



CAPITOL COMPLEX MASTERPLAN

DENVER,
COLORADO

Appendix 2 - Urban Design

- a) Intersection Analysis
- b) Multimodal Transportation Assessment
- c) West Lawn Report

Appendix 2 - Urban Design

a) Intersection Analysis



MEMORANDUM

Date: 4/16/2014

To: RNL Design, Inc.
1050 17th Street, Suite A200
Denver, CO 80265

From: Emily Gloeckner, P.E., Associate
Andrew McFadden, E.I.T., Transportation Engineer

Subject: Capitol Complex Master Plan –Intersection Analysis and Recommendations

DN13-0419

INTRODUCTION

The Capitol Complex Master Plan analyzes the feasibility of future improvements at the Colorado State Capitol (Capitol Complex). Located in central Denver on the southeast corner of Lincoln Street and Colfax Avenue, the Capitol Complex is on the cusp of the downtown central business district (CBD), leading to heavy volumes from all transport modes, including vehicles, transit, bicyclists, and pedestrians. This memo will provide an assessment of the pedestrian, bicycle, and transit circulation and recommendations for improving the multimodal experience around the Capitol.

VEHICULAR NETWORK

The existing road network in the Capitol Complex study area is bordered by multiple arterial roadways. The 14th/13th Avenue couplet is located to the south of the Capitol, the Broadway and Lincoln couplet border the west side of Capitol, the Grant and Logan couplet to the east, and Colfax Avenue to the north. Denver streets are based on an east-west/north-south grid, where roadways are parallel to the cardinal directions. Downtown Denver is based on a diagonal street grid, where the roadways were plotted to be parallel with Cherry Creek and the South Platte River. The intersection of Broadway and Colfax Avenue is where the two grid systems meet, just one block west of the Capitol Complex. Daily traffic counts were obtained from the City and County of Denver's traffic count database and the Denver Regional Council of Government (DRCOG) regional traffic count program. The annual counts were taken between 2002 and 2011. Based on the information collected, the traffic volumes have been consistent through the years. **Figure 1** shows the average daily traffic (ADT) counts for the surrounding roadway network.





Figure 1: Average Daily Traffic



MULTI-MODAL CIRCULATION

Transit

With a centralized site in downtown Denver, the Capitol Complex is in the core of several bus routes. Located one block away from Civic Center Station, there are multiple transit routes that access the site.

- **Lincoln Street/Broadway:** The one-way couplet of Lincoln Street and Broadway serves as a primary bus corridor, facilitating multiple routes into and out of downtown Denver at Civic Center Station. During peak hours, the corridor may see up to 17 bus routes, including express, limited, local, and regional services. Peak hour bus operations are accommodated by a reserved bus and right-turning vehicle lane. The intersection of 13th Avenue and Lincoln Street, south of the Capitol Complex, has a bus priority signal allowing for buses to shift lanes in advance of other vehicles. The advance signal phase assists buses on Lincoln Street that make left-turns on Colfax Avenue and into Civic Center Station.
- **Colfax Avenue:** The Colfax corridor facilitates regular bus service throughout the day, providing a key connection between Denver, Aurora, and Lakewood. In the Capitol area, buses provide local and limited services. At the northeast corner of the Capitol site, a bus stop provides convenient transit access to users of the Capitol. The following section describes details on two current transit studies for the Colfax Corridor.
- **Grant Street:** One local bus route runs on Grant Street, bordering the east side of the Capitol.

Due to limited parking stalls within the Civic Center Bus Station, RTD buses have a designated on-street dwelling zone on the west side of Broadway between Colfax and 16th Avenue. Buses ahead of schedule must wait on Broadway until 3 minutes before their scheduled departure from the station. Although the east side is not designated for bus dwelling, overflow parking can be seen there when buses have backed up into Colfax during peak hours. A number of issues result from these backups including blocked crosswalks and lanes near the Colfax Avenue and Lincoln St. intersection. These blockages could be a potential safety concern as reversing buses and turning movements could result in pedestrian and automobile conflicts.

School buses also affect the local traffic around the Capitol Complex during the morning and afternoon hours. The official policy for school field trips visiting the Capitol is for school buses to park on both sides of Broadway between Colfax and 14th Avenue. Tours are offered from 10 am – 3 pm on weekdays. **Figure 2** outlines the general location of both the school and RTD bus dwelling zones.



