

MEMORANDUM

To: Giovanni Zinn, City of New Haven
From: Jeremy Chrzan, PE, PTOE, LEED AP, Multimodal Design Practice Lead
Date: May 16, 2022

RE: State Street Redevelopment Concept Plan Review

The purpose of this memorandum is to summarize our peer review of the current concept plans for State Street in New Haven, CT. The review was performed based on published design guidance from NACTO and other state agencies, published research, and the reviewer's personal experiences of design best practices for separated bike lanes. No site visit was performed as part of this review, though a desktop review of the location was performed using Google streetview.

State Street Redevelopment Project Review

The City of New Haven is pursuing a project that will meet multiple goals related to transportation, sustainability, housing, and economic development. The City's Vision 2025 document articulates the City's goals for transportation, which were used to guide the review of this project:

The primary transportation goal is to encourage a modal shift in the city, from a population largely dependent on single-occupant vehicles to a population with a wide range of options including public transit, bike, and pedestrian systems. In general, transit and bike/pedestrian improvements must complement each other and accommodate the needs of people of all ages and abilities.

The concept plans provided for review are envisioned to transform an automobile-oriented corridor to a multimodal street with high quality walking and biking infrastructure, more efficient and convenient transit operations, and a focus on safety for all users. To meet the goals cited above, this review specifically reviewed the design principles of safety, comfort, and connectivity.

Safety

Separated bike lanes are designed to separate bicyclists from motor vehicle traffic and from pedestrians to improve safety for each of these roadway users. In addition to the physical separation of users, the minimization of conflict areas (e.g. the number of conflicts) is an important consideration for improving safety for bicyclists.

This review looked at the currently proposed two-way separated bike lanes to assess whether a one-way configuration would be safer. Although research indicates that one-way separated bike lanes have a lower crash risk than two-way facilities, the number of conflicts and frequency of vehicle movements at those conflict areas must be considered.

The two-way portion of the project extends along the East side of State Street from George Street/Fair Street to Grove Street/Olive Street. Table 1 below compares the number of conflict areas that exist on each side of the street through this portion of the corridor:

Table 1: Comparison of Potential Conflict Areas along State Street

West Side			East Side		
Conflict Name	Type	# conflict areas	Conflict Name	Type	# conflict areas
Crown St.	Uncontrolled	2			
270 State St. Parking Garage	Uncontrolled	2			
300 State St. Parking Lot	Uncontrolled	2			
Chapel Street	Signalized	1*	Chapel Street	Signalized	1*
360 State St. Parking Garage/Pitkin St. Tunnel	Signalized	2**	State St. Station Drop-off Loop	Uncontrolled	2
Court Street	Signalized	0*	Court Street	Signalized	2**
State St. Lot #32	Uncontrolled	1	Parcel 2 Parking Lot	Uncontrolled	0***
News 8 Lot (gated)	Uncontrolled	2			
Elm Street	Signalized	1**	Grand Street	Signalized & Uncontrolled	2**
Kumo Sushi Parking Lot	Uncontrolled	1	Parcel 3 Parking Lot	Uncontrolled	0***
Harold's Parking Lot	Uncontrolled	1			
Wall Street	Uncontrolled	2			

* -- Right-turn on red is currently prohibited

** -- Right-turn on red is currently permitted

*** -- A current conflict point, but plans indicate the driveways are proposed to be removed

The proposed two-way separated bike lane on the East side of State Street is expected to have 7 potential conflict areas with most of those occurring at signalized intersections. The inclusion of a one-way separated bike lane on the West side of State Street would include 17 potential conflict areas, 13 of which are uncontrolled and therefore more difficult to mitigate. This West side of the street includes more intersecting side streets, as well as two higher volume parking locations: the 270 State Street Parking Garage and the 360 State Street Parking Garage/Pitkin Street Tunnel. Based on an assessment of potential conflicts between bicyclists and motorists, a two-way separated bike lane on the East side of the street appears to provide an opportunity for safer bicyclist operations so long as the contraflow conflicts are clearly communicated. At locations of uncontrolled crossings (e.g. the State Street Station exit and the slip lane at Grand Ave.), a W16-21P (2-WAY BICYCLE CROSSING) sign should supplement the signing at those locations. It appears that leading bicycle intervals are proposed for each of the signalized crossings which will help to reduce the number of conflicts experienced on the corridor. It also appears that raised crossings are also proposed at each of the intersection and driveway crossings, which will help to control motorist speeds at conflict points and encourage motorist yielding in conflict areas.

