for the forecast year 2035), including the No Build, result in significant reductions in traffic-related air pollution largely attributed to advancements in vehicle emission standards and technologies.
- Future assessment of health impacts and benefits of proposed Build alternatives should be conducted once more robust project-specific information and transportation data become available.
- De-elevation of the highway structure is anticipated to result in an increase in ground-level exposure to traffic-related air pollutant emissions.
- Mitigation measures (locating sidewalks and bike paths further away from the roadway, installing barriers, planting trees) should be explored where possible to reduce exposure to traffic related air pollutants.

Feedback from the Working Group

Through the study's public outreach process - specifically Working Group meetings held February 13, 2013 and April 25, 2013 - preference for the criteria related to livability, multimodal transportation, connectivity, community development, and placemaking were expressed, and were also given priority by Working Group members in evaluating their preference for a long-term alternative. The Working Group expressed support for MassDOT to recommend a Boulevard Alternative at a public meeting. Some members of the Working Group expressed interest in pursuing a narrower Boulevard Alternative in subsequent stages, particularly once there is new traffic data from the potential District 4 short-term improvements described above.