

Memorandum



To: Mark Dorn

CC:

From: Mike Tresidder and Kim Voros

Date: February 5, 2010

Re: First Hill Streetcar - Preliminary Alternatives Analysis

INTRODUCTION

The First Hill Streetcar will provide additional fixed-rail transit capacity for the residents and visitors to Capitol Hill, First Hill, the International District and Pioneer Square. A key value of Seattle's Department of Transportation is to create transportation system that provides real alternatives to driving. To help maintain the overall quality Seattle's transportation network, each candidate roadway segment being considered to be part of the proposed alignment for the First Hill Streetcar will be screened to determine how it performs from a motor vehicle, transit, bicycle and pedestrian perspective.

This memorandum provides an overview of the alignment options, a preliminary evaluation of the effect streetcar tracks may have on current cycling conditions and identifies those alignment options that will optimize streetcar/bicycle compatibility. Figure 1 shows roadways under consideration as potential segments of the First Hill Streetcar system.

The three most commonly cited challenges cyclists experience when traveling on roadways with streetcar tracks are:

- Right-running tracks in the bicycle travelway;
- Flange gap and angle of crossing at intersections; and
- Streetcar platforms (curb extensions) located in bicycle travelway

Along with these factors, additional factors taken into consideration in this analysis include:

- Presence of transit routes on the roadway;
- Motor vehicle/bicycle interaction;
- Steep/challenging topography; and
- Proximity to destinations

The first set of factors are directly related to the impacts of streetcar tracks on the bicycling environment while the second set of factors relate to the existing quality of the cycling environment on any given roadway. Understanding how the existing cycling environment is affected by streetcar tracks will help the Project Team understand how much comfort or discomfort a cyclist might feel when using these roadways.