Comfort

The assessment of comfort considers which design will attract the most people to consider biking as an option, specifically looking at which design would reduce delay for bicyclists, accommodate passing (and side-by-side bicycling if possible), maximize separation from motor vehicles, and minimize conflicts (with motorists and pedestrians) discussed in the Safety Section above.

Bicyclist Delay:

Considering bicyclist delay, a bikeway on the East side of State Street would have one less signaled intersection than the West side (at the 360 State St. Parking Garage/Pitkin St. Tunnel) and has fewer conflict points. This means that bicyclist travel time could be shorter on the East side of the street than along the West side because bicyclists will slow or stop for fewer conflicts. However, bicyclist travel time is dependent on a variety of factors, including which side of the street a bicyclist is connecting from, connecting to, and in which direction they are traveling. In general, travel times will be fairly similar regardless of which side of the street the bikeway is located.

Providing Comfortable Bike Lane Widths:

Based on the provided concept plans, it appears that the proposed two-way separated bike lane width is 12-feet, which would easily accommodate frequent passing and side-by-side riding for bicyclists. This implies that 6-feet of width may be available for two one-way separated bike lanes, though this could be slightly more or slightly less when considering the design of the street buffer widths. 6.5-feet of width is the minimum needed to accommodate occasional passing, with more width needed to comfortably accommodate frequent passing and side-by-side riding. As such, it appears that the two-way configuration has more opportunity to accommodate bicyclists of varying speeds and riding styles.

Providing Comfortable Street Buffer Widths:

The street buffer width (e.g., the space between the bike lane and motorist travel/parking lanes) shown on the concept plans varies throughout the corridor, but appears to be between 6-feet and 16-feet wide. Increased widths for street buffers along corridors help to reduce bicyclist exposure to traffic noise and emissions, create opportunities for landscaping and other streetscape amenities, and accommodate curbside activities (e.g., on-street parking, loading/unloading). At intersections where motorist and bicyclist paths are not separated by signal phasing, the provision of a street buffer of between 6-feet and 16.5-feet has been shown to result in the highest rate of motorists yielding to bicyclists. The design as shown for the two-way separated bike lane crossings falls within this recommend range and is expected to encourage motorist yielding. Given that the lowest range of street buffers is 6-feet for the two-way separated bike lane configuration, it can be reasonably assumed that the street buffer widths for a pair of one-way separated bike lanes may be as low as 3-feet wide in some locations. 2-feet is the minimum width needed for a street buffer along a separated bike lane (3-feet minimum recommended along areas with on-street parking), so the buffer for a pair of one-ways is likely to be acceptable; however, at intersections the need for at least 6-feet could result in additional right-of-way impacts or disturbances that are not necessary in the two-way design. The street buffer width is also an essential component for access to transit, with at least an 8-foot wide street buffer needed to serve as the ADA compliant boarding and alighting area. Given the number of transit stops along both sides of the corridor, implementation of the design is likely to be more difficult if the pair of one-way separated bike lanes were proposed.

Connectivity

This assessment of connectivity reviews the ease of access into and out of the bikeway, the accommodation of all necessary transitions between bikeways, and access to key destinations.

Because of the nature of separated bike lanes, bicyclist movements at intersections into and out-of the separated bike lanes must be carefully considered. One-way separated bike lanes have the benefit of easily accommodating right-turns, but requiring a two-stage turn to make left-turns. Similarly, for the proposed two-way separated bike lanes, bicyclists turning down a side street on the East side of State St. can make these movements in one turning movement whereas those wishing to cross to the West side must make a two-stage turn. A review of this particular corridor indicates that bicyclist movements into and out of the proposed separated bike lane could be accommodated at each side street whether a one-way or two-way separated bike lane configuration is proposed. The supplemental redlined plans provide some additional suggestions for accommodating some of these movements and transitions between different facilities.

It appears that a major destination along this corridor is the State Street Station; as such, the provision of the two-way separated bike lane on the East side of the street can provide more direct access to and from this train station. If one-way separated bike lanes were proposed along this portion of the corridor, it is likely that the one-way bike lane in front of the train station would operate as a two-way facility as bicyclists will seek to reduce out of direction travel when beginning or ending their trip at the station. Although a pair of one-way separated bike lanes would provide direct access to the properties on each side of the corridor, the fact that the block spacing is only 400 to 500-feet long means that bicyclists wishing to access properties on the West side of the street will never need to walk more than that distance to access those properties.