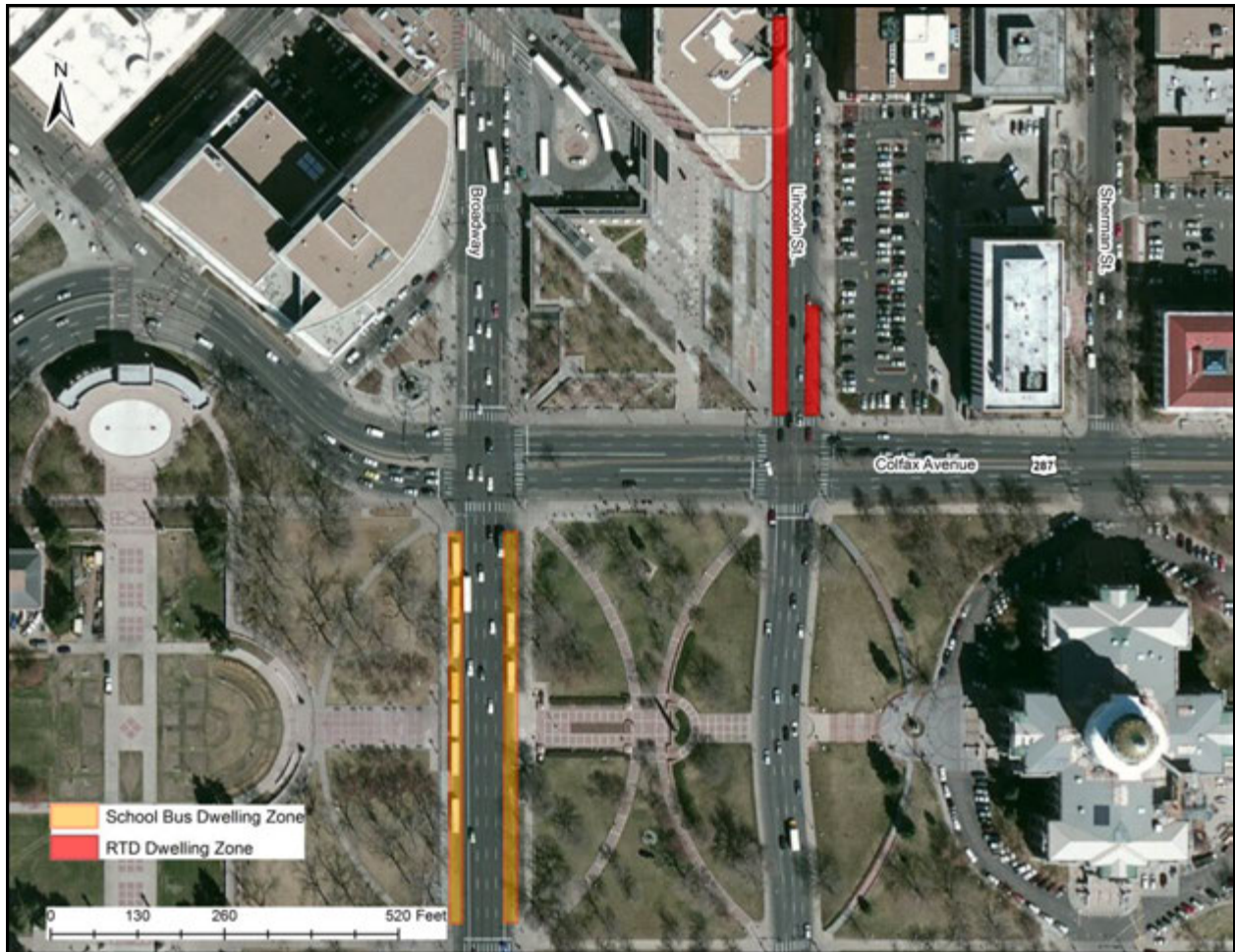


Figure 2: Bus Dwelling Zones near Capitol Complex

RTD has teamed with the City of Denver and has obtained funding to determine the future of the Civic Center Station. This partnership is aimed to address the station's existing limited capacity and seeks to improve the way buses access the station.

Bicycle Facilities

Many of the roads surrounding the Capitol Complex area are designated to facilitate bicycle traffic. Sherman Street, which intersects the driveway surrounding the Capitol, features sharrows (shared bike lane markings) in both directions. East-west bike traffic is facilitated by a bike lane on 16th Avenue and bike routes/sharrows on 12th Avenue. Connections into the CBD are provided by the bike lane on 16th Avenue and cycle track on Bannock Street, in front of the City and County of Denver building. The existing bicycle network surrounding the Capitol Complex area is shown in **Figure 3**.



Figure 3 also includes improvements to the bicycle network within the area identified in the Denver Moves Plan, as well as, existing B-cycle stations which offer visitors and residents easy access to bicycles around the Capitol Complex.

Bicycle Accommodations

To encourage bicycling to and from the Capitol, adequate bike parking facilities are recommended. Currently, employees working in the Capitol Complex are allowed to register for bike lockers. Appropriate long-term bike parking should be included as covered parking. Long-term bike parking for employees and visitors should provide controlled access, weather protection, and higher security. These facilities may include bike lockers, an indoor cage, or a bicycle room. Additionally, short-term bicycle parking should be added within 50' of the entrances of the Capitol Complex, as it not only facilitates easier and faster bicycle access to the building, but also serves as an endorsement of multi-modal travel. Examples of short-term and long-term bike parking are shown below.

Short Term Bicycle Parking



Denver Standard Inverted U Bike Rack

Long Term Bicycle Parking



Indoor Bike Cage (Seattle, Washington)



Bike Locker (University of Texas at Austin)



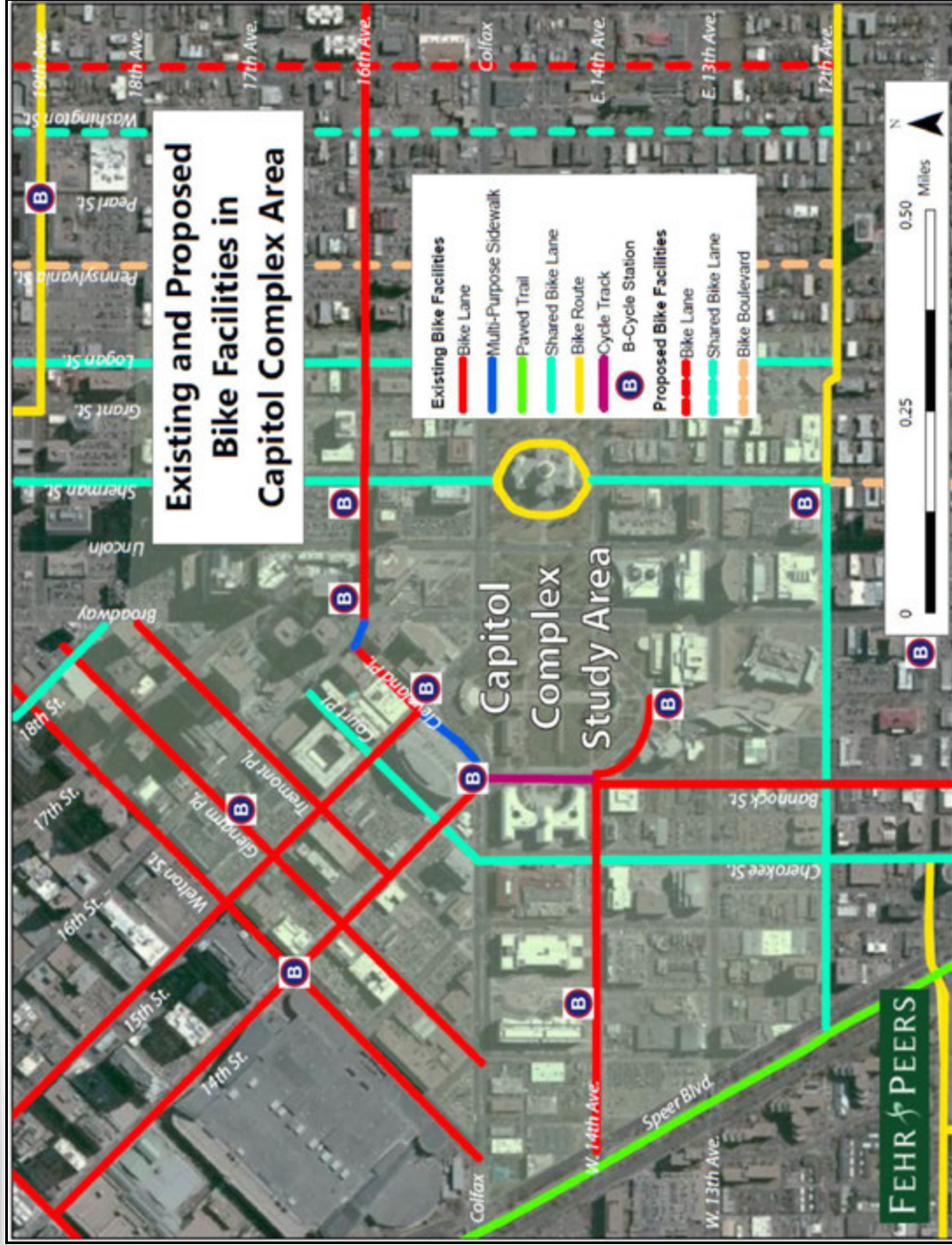


Figure 3: Existing and Proposed Bike Facilities



Signalized Intersections and Pedestrian Facilities

All of the intersections bordering the Capitol Complex are currently signalized. These include:

- Lincoln Street and 14th Avenue
- Lincoln Street and Colfax Avenue
- Sherman Street and 14th Avenue
- Sherman Street and Colfax Avenue
- Grant Street and 14th Avenue
- Grant Street and Colfax Avenue

In order to focus the analysis on the intersections that were identified to have heavy pedestrian activity associated with the State Capitol, pedestrian activity was observed on various days throughout the week of March 17, 2014. The three intersections identified to have heavy pedestrian activities were determined to be:

- Lincoln Street and Colfax Avenue
- Sherman Street and Colfax Avenue
- Sherman Street and 14th Avenue

This initial analysis included an initial pedestrian flow count to understand the general spatial and temporal patterns of pedestrian movements north of the Capitol Complex. The intersections focused on in this initial study can be seen in Error! Reference source not found. with pictures of pedestrian facilities provided alongside. The results of this initial Capitol Complex Master Plan pedestrian count observation indicate:

Lincoln and Colfax

- Pedestrians seem to have a wider variety of origins and destinations when compared to the Sherman intersection
- Pedestrian traffic is more variable with clear peaks between 12:00 and 1:00 and 4:30 and 5:30. School tour groups of roughly 25 students and teachers crossed Lincoln on the South side of Colfax to reach their buses parked on Broadway
- A number of mid-block pedestrian crossings occurred on Colfax between Lincoln and Grant Street. Also a number of pedestrian crossings were seen just north of the Lincoln and Colfax intersection.