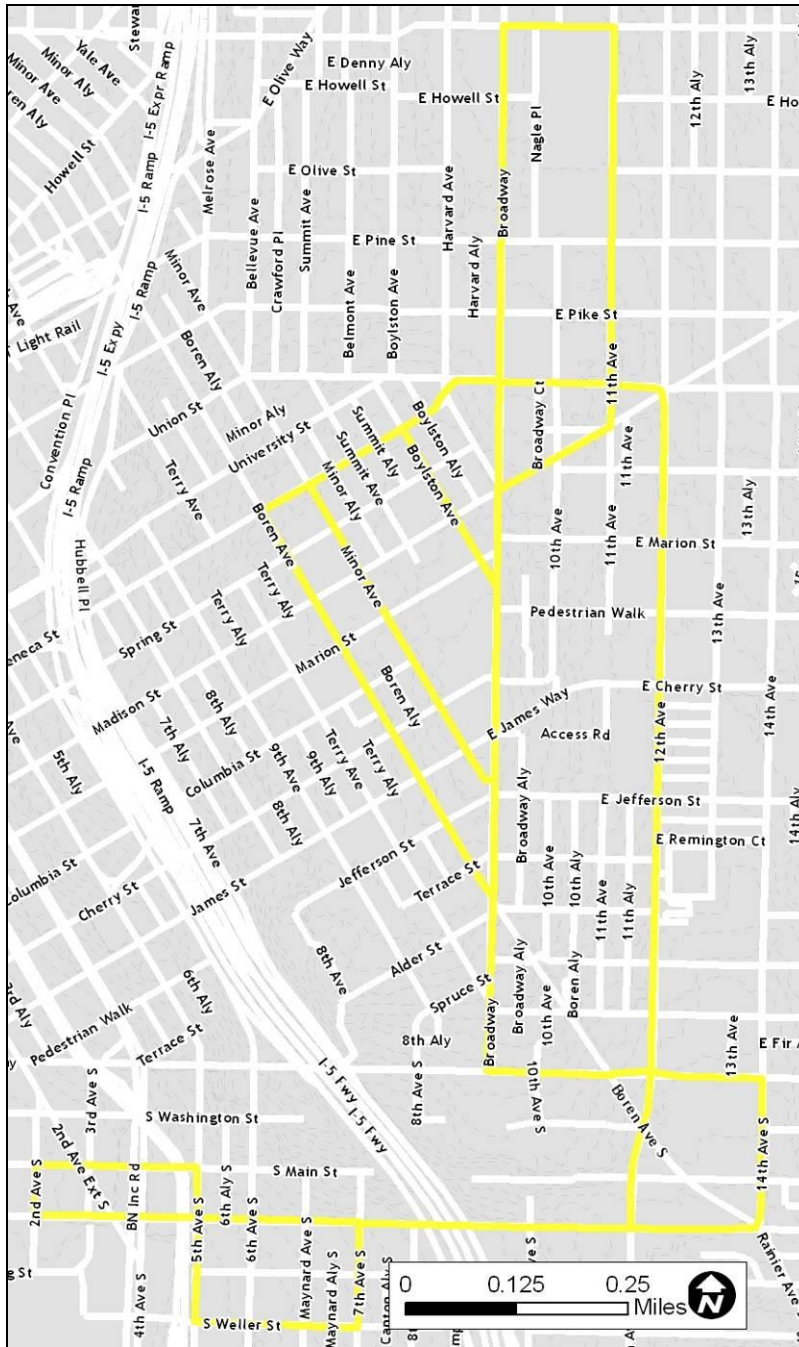


Figure 1. Potential Streetcar Alignments

The following roads were analyzed as part of this analysis:

- E Denny Way
- Broadway
- 11th Avenue
- 12th Avenue
- E Union Street
- Seneca Street
- Boylston Avenue
- Minor Avenue
- Boren Avenue
- E Madison Street
- E Yesler Way
- 14th Avenue S
- S Jackson Street
- 7th Avenue S
- Weller Street S
- 5th Avenue S
- S Main Street
- S 2nd Avenue

Table 1 defines the criteria utilized in this analysis while Table 2 shows the results of the analysis for each roadway. In cases where a roadway has multiple section options (e.g., one-way vs. two-way tracks) the roadway was analyzed separately under each set of conditions. Roadways were considered independently of their inclusion in any specific alignment alternative. For example, Broadway was analyzed as a discreet entity though it is utilized in several alignment alternatives. The results of this analysis are discussed in more detail in the narrative portion of this memorandum.

Table 1. Analysis Criteria and Definitions

	Ranking	Explanation
Presence of transit routes on the roadway	●	One or no transit routes use the roadway.
	◐	Two or three transit routes use the roadway.
	○	Four or more transit routes use the roadway.
Presence of on-street parking	●	There is no parking along the entire roadway.
	◐	Parking exists only along part of the corridor or one side of the roadway.
	○	Parking exists along the entire alignment.
Motor vehicle/ bicycle interaction	●	Bike lanes are available in both travel directions.
	◐	Bike lanes are available in one travel direction ¹ .
	○	Motor vehicles and cyclists must use the same lane in both travel directions.
Left turn conflicts	●	A cyclist never has to cross more than one set of tracks when turning left, all turns are at right angles.
	◐	A cyclist has to cross more than two sets of tracks at least once in the corridor; at least one turn has potential irregular intersection geometry.
	○	More than one intersection requires crossing two sets of tracks; multiple intersections have irregular geometry, or other potential challenges are present.

¹ Assuming a two-way street.

Steep/ challenging topography	●	The roadway is nearly flat and presents little topographic challenge.
	◐	The roadway has a moderate grade but most cyclists would use this route rather than seeking an alternative.
	○	The roadway is too steep for regular use by most cyclists.
Proximity to destinations	●	There are numerous cyclist destinations and attractors (e.g., commercial locations, businesses and schools) along this roadway.
	◐	There are some cycling destinations along this roadway; a moderate number of cyclists would access destinations along this route.
	○	There are few cycling destinations along this roadway; development is primarily auto oriented commercial, or residential. Cyclists are more likely to pass through rather than stop here.
Angle of track crossing at intersections	●	Intersection geometry is regular and tracks are center running, minimizing turning conflicts
	◐	The intersection geometry throughout the corridor is generally regular, but some turns are potentially challenging.
	○	The intersection geometry in this corridor is irregular, creating potentially significant conflicts. Other significant hazards may be present.
Platform/ cyclist conflicts	●	There is no station present, the station is in the roadway center, or the tracks are left running on a one-way street and platform is curbtight.
	◐	A station location has not been determined.
	○	Station is curbtight and sits in the bicycle travelway.
Bicycle/ streetcar interaction	●	The streetcar and cyclists travel in separate lanes
	◐	Cyclist and streetcar travel occurs in separate lanes but bike facilities are next to on-street parking. This configuration creates a potential hazard for a cyclist maneuvering into the vehicle travel lane to avoid an open car door. If this maneuver happens suddenly, the unwary cyclist may be at an increased risk of misjudging the placement of the streetcar track groove and catch their wheel.
	○	Cyclists must share a lane with streetcar tracks, on-street parking may be present.
Posted speed limit	●	The posted speed limit is less than 25 miles per hour.
	◐	The posted speed limit is 30 miles per hour.
	○	The posted speed limit is 35 miles per hour or greater.