Other Considerations

Beyond the topics of safety, comfort, and connectivity, the decision to choose between a pair of one-way vs. a single two-way separated bike lane configuration should assess the cost of maintenance and constructability. It is recommended that the City consider whether they have (or plan to purchase) narrower equipment that would be needed to sweep and plow a narrower one-way separated bike lane. Typically, a two-way separated bike lane is sufficiently wide to sweep or clear with conventional maintenance equipment whereas one-way separated bike lanes typically required the use of smaller equipment.

Constructability of the configuration must also be assessed, including the movement of curblines, utility and drainage impacts, etc. A detailed assessment of these issues is beyond the scope of this concept-level review; however, at a high-level it appears that the two-way separated bike lane allows existing curblines and street trees along the West side of the street to be preserved, as well as preserving street trees and landscaping that currently exist in the street median. It is assumed that the inclusion of one-way separated bike lanes is likely to disturb street trees on the West side of the street and would require reconstruction of the existing curblines and median to accommodate the shifting of travel lanes further East.

Conclusions of One-Way vs Two-Way Separated Bike Lanes

Based on this assessment of safety, comfort, connectivity, and other considerations within this project area, the two-way separated bike lane concept appears to be preferable compared to a pair of one-way separated bike lanes.

Design Comments for the Concept-Level Two-Way Separated Bike Lanes

A set of redlined plans is included as part of this review to highlight potential areas for improvement or design changes that should be considered as part of the project development. A few specific focus areas are discussed below.

Sidewalk Buffer and Separated Bike Lane Elevation:

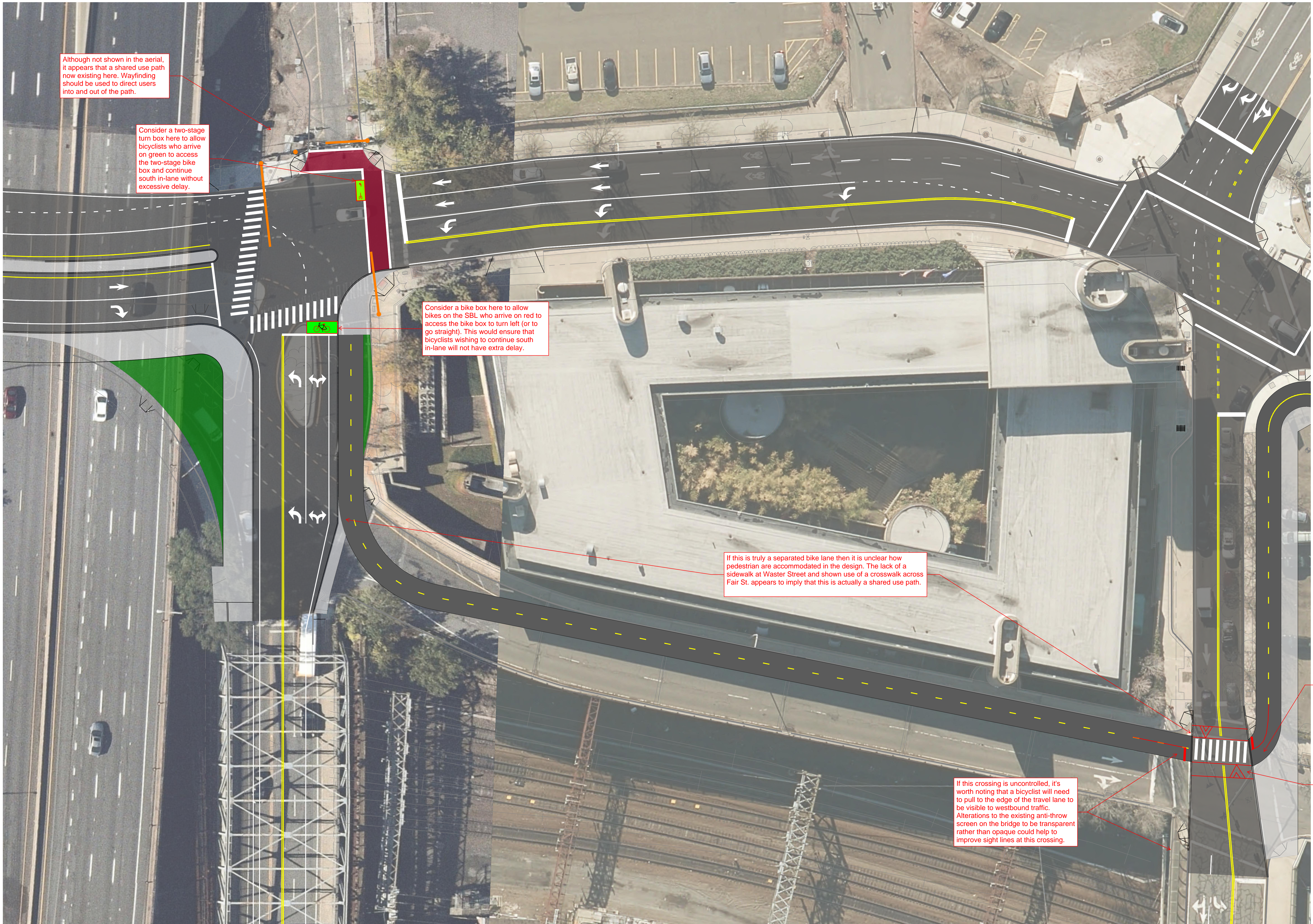
The provided proposed cross-section shows a 12-foot wide sidewalk-level separated bike lane that is flush against an 8-foot wide sidewalk. A key component of any separated bike lane is a sidewalk buffer between the sidewalk and the separated bike lane that is reliably detectable underfoot and with a white cane. Pedestrian crossings of the separated bike lane should then be demarcated with crosswalks and detectable warning surfaces. Failure to provide these features will result in a design that is not understood by pedestrians with vision disabilities and will instead function as a shared use path. As an example, it appears that the recently constructed facility along MLK Jr. Blvd. (from Church St. to Orange St.) has this design issue. An intermediate-level separated bike lane (located 3-inches below the sidewalk elevation) with a beveled curb between the sidewalk and the bike lane should be considered as it has been shown to be reliably detectable for pedestrians. These intermediate-level designs can also help to simplify the design and grading of pedestrian curb ramps and crossings at intersections.