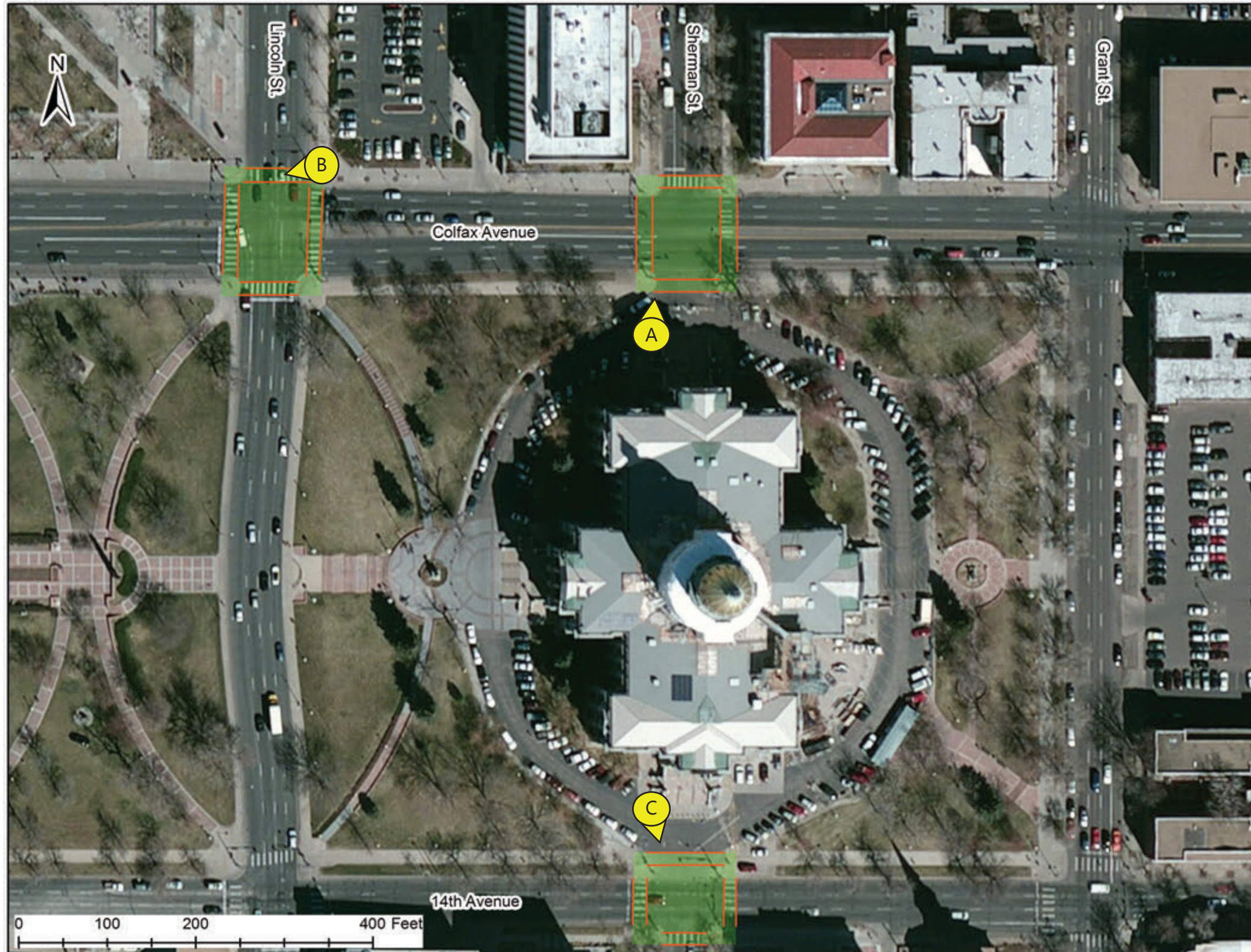


FIGURE 4: STUDY INTERSECTIONS AT THE CAPITOL COMPLEX

A



B



C



Sherman and Colfax

- A substantial portion of pedestrian traffic (especially North/South traffic) is associated with the Capitol Complex
- Traffic peaks earlier in the day near 11:45 and 1:00 pm due to several large groups of people headed to/from the Capitol crossing at once. The exact time of this peak is subject to change, however, as it is dependent upon a number of factors including the adjournment of committee meetings and tour groups
- Compared to Lincoln and Colfax, Sherman and Colfax has less variable pedestrian traffic, especially in the N/S direction

Currently, all of the intersections surrounding the Capitol have pre-timed pedestrian phases. These signals allow for regular pedestrian movements, while accommodating vehicular traffic. Crosswalks are clearly marked in all of the intersections, providing a designated area for pedestrians to cross. Existing pedestrian facilities at the intersections of Colfax and Lincoln, Colfax and Sherman, and 14th and Sherman are summarized in **Table 1** below.

Table 1: Existing Pedestrian Facilities at 3 study intersections

Intersection	Number	Direction	Walk Signal Flashing (seconds)	Crosswalk Length (ft)	Countdown Walk Signal	Intact Striping	Audible Walk Signal Indicator	Push Button Detector
Lincoln and Colfax	1	N/S	20	80-86	✓	Partial		
		E/W	12	53-58	✓	✓		
Sherman and Colfax	2	N/S	15	65.5	✓	✓	✓	✓
		E/W	12	40-50	✓	✓		✓
Sherman and 14th	3	N/S	10	40		✓		
		E/W	11	36-54	N. Side Only	✓		

This initial pedestrian observation was used to both inform and validate the formal vehicle and pedestrian turning movement counts performed at all three intersections on Tuesday, March 25, 2014. **Figure 4** below shows the pedestrian volumes collected during this study for AM, MID, and PM peak hour periods.