A system of “●”, “◐”, and “○” was used to rate each alignment. A “●” indicates favorable conditions, a “◐” indicates moderate or neutral impact, and a “○” indicates the least favorable conditions. In cases of “○” or “◐” additional engineering and design may be necessary to confirm cyclist’s needs are met. A brief written discussion of the benefits and constraints of each roadway follows. Roadway analyses that are highlighted in gray denote an alignment that performs better for bicycles when more than one option is available (e.g., single track vs. double track).

Table 2. Summary of Alternatives Analysis Evaluation

Roadway	Posted speed limit	Roadway grade	Proximity to destinations	Presence of transit routes on the roadway	Presence of on-street parking	Motor vehicle/ bicycle interaction	Left turn conflicts	Angle of track crossing at intersections	Cyclist/ platform conflicts	Bicycle/ streetcar interaction
Denny Way (Single track)	○	●	●	●	◐	○	●	●	●	◐
Denny Way (with track terminus)	○	●	●	●	◐	○	◐	◐	○	◐
Broadway (Single track)	○	◐	●	◐	○	◐	◐	◐	●	◐
Broadway (Double track preferred section)	○	◐	●	◐	◐	○	◐	◐	◐	◐
Broadway (Double track alternative section)	○	◐	●	◐	◐	●	○	◐	●	●
11th Avenue	●	●	◐	●	◐	◐	●	●	◐	○
Madison Street	○	◐	●	◐	●	○	◐	◐	●	●

Roadway	Posted speed limit	Roadway grade	Proximity to destinations	Presence of transit routes on the roadway	Presence of on-street parking	Motor vehicle/ bicycle interaction	Left turn conflicts	Angle of track crossing at intersections	Cyclist/ platform conflicts	Bicycle/ streetcar interaction
12th Avenue (Yesler Way to Union Street)	○	◐	◐	●	○	◐	◐	●	○	◐
Union Street	●	●	○	●	○	○	◐	○	●	~
Seneca Street	●	◐	◐	●	◐	●	●	●	●	⊕
Boylston Avenue	○	◐	◐	●	●	●	◐	◐	○	~
Minor Avenue	●	◐	◐	●	○	○	○	○	○	~
Boren Avenue	○	○	◐	○	●	○	○	◐	○	~
Yesler Way	○	◐	○	●	◐	●	◐	◐	●	⊕
12th Avenue (Jackson Street to Yesler Way)	○	◐	◐	●	●	◐	○	○	○	◐
14th Avenue	●	◐	○	◐	○	●	●	●	●	◐
Jackson Street	●	◐	○	●	◐	○	◐	◐	●	◐
7th Avenue	●	◐	◐	●	◐	◐	◐	◐	●	●
Weller Street	●	◐	◐	●	○	●	●	●	●	○
5th Avenue	○	◐	●	○	●	○	●	◐	○	●

Roadway	Posted speed limit	Roadway grade	Proximity to destinations	Presence of transit routes on the roadway	Presence of on-street parking	Motor vehicle/ bicycle interaction	Left turn conflicts	Angle of track crossing at intersections	Cyclist/ platform conflicts	Bicycle/ streetcar interaction
Main Street	●	◐	◐	○	●	○	◐	◐	●	◐
2nd Avenue	●	●	●	●	●	○	●	●	●	◐

Roadway Alternatives Analysis

This section provides additional commentary on the affect that streetcar tracks will have on the cycling environment. This narrative calls out noteworthy constraints but does not necessary address constraints common to all corridors (e.g., there is a potential for a cyclist to catch there wheel in the track groove at every intersection where a left-turn is possible). Even if a specific constraint is not called out there could still be additional conflicts that should be addressed during further phases of design and analysis. Future phases of the alternative refinement will address constraints on the selected corridors in greater detail.