State Street Station:

The proposed design requires bicyclists to cross the entering and exiting lanes of the station drop-off loop which introduces unnecessary conflicts between motorists and bicyclists. Given that this is the only uncontrolled driveway crossing proposed along the two-way separated bike lane, it would be ideal to remove those conflicts entirely, particularly as these are likely to be conflicts between buses and bicyclists. Additionally, the station is an origin and destination for bicycle trips, but the current design separates bicyclists from having direct access to the station and the bicycle parking canopy. As noted in the City's goals, the priority is to encourage modal shift away from single occupancy vehicles, along with bicycle, pedestrian, and transit options that complement each other. Moving the bicycle facility closer to the station will help to achieve this goal by creating direct links between transit and bicycle facilities. Lastly, as noted on the redlined plans, the current design in this vicinity will encourage pedestrians to use the separated bike lane as it will represent the straightest route for some pedestrian desire lines.

Transit Stops:

State Street includes bus stops along the corridor; however, the accommodation of these transit stops and the corresponding boarding and alighting areas for passengers is not shown in the concept plans. The street buffer between the roadway and the edge of the separated bike lane at each transit stop will need to be at least 8-foot wide to serve as an accessible boarding and alighting area. If shelters are provided at these stops, they should be located and designed to ensure that sight lines are maintained between bicyclist and crossing pedestrians.



Although not shown in the aerial, it appears that a shared use path now existing here. Wayfinding should be used to direct users into and out of the path.

Consider a two-stage turn box here to allow bicyclists who arrive on green to access the two-stage bike box and continue south in-lane without excessive delay.

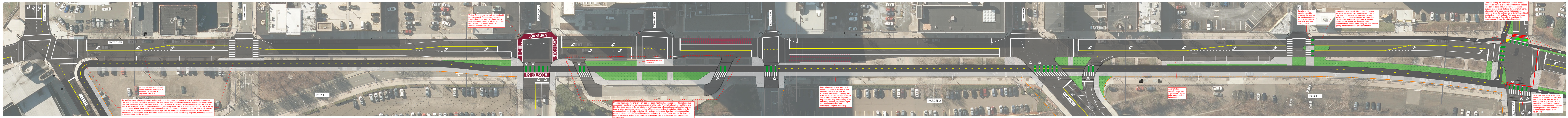
Consider a bike box here to allow bikes on the SBL who arrive on red to access the bike box to turn left (or to go straight). This would ensure that bicyclists wishing to continue south in-lane will not have extra delay.