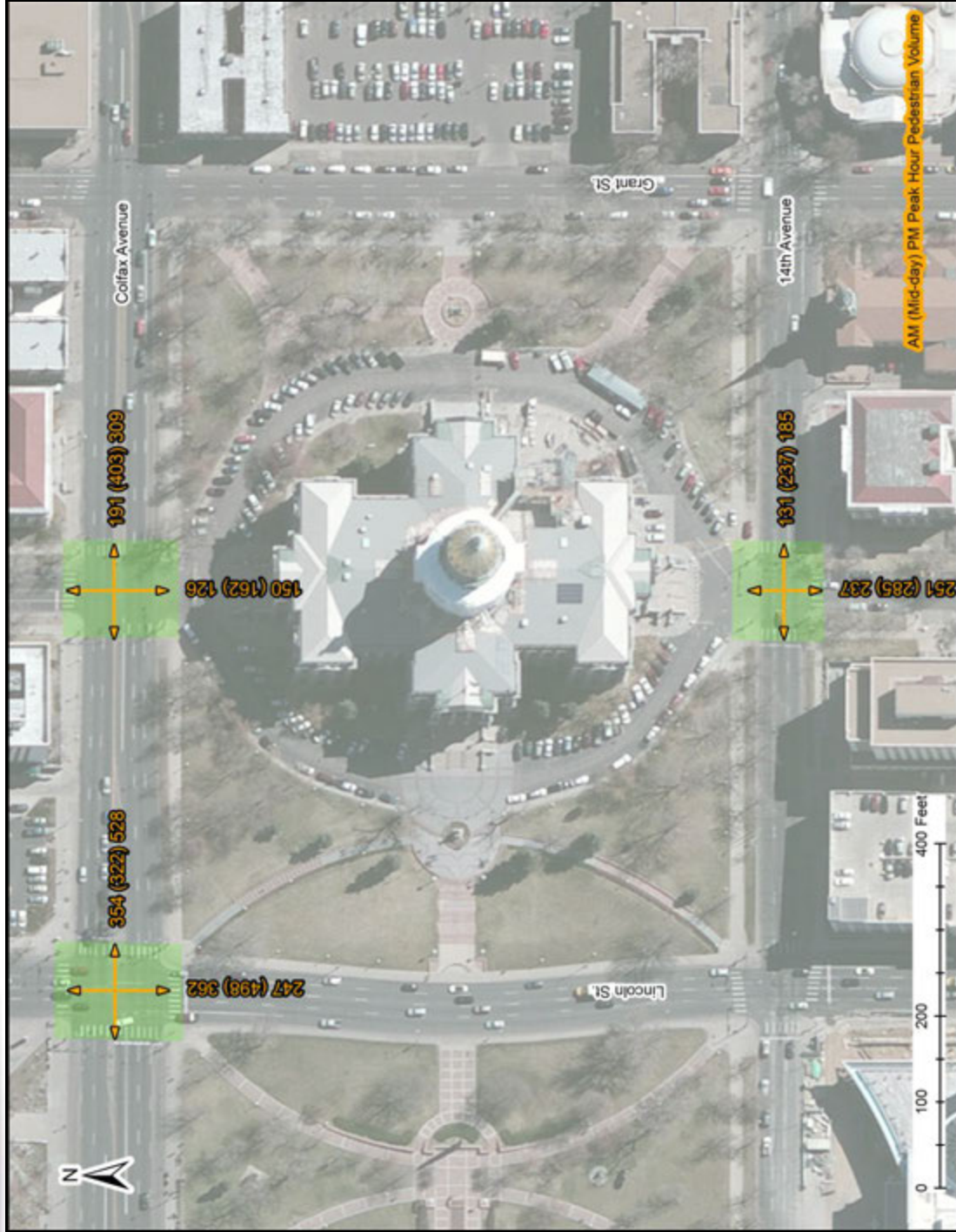


Figure 4: AM Mid-Day and PM Peak Pedestrian Intersection Volume



The intersection turning movement counts obtained on Tuesday, March 25, 2014 were also used to gain a more accurate and up-to-date analysis of intersection performance around the Capitol Complex. **Figure 5** shows the morning (AM), afternoon (MID), and evening (PM) peak period turning movements for each intersection.

These volumes were inputted into a Synchro intersection network to understand the operational performance of each intersection under existing conditions. Relevant conflicting pedestrians and bicycles, signal timing, bus blockages, and parking activity were included in this analysis. Bus blockages on eastbound Colfax Ave. (west of Lincoln) were estimated based upon the headways of buses at the Colfax and Broadway stop during peak periods. Parking activity was estimated as 10 parking maneuvers per peak hour (AM and PM) on the approaches across from the Capitol on Sherman St. **Table 2** shows results of this analysis, specifying the level of service (LOS) and delay for the three intersections. The LOS results are also included in **Figure 5**.

Table 2. Intersection Level of Service (LOS) and Delay for AM, MID, and PM Peak Periods

Intersection	Control	AM Peak Hour 7:30-8:30		MID Peak Hour 12:15-1:15		PM Peak Hour 4:30-5:30	
		LOS	Delay ¹	LOS	Delay ¹	LOS	Delay ¹
Lincoln and Colfax	Signalized	E	61.4	C	20.8	C	26.1
Sherman and Colfax	Signalized	C	33.2	C	33.7	D	35.4
Sherman and 14 th	Signalized	A	7.7	A	7.9	A	9.2

Source: Fehr & Peers, April 2014
¹ The delay is reported as the average delay per vehicle in seconds.

The results of this intersection analysis indicate that these intersections generally perform with limited delay, considering their location near Denver’s CBD and other downtown attractions. Only the intersection of Lincoln St. and Colfax Ave. during the AM peak period operated at a level of service LOS E. This intersection’s excess delay is primarily caused by the northbound Lincoln approach, popular with commuters traveling on the Lincoln St. corridor into the central city from south of Denver.