Denny Way

Pros: Denny Way between Broadway and 11th Avenue is not an arterial street and servers primarily to provide local access and as a point of access to Cal Anderson Park.

Mixed impact/Neutral: If any of the loop options are implemented, Denny Way will have one-way streetcar service; the double track streetcar on Broadway would create an additional tail-track terminus on Denny Way. Either option would require Denny Way to be converted to a one-way operation and create a separate auto lane and potential bike lane.

Cons: Either option will modify this portion of Denny Way from a two-way to one-way street. This may somewhat affect the access to/from the light rail station.

Summary: Either track alignment option will require cyclists to change their travel route through this area, Installation of streetcar tracks in this area should be accompanied by improved wayfinding signage and pavement markings as necessary to help cyclists move through this area.

Broadway Double Track

Pros: As Broadway is as a primary commercial corridor, maintaining optimal access and safety for users of all modes is a key consideration. The double track alignment maximizes user access rather than roadway capacity. The needs of through traffic should not be disregarded, but could potentially be accommodated on a parallel roadway. An alternate three-lane section proposed by URS would install bike lanes and remove parking on one side of the corridor, creating excellent travel conditions for bicyclists.

Mixed impact/Neutral: There is a trade-off between the benefit provided by center running tracks and potential left turn conflicts mitigated by this proposed section. When faced with irregular intersection geometry, the center running configuration (4-lane section) ensures that the cyclist will cross at an angle close to perpendicular. In the alternative (3-lane) section, the cyclist has a fairly narrow travel channel and faces a greater risk of catching the bicycle tire in the track groove.

Cons: The biggest potential obstacles to bicycle travel with the “4-lane” lane section on Broadway are the combination of shared motor vehicle/bike lanes next to parking, irregular intersection geometry throughout the corridor and potential changes in roadway configuration at stations stops throughout the corridor. Additional study and development of design treatments at station locations is necessary if the preferred design is selected for implementation.

Summary: While the “4-lane” section reduces the potential of conflicts for cyclists turning left, the “3-lane” section performs better for cyclists overall as it allows for greater separation between bikes and motor vehicles, which increases the comfort of bicycle travel and simplifies the roadway configuration at platforms for all users. Additional study and development of design treatments at station locations will be studied during the next phase of design.

Broadway Single Track

Pros: The single track streetcar section identified by URS on Broadway reduces the conflicts for cyclists traveling southbound.

Cons: Cyclists traveling northbound will still experience the challenges of turning left at intersections with irregular geometry.

Summary: This option minimizes station conflicts and provides a marked bike lane but still requires cyclists to travel between parked cars and a travel lane with streetcar tracks and places them at an increased risk of catching their wheel in the track groove if they have to maneuver to avoid an open car door.

11th Avenue

Pros: The lack of transit routes on 11th Avenue reduces the potential bicycle/motor vehicle/streetcar conflicts.

Mixed impact/Neutral: Depending on the alignment alternatives selected, a streetcar on 11th Avenue will likely need to convert 11th Avenue to a one-way street either northbound or southbound. The most significant impact will be to cyclists traveling in the opposite direction who will need to divert to a parallel street or pathway. The cyclists traveling in the same direction as the streetcar will need to have a dedicated bike lane between the streetcar and parked cars. There will be an increased risk for the potential of a cyclist catching a tire in the track groove and falling if a cyclist must swerve to avoid an open car door. Even if parking is not present, cyclists traveling between the streetcar and the curb have a narrower travel channel and must also cross the streetcar tracks to change lanes or make a left turn.