If this is truly a separated bike lane then it is unclear how pedestrian are accommodated in the design. The lack of a sidewalk at Waster Street and shown use of a crosswalk across Fair St. appears to imply that this is actually a shared use path.

If this crossing is uncontrolled, it's worth noting that a bicyclist will need to pull to the edge of the travel lane to be visible to westbound traffic. Alterations to the existing anti-throw screen on the bridge to be transparent rather than opaque could help to improve sight lines at this crossing.

If the portion south of here is intended to function as a shared use path, additional accessibility guidance will be needed here to separate pedestrians and bicyclists into the designated sidewalk and separated bike lane spaces.

It is unclear from the design if this intersection will remain signalized or will become uncontrolled. If uncontrolled, consider the use of a raised crossing. The crossing distance may also be reduced slightly if the length of the left-turn lane on the adjacent bridge can be reduced and the northern curbline further refined.



Typical Comment: Single curb ramps should be discouraged. Separate curb ramps at intersection can provide directional cues to pedestrians and can allow adjustment of the curb ramp and crosswalk locations to shorten crossing distances.

At least a 3-foot wide sidewalk buffer is needed between any on-street parking and a separated bike lane.

Typical Comment: It is the reviewer's understanding that the design is intended to be a sidewalk-level separated bike lane. If the design truly is a separated bike lane, then a detectable buffer is needed between the sidewalk and SBL, and pedestrian accommodations must address pedestrian accessibility and movements across the SBL. At Fair St, for example, there is no pedestrian crossing of the separated bike lane and the curb ramp landing at the top of ramp would require pedestrians to stand in the bike lane. At Crown St, crossings of the bike lane would need to be marked with crosswalks and detectable warnings, and the pedestrian refuge between the SBL and roadway would need to be designed as an accessible pedestrian refuge median. As currently proposed, the design appears to be more like a shared use path.

Consider flipping the motorist drop-off loop and separated bike lane. As designed it introduces two unnecessary conflict areas between motorists and bicyclists. Flipping the locations would also give bicyclists direct access to the transit station and bike canopy, whereas the current design requires them to either use the sidewalk or the drop-off loop to get to the station. Additionally, the current design is not likely to be followed by pedestrians because there isn't a direct pedestrian connection from the Pitkin Tunnel intersection continuing North and South, as such, the design is likely to encourage pedestrians to walk in the separated bike lane since that can represent the shortest path.

example pedestrian desire line

If this is intended to be a bus boarding and alighting area, at least an 8' wide median is needed to provide an accessible boarding and alighting area that is separate from the separated bike lanes. If transit shelters are proposed, they should be fully transparent (i.e. no advertising on them) to preserve sight lines between bicyclists and pedestrians using this transit stop

A transit stop currently exists here which doesn't appear to be accommodate in the design

If retaining this crossing, consider enlarging the width of the median to at least 10' to accommodate space for a bicyclist pulling a trailer.

It is unclear what benefit this portion of one-way separated bike lane provides given that it directs bicyclists to cross at an uncontrolled crossing location as opposed to the signalized crossing at Grove Street. Perhaps it is provided to provide access to Wall Street, but even that is not accommodated without either using the curb ramp or getting into the travel lane on State St to turn.

Consider shifting the pedestrian and bike crossing further west into Grove St. This would create a space for a corner island (shown in yellow), a forward queuing area to cross State on the southern leg of the intersection, and would ensure that pedestrians waiting to cross the northern leg of State St. would not be standing in the bike lane. This would also locate the bike crossing of Grove St. to be at least the recommended 6' from the edge of travel lane

Depending on when a SB bicyclist arrives at this intersection, they may wish to follow the dark red arrow. Similarly, WB bicyclists on Olive St. wishing to access the two-way SBL need to be accommodated. Consider widening the bike lane on the SE corner to accommodate these movements

SEE PREVIOUS PAGE FOR INTERSECTION COMMENTS

It appears that the crossing distance may be able to be reduced here since there is only a need for one receiving lane on Olive St.

may need to bend the bikeway out further from the adjacent road to create space for a pedestrian refuge/curb ramp here

If right-on-red is permitted from Audubon St, consider shortening the crossing distance and controlling right-turning motorist speeds.

A transit stop currently exists here which doesn't appear to be accommodate in the design

The change to smaller radii is a great improvement here. As a high volume, uncontrolled intersection, the length of this crossing should be reduced as much as possible.