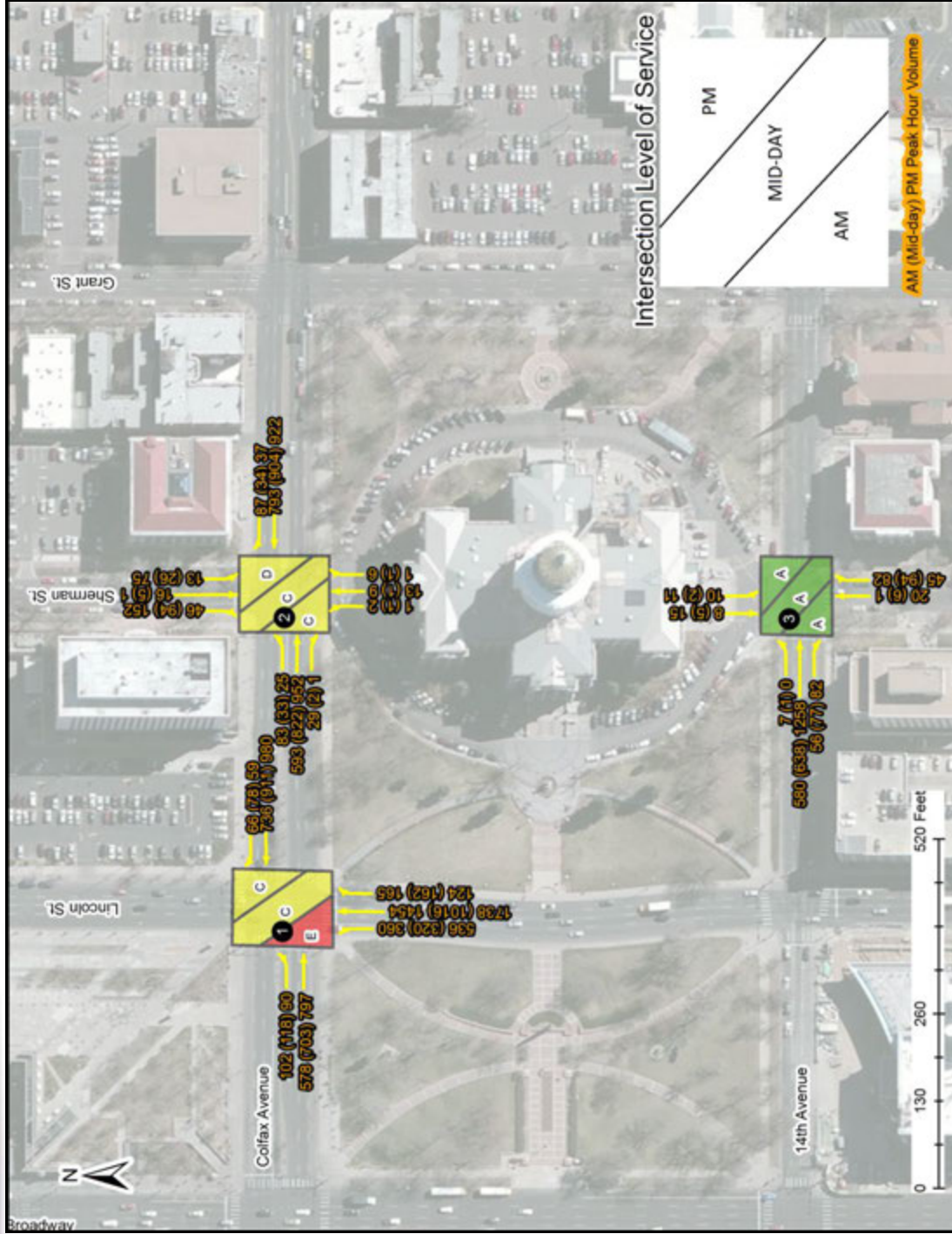


Figure 5: AM Mid-Day and PM Peak Hour Traffic Volumes and Intersection LOS



Pedestrian Toolbox Strategies

Based upon the heavy pedestrian traffic associated with the intersection analysis, Fehr & Peers utilized a proprietary crosswalk tool that was created by Fehr & Peers based on research from the National Cooperative highway Research Program and Federal Highway Administration. Each of the three targeted intersections was inputted into the crosswalk tool to determine the most appropriate intersection pedestrian treatment based upon a given set of inputs. In addition to evaluating the warrants to install a signalized crossing at an intersection, the tool explores techniques such as high visibility crosswalks, curb extensions, median refuge, in-pavement and overhead flasher, and hawk signals. The results of applying this tool to this study's intersections indicated that all intersections warrant a signalized crossing with pedestrian level of service F and are not capable of utilizing a median refuge island or road diet. **Figure 6** below shows an example of the inputs and outputs of this crosswalk tool for the intersection of Lincoln and Colfax.

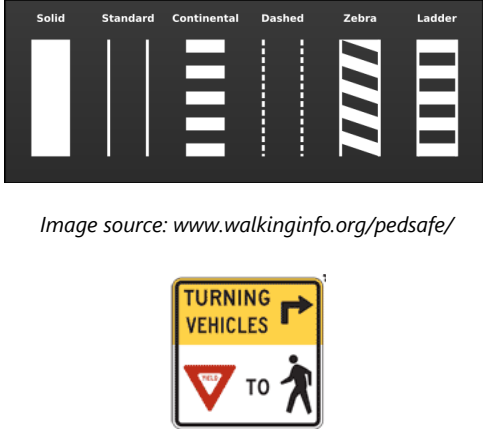
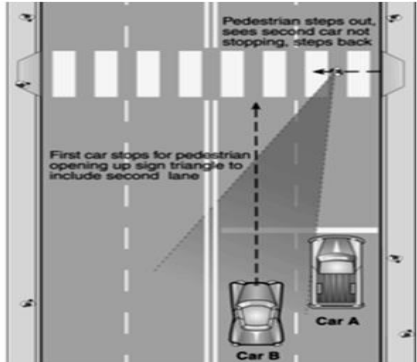
required input				
optional/default input (update if location-specific data is available)				
required only when a median refuge island is present				
Intersection: Lincoln and Colfax, Crossing Lincoln				
Case Study 1				
FIELD	CATEGORY	INPUT	UNITS	DESCRIPTION / NOTES
1	Speed Limit	30	mph	Posted or statutory speed limit or the 85th percentile speed on the major street
2	Peak Hour Pedestrian Volume	528	ped/h	Number of pedestrians crossing the major roadway in a peak hour
3	Major Road Peak Hour Volume (Total)	2398	veh/h	Total number of vehicles and bicylists on both approaches during the peak hour
4	Major Road Peak Hour Volume Direction 1	300	veh/h	Include only if a painted or raised median is present (min of 6 feet wide)
5	Major Road Peak Hour Volume Direction 2	300	veh/h	Include only if a painted or raised median is present (min of 6 feet wide)
6	Average Pedestrian Walking Speed	3.5	ft/s	Average pedestrian walking speed, default speed = 3.5 feet/second
7	15th Percentile Crossing Speed	3	ft/s	Speed for the slowest 15% of pedestrians; default speed = 3 feet/second
8	Pedestrian start-up time and end clearance time*	3	s	The <i>Highway Capacity Manual</i> suggests 3 seconds
9	Pedestrian Crossing Distance (curb to curb)	58	ft	Distance between the near and far curbs
10	First Half Crossing Distance	15	ft	Distance between the near curb and a painted or raised median refuge island
11	Second Half Crossing Distance	15	ft	Distance between a painted or raised median refuge island and the far curb
12	Number of Lanes (total both directions)	5	Lanes	Number of lanes on major roadway
13	Expected Motorist Compliance	Low		Typical motorist compliance, default = Low
14	Is frequent at-grade transit present?	Yes	x	Does frequent surface transit run along major or minor road at the intersection?
15	Are bicycle lanes present?	No	x	
16	Is there heavy bicycle traffic?	No	x	
17	Is there a clear major and minor road?	No	x	Is there a clear differentiation in the traffic volume between the two roads?
18	Is this a midblock location or off-set intersection?	No	x	
19	Is there heavy truck traffic?	No	x	
20	Does existing infrastructure limit potential treatments?	No	x	Are there storm drains, poles, or other permanent structures at any corner of the intersection?
21	Is there on-street parking at the location?	No	x	
22	Is the location in a downtown area?	Yes	x	
23	Is a median refuge island present?	No	x	Does the refuge island have a width of at least 6 feet to accommodate pedestrian queues?
24	Is there sufficient width to accommodate a median?	No	x	At least 4 feet (with lane widths reduced to 10 or 11 feet)
25	Actual Total Pedestrian Delay		s	Optional (if calculated at the site)
OUTPUTS				
Signalized Crossing or Unsignalized Crossing?		Signalized Crossing		
Pedestrian LOS		F		
Candidate Pedestrian Treatment Identified:		Signalized Crossing		
Candidate for Median Refuge Island?		NO		
Candidate for Road Diet?		NO		





Figure 6: Fehr & Peers Crosswalk Tool Example




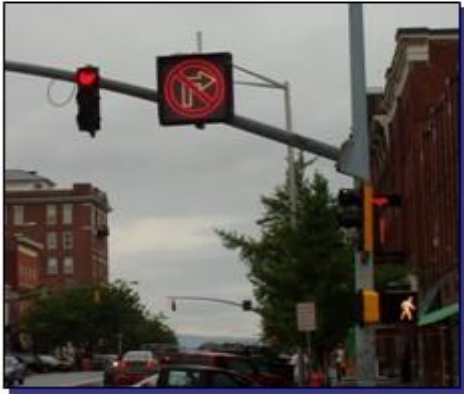
While this analysis shows that each intersection is generally using the correct pedestrian crossing treatment, to facilitate heavy pedestrian traffic the Capitol Complex Master Plan should consider further improvements to the existing pedestrian facilities. The next pages outline several potential pedestrian improvements that could enhance the Capitol Complex area.