Cons: The conflicts with bicycle and streetcar travel on 11th Avenue include shared northbound or southbound bicycle/streetcar/ motor vehicle travel lane. The cyclists traveling in the direction opposite the streetcar must divert to either Broadway or 12th Avenue.

Summary: If the 11th Avenue couplet alignment is selected, the City will need to finalize the design section for the street to accommodate bicycles (bike lane), streetcar/motor vehicle travel lane and the on-street parking.

Madison Street

Pros: There are two travel lanes in each direction and the northbound streetcar would utilize the left, eastbound lanes, which reduces the potential conflict created by the shared cyclists and motor vehicles sharing the outside travel lanes.

Cons: The key design challenge will be accommodating cyclist through the irregular intersection at 11th Avenue.

Summary: Madison Street does not present significant challenges for cyclists. The street performs adequately, even with the installation of streetcar tracks.

12th Avenue (Yesler Way to Union Street)

Pros: Twelfth Avenue acts as a key north/south bicycle route and provides connectivity to neighborhoods in south Seattle and neighborhoods further north, such as Eastlake and the University District.

Mixed impact/Neutral: The streetcar tracks would have moderate impacts on this street. Intersection geometry is regular, so the difficulty of left hand turns would be minimized.

Cons: There are no other comparable bicycle connections through this portion of the City.

The existing bike-lanes are already of a sub-standard width and therefore, decreasing the comfort and accessibility of this route could degrade the cycling experience for existing and potential riders in many parts of the city and disrupt the flow of riders along this corridor.

Summary: Installation of streetcar tracks on 12th Avenue could significantly degrade the current cycling environment on this roadway.

Union Street

Pros: As Union Street is designated as a shared street for bicycles and motor vehicles, care should be taken to avoid degradation of the cycling experience on this roadway. The proposed section would add provide tracks in the existing auto lane (potentially eastbound or westbound).

Cons: The key challenge for cyclists on Union Street would be created by the intersection geometry at Broadway and Union Street, which is already tight and will likely impact the angle of streetcar tracks through the intersection. One potential mitigation measure could include pavement markings to help guide cyclists safely through this intersection.

Summary: Union Street is part of the existing bikeway system, but the streetcar would only utilize the roadway for a short distance. If this roadway is used, safe bicycle accommodation on this road should be a high priority. The design of the street section will be finalized in the next phase of design to accommodate bike lanes, streetcar/auto lane and maintain on-street parking.

Seneca Street

Pros: Seneca's slow speed limit and moderate grade make it a good street for cyclists. Cyclists traveling downhill are not exposed to the potential "dooring" conflict created by on-street parking. The *Seattle Bicycle Master Plan* does propose Seneca Street as a corridor for further study but bike lanes proposed in this process would create a higher quality cycling environment than the installation of shared lane marking.

Mixed impact/Neutral: Some of the potential concerns of installing streetcar tracks on the narrower segment of Seneca Street would be mitigated by the formalization of striped bike lanes.

Summary: Seneca performs fairly well for cyclists, even with the installation of streetcar tracks.

Minor Avenue

Cons: The proposed section would create a single northbound travel lane with parking at some locations along the corridor. The proximity of the shared lane to parking would give cyclists the option to travel either between the streetcar rails or in the narrow space between rails and parked cars/sidewalk. This configuration creates potential hazards for "dooring" and falling in grooves created by the track along the entire corridor. It is likely that cyclists using this route would be slowed by this additional navigational hazard, which could in turn affect motor vehicle traffic and emergency vehicles accessing the hospitals. For these reasons, it is likely that installing tracks on Minor Ave may require the conversion of the street to one-way operations for all traffic.

Summary: Installation of streetcar tracks on Minor Avenue will create significant degradation of the cycling environment. As this roadway is relatively quiet and comfortable in relation to neighboring Boren Avenue its modification could significantly impact the accessibility of this area for cyclists.

Boren Avenue

Cons: The proposed section would install tracks on the “right” southbound travel due to the width of the existing street and its travel lanes. Any southbound cyclist would need to travel between the streetcar rails or in the narrow space between rails and sidewalk. It is likely that cyclists using this route would be slowed by this additional navigational hazard. As the posted speed on this roadway is 35 miles per hour, additional slowing of cyclists could have a noticeable impact on the entire roadway system.