TOOL	DESCRIPTION	BENEFITS	APPLICATION/ CONSIDERATION
<p>High-Visibility Markings and Signs</p>  <p><i>Image source: www.walkinginfo.org/pedsafe/</i></p>	<ul style="list-style-type: none"> • A series of high visibility markings such as “continental”, “Zebra”, and ladder. • High-visibility colored signs, including advance warning signs with flashing beacons (if necessary) posted near pedestrian crossings to increase driver awareness of the pedestrian crossing. 	<ul style="list-style-type: none"> • Increase drivers’ expectations about impending pedestrian activity. 	<ul style="list-style-type: none"> • Beneficial in areas where drivers might not expect a pedestrian crossing or where a higher level of driver attention is required due to potential pedestrian and bicycle conflicts. • Continental markings have the highest visibility from the motorists’ perspective.
<p>Setback Stop Bar</p> 	<ul style="list-style-type: none"> • Solid white bar signaling drivers where to stop is set back further from the crosswalk 	<ul style="list-style-type: none"> • Improves pedestrian visibility 	<ul style="list-style-type: none"> • Useful in areas where pedestrian visibility is low and in areas with aggressive drivers. • Addresses the multiple-threat collision on multi-lane roads.



TOOL	DESCRIPTION	BENEFITS	APPLICATION/ CONSIDERATION
<p>Detection Systems</p>  <p>http://www.fhwa.dot.gov/publications/research/safety/pedbike/05085/chapt10.cfm</p>	<ul style="list-style-type: none"> Offers visual and audio feedback given when pedestrian push-buttons are used 	<ul style="list-style-type: none"> Creates a better pedestrian experience Can be utilized to better accommodate elderly and disabled pedestrians longer crossing times 	<ul style="list-style-type: none"> Automatic detection systems are available which utilize microwave and infrared technologies to detect pedestrian presence and speed
<p>Animated Eyes</p>  <p>https://www.fhwa.dot.gov/publications/research/safety/pedbike/05085/chapt23.cfm</p>	<ul style="list-style-type: none"> Shows animated eyes at the start of a WALK indication 	<ul style="list-style-type: none"> Alerts pedestrians to watch out for vehicles 	<ul style="list-style-type: none"> Useful in areas with frequent vehicle turning movements



TOOL	DESCRIPTION	BENEFITS	APPLICATION/ CONSIDERATION
<p>Pedestrian Priority Signals</p> 	<ul style="list-style-type: none"> Gives pedestrians a WALK signal before motorists get a green light. 	<ul style="list-style-type: none"> Can limit conflicts arising from turning vehicle Gives pedestrians increased visibility 	<ul style="list-style-type: none"> Most applicable to left turn conflicts Can result in increased cost when implemented on older traffic signals
<p>No Turn on Red</p>  <p>http://safety.fhwa.dot.gov/intersection/signalized/presentations/nchrp500_v12/</p>	<ul style="list-style-type: none"> Prohibit right turning movements when pedestrians are crossing 	<ul style="list-style-type: none"> Limit turning conflicts LED signs indicating when right turns are prohibited can improve intersection LOS and driver compliance 	<ul style="list-style-type: none"> An assessment of the impact on traffic is needed

Findings

Vehicular Network

Based on the findings of this traffic operations analysis, no vehicle network changes are recommended. The intersection of Lincoln Street and Colfax Avenue was found to operate at a level of service E during the AM peak period. This was the only intersection and peak period combination to operate below level of service D.



Transit

Existing transit surrounding the Capitol Complex was reviewed as part of this analysis. Particular attention was paid to backups associated with capacity constraints in the Civic Center Bus Terminal. As this issue should be studied in coordinated efforts between the City and RTD, further recommendations are to be determined with Civic Center Master Plan

Bike

The Capitol Complex is located adjacent to an expansive and developing bike infrastructure network that includes B-cycle stations, bike lanes, and shared roadways. Future development at the Capitol Complex should consider adding long-term and short-term bicycle parking where appropriate to facilitate multi-modal access to and from the Complex for employees, residents, and visitors. The long-term parking should be covered and secure, and the short-term parking should be located within 50 of entrances.

Pedestrian

This analysis recommended several strategies specifically targeted to address the existing pedestrian environment around the Capitol Complex, including:

- High visibility markings and signs
- Setback stop Bars
- Advanced detection systems
- Animated eyes
- Pedestrian Priority Signals
- No turn on red signal improvements

We recommend these strategies be considered as part of the Master Plan to create more walkable spaces where people will want to walk and bike. These improvements will require close coordination with City and County of Denver for implementation.



Appendix 2 - Urban Design

b) Multimodal Transportation Assessment



MEMORANDUM

Date: September 10, 2013

To: RNL Design, Inc.
1050 17th Street, Suite A200
Denver, CO 80265

From: Emily Gloeckner, P.E., Associate
Lisa Truong, E.I.T., Transportation Engineer

Subject: Capitol Complex Master Plan – Baseline Multimodal Transportation Assessment

DN13-0419

INTRODUCTION

The Capitol Complex Master Plan analyzes the feasibility of future improvements at the Colorado State Capitol (Capitol Complex). Located in central Denver on the southeast corner of Lincoln Street and Colfax Avenue, the Capitol Complex is on the cusp of the downtown central business district (CBD). The adjacent street network experiences high traffic volumes from a variety of modes.

In the preliminary concepts for the Capitol Complex Master Plan, an underground parking garage is proposed to serve the Capitol Complex. Additionally, a sub-grade tunnel would be built on the block of Lincoln Street between Colfax Avenue and 14th Avenue. On top of this roadway, the Capitol Complex west lawn will be extended to connect with the existing park space between Broadway and Lincoln, forming a continuous open lawn and path.

In order to understand how these improvements could affect future traffic operations in the Capitol Complex area, this memo will provide a baseline assessment of the existing transportation network.

VEHICULAR NETWORK

The existing road network in the Capitol Complex study area is bordered by multiple one-way street couplets. Denver streets are based on an east-west/north-south grid, where roadways are parallel to the cardinal directions. Downtown Denver is based on a diagonal street grid, where the roadways were



plotted to be parallel with Cherry Creek and the South Platte River. The intersection of Broadway and Colfax Avenue is where the two grid systems meet, just one block west of the Capitol Complex.

Roadways

Daily traffic counts were obtained from the City and County of Denver's traffic count database and the Denver Regional Council of Government (DRCOG) regional traffic count program. The annual counts were taken between 2002 and 2011. Based on the information collected, the traffic volumes have been consistent through the years. **Figure 1** shows the average daily traffic (ADT) counts for the surrounding roadway network.