Summary: Installation of streetcar tracks on Boren Avenue will significantly degrade the potential for use by southbound cyclists.

Boylston Avenue

Mixed impact/Neutral: The relatively narrow sidewalk width and high pedestrian volume in this area precludes accommodating cyclists on shared bicycle/pedestrian facilities. Cyclists would be accommodated on shared roadway facilities. The potential conflict created by shared lanes is mitigated in part by the slow travel speeds through this area.

Cons: Conflicts at station locations and the irregular intersection geometry at Harvard Avenue and Seneca Street would require additional design consideration to minimize conflicts created by the turns in the track.

Summary: Installation of streetcar tracks would create significant challenges for cyclists traveling in both directions due primarily to the shared streetcar/bicycle/motor vehicle travel lane. If this alignment is selected, the project should incorporate bike lanes or the city should develop alternative parallel on-street or off-street cycling facilities.

Yesler Way

Pros: Yesler Way would accommodate cyclists comfortably by providing wide travel lanes and center running streetcar platforms.

Mixed impact/Neutral: Parking along the eastbound side of the street creates a potential conflict for cyclists maneuvering into the travel lane to avoid an open car door. The width of the travel lanes does help to mitigate this impact.

Cons: There is a potential left turn conflict at Boren Avenue. Cyclists traveling downhill on Boren Avenue and turning onto Yesler Way will be forced to make a sharp left turn into the bike lane to avoid crossing into the existing tracks.

Summary: Yesler Way performs adequately for cyclists, though potential conflicts exist and should be addressed as the project moves forward.

14th Avenue

Pros: The 14th Avenue alignment would accommodate cyclists comfortably by providing them with separated bike lanes. The lack of stations in this segment also helps to minimize cyclist/streetcar conflicts.

Cons: One area of potential concern is the intersection of Rainer Avenue and Jackson Street. It may be beneficial to mark the cyclist’s preferred travel path through this intersection with dashed lines or green markings to minimize potential hazards.

Summary: Overall, if streetcar tracks are installed on 14th Avenue, it still performs adequately for cyclists.

12th Avenue (Jackson Street to Yesler Way)

Cons: The southbound track would need to be located in the right lane which creates a direct conflict with cyclists. The northbound track would be in the left lane which would not cause cyclists to have to share a travel lane with the streetcar but, tracks along this segment of roadway would add an additional layer of complexity to the already challenging travel conditions that include:

- Irregular intersection geometry at Boren Avenue
- Slip lane on 12th Avenue at Boren Avenue
- Double left turn lane on 12th Avenue Avenue
- Significant grade along intersection approaches that could impact travel speed and sight lines

As 12th Avenue is heavily utilized by cyclists and no other comparable routes are available in this area the potential impact on cyclists is increased.

Summary: Installation of streetcar tracks on 12th Avenue would significantly compromise a cyclists' ability to navigate this portion of the corridor, which could result in decreased cycling traffic and increased motor vehicle and cyclist conflicts.

Jackson Street

Pro: The reconfiguration of Jackson Street presents the City with an opportunity to implement bicycle facilities recommended in the *Seattle Bicycle Master Plan*.

Mixed impact/Neutral: The center running streetcar tracks on Jackson Street minimize bicycle / streetcar conflicts along the roadway. Cyclists attempting to turn left must still contend with streetcar tracks as they would anywhere else along the proposed alignment. Jackson Street is classified as a freight route and the *Seattle Bicycle Master Plan* recommends that all freight routes in hilly locations call for an uphill bike lane and downhill shared lane markings.

Summary: If the City decides to implement components of the Seattle Bicycle Master Plan concurrent with the First Hill Streetcar Project, additional study and development of design treatments will be studied during the next phase of design.

7th Avenue

Pros: Conversion of 7th Avenue to a one-way northbound street would allow cyclists to maximize their distance from the streetcar.

Cons: This one-way alignment would create track crossing conflicts for cyclists turning left onto Jackson Street and potentially with right-turning cyclist

Summary: 7th Avenue performs adequately with streetcar tracks, but some significant design challenges are present. If this alignment is chosen it may be necessary to remove a portion of the curb extension at Jackson Street to accommodate right-turning cyclists.

Weller Street

Pros: Though the proposed section on Weller Street would accommodate cyclists and the streetcar in a shared lane, the width does provide the cyclist with some room between parked cars and the tracks. The slow posted speed, 25 miles per hour, reduces the severity of potential conflict. There are no platforms along this roadway to create conflicts.

Cons: The shared lane does increase the chance that an unwary cyclist will try to take the lane and catch their tire in the track groove.

Summary: The roadway performs adequately if streetcar tracks are installed.

5th Avenue S

Mixed impact/Neutral: The International District's light rail stop is located along this roadway corridor. The streetcar stop proposed on 5th Avenue S would provide good transit connectivity but would increase the difficulty of bicycle travel along this street.

Cons: The challenges presented to cyclists in this alignment stem from right running tracks, shared bicycle/streetcar travel lanes and heavy transit use. Tracks transition from the left lane to the curbside lane, requiring cyclists to share the lane with the streetcar tracks. The curb-tight station between King Street and Weller Street would create additional complications for cyclists using this roadway.

Summary: Installation of streetcar tracks on 5th Avenue S could create a significant barrier for cyclists seeking to access King Street. This could constrain network connectivity if bike lanes are not provided on Jackson Street and King Street is designated as the preferred bicycle corridor.

Main Street

Mixed impact/Neutral: Despite heavy transit utilization, Main Street can accommodate cyclists adequately in a shared auto/ bicycle travel lane. The posted speed limit, 25 miles per hour, is likely comfortable for the type of cyclist that would use this roadway.

Summary: Streetcar operations on Main Street would mimic those of the Waterfront Trolley and not change any of the existing uses of the street that exist today.

2nd Avenue South

Pros: Cyclists traveling along Second Avenue South will be minimally impacted by the installation of northbound streetcar tracks; the roadway is flat and relatively wide, which helps to reduce the severity of potential conflicts.

Mixed impact/Neutral: Installation of streetcar tracks could affect motor vehicle traffic for attendees of events at the sports stadiums. Additional congestion on Second Avenue South during these times could create additional conflicts for cyclists.

Cons: The geometry of the turn from Jackson Street to Second Avenue South may be impacted by an already existing water main, which would ultimately create a greater turning radius and impact cyclists making turns at this intersection.

Summary: Installation of facilities on this roadway would likely have little impact on bicycle traffic in this area.

Key Findings

Based on the bicycle benefits and constraints analysis, Alta finds that

- The Two-Way Broadway and Pioneer Square loop alignments maximize cyclist comfort and maintain bicycle system quality.
- Streetcar tracks along 5th Avenue south of Jackson create challenges for cyclists accessing King Street.
- The Minor/Boren couplet has the highest potential to negatively impact cycling conditions. These impacts occur primarily through the installation of tracks on roadways that already present significant challenges to a cyclist (e.g., roadway speed, and number of potential vehicle conflicts).
- The Broadway/Boylston alignment could provide good connectivity while minimally impacting the cycling environment. There are some design challenges created by tight

intersection geometry and irregular left turns. Alternate cycling routes may be necessary through this area.

- Installing streetcar tracks on any portion of 12th Avenue will result in degradation of a key north/south cycling corridor.
- Jackson Street presents significant challenges for adequately accommodating all transportation modes. The City should consider designating King Street as the preferred bicycle travel corridor, optimize the street for bicycle travel and provide enhanced wayfinding signage to direct people to the facility.
- Many intersections on the proposed study corridor present potential hazards for cyclists turning left due in part the juxtaposition of offset roadway grids. As the track alignment is further refined, bicycle friendly design solutions specific to each intersection will be finalized.
- The several potential alignments in the northern (Broadway) portion of the corridor include loop options along 11th and 12th Avenues that would create either clockwise or counterclockwise streetcar service. Either option will need to carefully be designed to include bike lanes and minimize the loss of parking where possible.