Lincoln Street is a four-lane, northbound urban arterial that facilitates a substantial amount of traffic into the downtown CBD. This one-way northbound road couples with Broadway to serve traffic between downtown and I-25. Between Colfax Avenue and 14th Avenue, Lincoln Street carries about 32,000 vehicles per day (vpd). The posted speed limit is 30 miles per hour (mph) within the study area. During the peak period, the rightmost lane is reserved for buses and right-turning vehicles. On-street parking is permitted on either side of Lincoln Street, with an exception to the blocks between 14th Avenue and 16th Avenue. The City and County of Denver oversees maintenance of the roadway.

Broadway is a four-lane, southbound regional arterial that serves as a considerable volume of traffic out of the downtown CBD. Paired with Lincoln as a one-way couplet, Broadway serves southbound traffic through Denver. The roadway spans from Brighton Boulevard in north Denver through Highlands Ranch, including two segments designated as State Highway 75. Within the Capitol Complex study area, Broadway carries about 28,600 vpd. The posted speed limit is 30 mph. Similar to Lincoln Street, the rightmost lane is reserved for buses and right-turning vehicles in the peak period. Depending on bus stops and business access, on-street parking is allowed on certain sections of Broadway. The City and County of Denver oversees maintenance of the roadway.

Colfax Avenue is a four-lane, east-west regional arterial that runs from Lakewood to Aurora, also serving as US Highway 40. It connects several communities and neighborhoods with downtown Denver, as well as facilitating access throughout the Denver metro region. In the study area, the annual daily traffic (ADT) along Colfax between Lincoln and Grant is approximately 31,000 vpd. Moving west, traffic between Broadway and Lincoln increases to 50,000 vpd. West of Broadway, the volumes decrease to about 23,000 vpd. Based on these volumes, it is evident that Colfax facilitates high turning volumes into and out of the CBD. The posted speed on Colfax is 30 mph. Currently, Colfax Avenue is being analyzed in two major transit studies, Colfax Corridor Connections and 15/15L Transit Priority study; more details can be found in the Transit Improvements section. Within the Capitol Complex study area, Colfax Avenue is the only roadway in which CDOT provides jurisdiction and maintenance.



Sherman Street is a two-lane, north-south local road that provides direct access into the Colorado State Capitol. Segmented by the State Capitol building, Sherman Street accommodates movements into the Capitol's current surface parking lot and drop-off zones from both the north and south ends. Sherman spans from 20th Avenue through south Denver, connecting residential neighborhoods and communities. On-street parking is permitted on either end of the street. Maintenance is handled by the City and County of Denver.

Grant Street is a three-lane, southbound urban arterial road that borders the east side of the Colorado State Capitol. This one-way road couples with Logan Street to serve the neighborhoods and communities of Denver. Based on traffic counts, the ADT for Grant is approximately 10,500 vpd near the Capitol. On-street parking is permitted on either side of the road and the posted speed is 30 mph. The City and County of Denver oversee maintenance of the street.

Logan Street is a two-lane, northbound urban arterial that serves residential neighborhoods and communities in Denver. It pairs with Grant Street as a one-way couplet. Vehicular traffic on Logan is approximately 6,800 vpd. On-street parking is permitted on the east side and the posted speed is 30 mph. The City and County of Denver oversee maintenance of the street.

14th Avenue is a three-lane, eastbound urban arterial that borders the south end of the Capitol. It pairs with 13th Avenue as a one-way couplet. In the Capitol study area, volumes on 14th Avenue are approximately 14,800 vpd. The posted speed on the road is 30 mph. On-street parking is not allowed. The City and County of Denver oversee maintenance of the street.

13th Avenue is a three-lane, eastbound urban arterial that borders the south end of the Capitol. It pairs with 13th Avenue as a one-way couplet. East of Broadway, volumes on 13th Avenue is approximately 12,000 vpd. Moving west of Broadway, vehicular traffic is about 10,500 vpd. The posted speed on the road is 30 mph and on-street parking is allowed on the north side. The City and County of Denver oversee maintenance of the street.



Intersections

All of the intersections bordering the Capitol Complex are currently signalized. These include:

- Lincoln Street and 14th Avenue
- Lincoln Street and Colfax Avenue
- Sherman Street and 14th Avenue
- Sherman Street and Colfax Avenue
- Grant Street and 14th Avenue
- Grant Street and Colfax Avenue

The intersection of 13th Avenue and Lincoln Street, south of the Capitol Complex, has a bus priority signal allowing for buses to shift lanes in advance of other vehicles. The advance signal phase assists buses on Lincoln Street that make left-turns on Colfax Avenue and into Civic Center Station.

Trip Generation

Trip generation for the underground parking garage was obtained from *ITE Parking Generation, 4th edition (2010)*, where the Capitol Complex is classified as Land Use 730: Government Office Building. Ingress and egress percentages for the AM and PM peak hours were obtained from *Parking (Weant and Levinson, 1990)*. Based on a parking garage with 190 spaces, the trip generation during the AM and PM peak hours was determined, as shown in **Table 1**. As shown, most of the traffic is generated during the AM peak hour, with 158 trips. Due to the nature of a state government office, the PM peak generates fewer trips, with 133 vehicles.

Table 1: Trip Generation¹

ITE Land Use Code	Land Use Description	Size		Trip Generation Rates						Trips Generated					
				AM Peak			PM Peak			AM Peak			PM Peak		
				Rate	% Enter	% Exit	Rate	% Enter	% Exit	Trips IN	Trips OUT	Total	Trips IN	Trips OUT	Total
Proposed Parking Garage															
730	Government Office Building	190	spaces	0.83	70%	30%	0.70	40%	60%	111	47	158	53	80	133

¹ Values obtained from ITE Parking Manual, 4th Edition



Operational Analysis

A rough, preliminary traffic simulation in Synchro was used to gauge how the Capitol Complex parking garage could affect existing traffic patterns. To gain a more accurate understanding of traffic operations, updated vehicle counts and signal timing will need to be included in the model.

Based on the preliminary Synchro model, a rough estimate shows that there may be some delays along Lincoln Street. Screen captures from the preliminary SimTraffic model are shown in **Figure 2**. In the AM peak hour, northbound traffic on Lincoln could queue from Colfax past 14th Avenue. This may limit the efficiency of vehicles entering and exiting the Capitol garage. During the PM peak hour, heavy northbound traffic on Lincoln may create difficulties for vehicles exiting the garage. In particular, vehicles heading for a left-turn onto westbound Colfax may struggle crossing over three lanes of traffic.

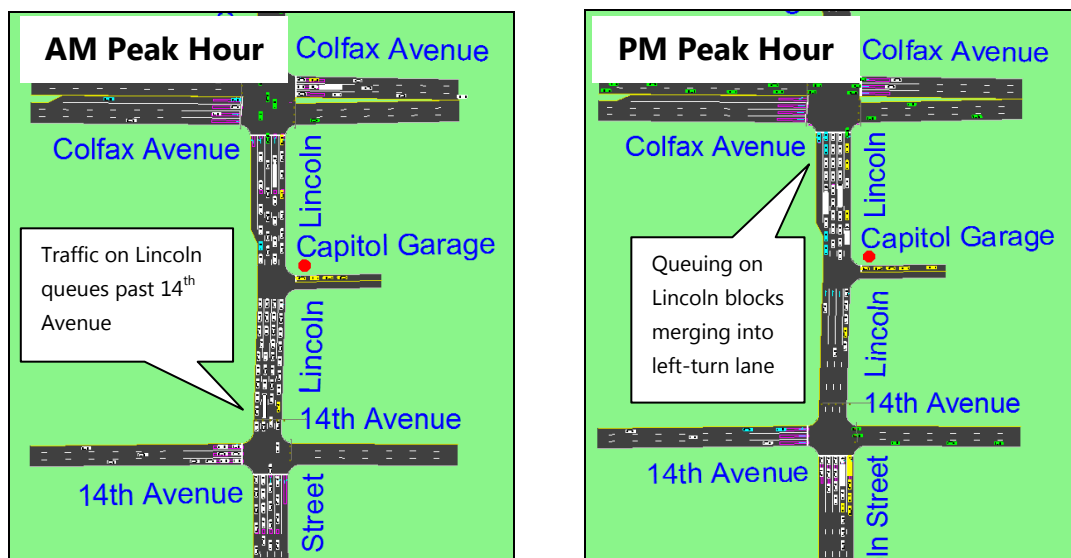


Figure 2: Preliminary Synchro Models (Need Verification)



INGRESS/EGRESS REQUIREMENTS

The underground garage at the Capitol Complex is expected to hold approximately 190 vehicles. Concept plans anticipate a majority of this traffic to be from employees, who will access the garage via gate entrance by coded card. Assuming the Capitol Complex classifies as an office building land use, the expected number of lanes for the facility are:

- Inbound = 1 lane
- Outbound = 1 to 2 lanes, depended on control type

These results were interpreted from the graph on **Figure 3**, which is used to assess the entrance-exit design for parking facilities (Crommelin, Robert W.)

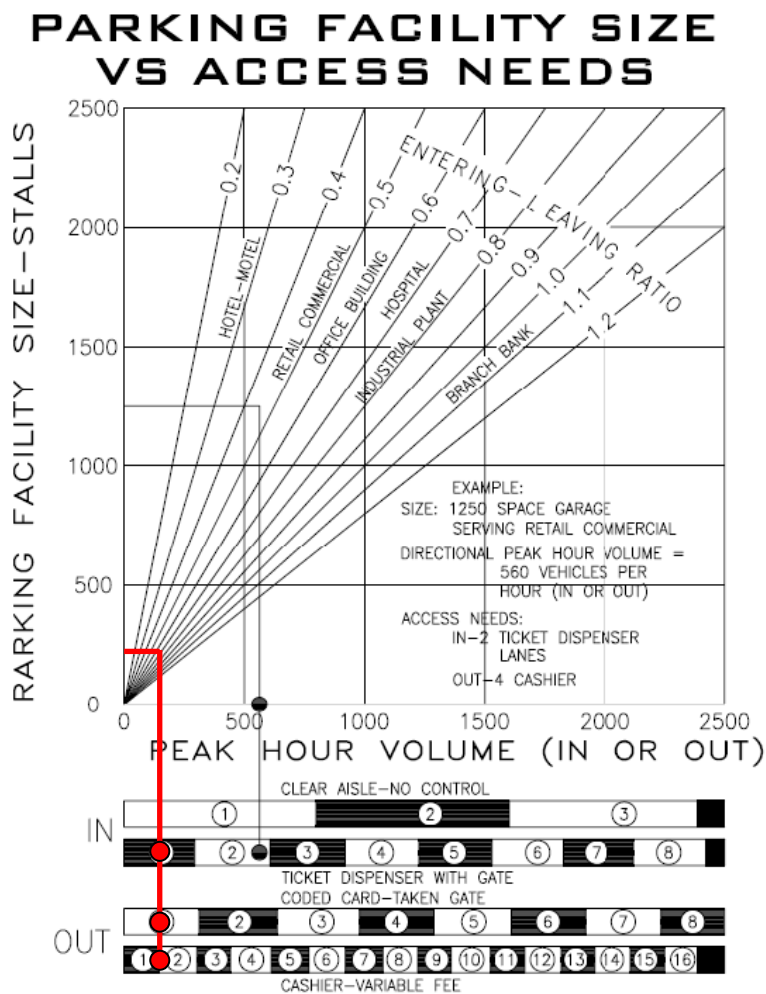


Figure 3: Inbound/Outbound Lane Design



MULTI-MODAL CIRCULATION

Located in central Denver and on the cusp of the Denver CBD, the Capitol Complex experiences heavy volumes from all transport modes, including vehicles, transit, bicyclists, and pedestrians. The following section provides details for alternative transportation modes, including transit, bicycles, and pedestrians. Current services and facilities will be presented, as well as areas for potential improvement.

Transit

With a centralized site in downtown Denver, the Capitol Complex is in the core of several bus routes. Located one block away from Civic Center Station, there are multiple transit routes to access the site. A map of transit routes in the Capitol Complex area is shown in **Figure 4**.

- **Lincoln Street/Broadway:** The one-way couplet of Lincoln Street and Broadway serves as a primary bus corridor, facilitating multiple routes into and out of downtown Denver at Civic Center Station. During peak hours, the corridor may see up to 17 bus routes, including express, limited, local, and regional services. Peak hour bus operations are accommodated by a reserved bus and right-turning vehicle lane.
- **Colfax Avenue:** The Colfax corridor facilitates regular bus service throughout the day, providing a key connection between Denver, Aurora, and Lakewood. In the Capitol area, buses provide local and limited services. At the northeast corner of the Capitol site, a bus stop provides convenient transit access to users of the Capitol. The following section describes details on two current transit studies for the Colfax Corridor.
- **Grant Street:** One local bus route runs on Grant Street, bordering the east side of the Capitol.

Transit Improvements

Currently, two separate projects are underway to study transit improvements on Colfax Avenue. As described below, the Colfax Corridor Connections project is led by the City and County of Denver, while the 15/15L Transit Priority Study is led by RTD. Although these projects are not tied together, both organizations are coordinating in planning efforts.

- **Study #1: Colfax Corridor Connections (City and County of Denver)** – This long-term study is intended to identify multi-modal transportation improvements on the East Colfax corridor, stretching from I-25 to I-225. As a follow-up to Denver’s 2010 Streetcar Feasibility Study, the



Colfax Corridor Connections project looks at a wider range of transit modes and alignments. The three modes being analyzed in the Alternatives Analysis (AA) evaluation include enhanced bus, bus rapid transit (BRT), and modern streetcar. As of summer 2013, the project is completing its AA evaluation and working to select a locally preferred alternative. Next steps will include conducting environmental clearance and hosting public meetings.

- **Study #2: 15/15L Transit Priority Study (RTD)** – This short-term study is intended to reduce travel times and increase security and ridership for bus routes 15/15L. The focus area is on East Colfax between Broadway and Yosemite. Potential improvements being studied include stop amenities, bus bulbs, bypass lanes/queue jumps, and transit signal priority. Currently, preliminary analysis has been completed and stakeholder meetings are underway. Next steps will include design, slated to start in late fall 2013, and construction in late 2014.



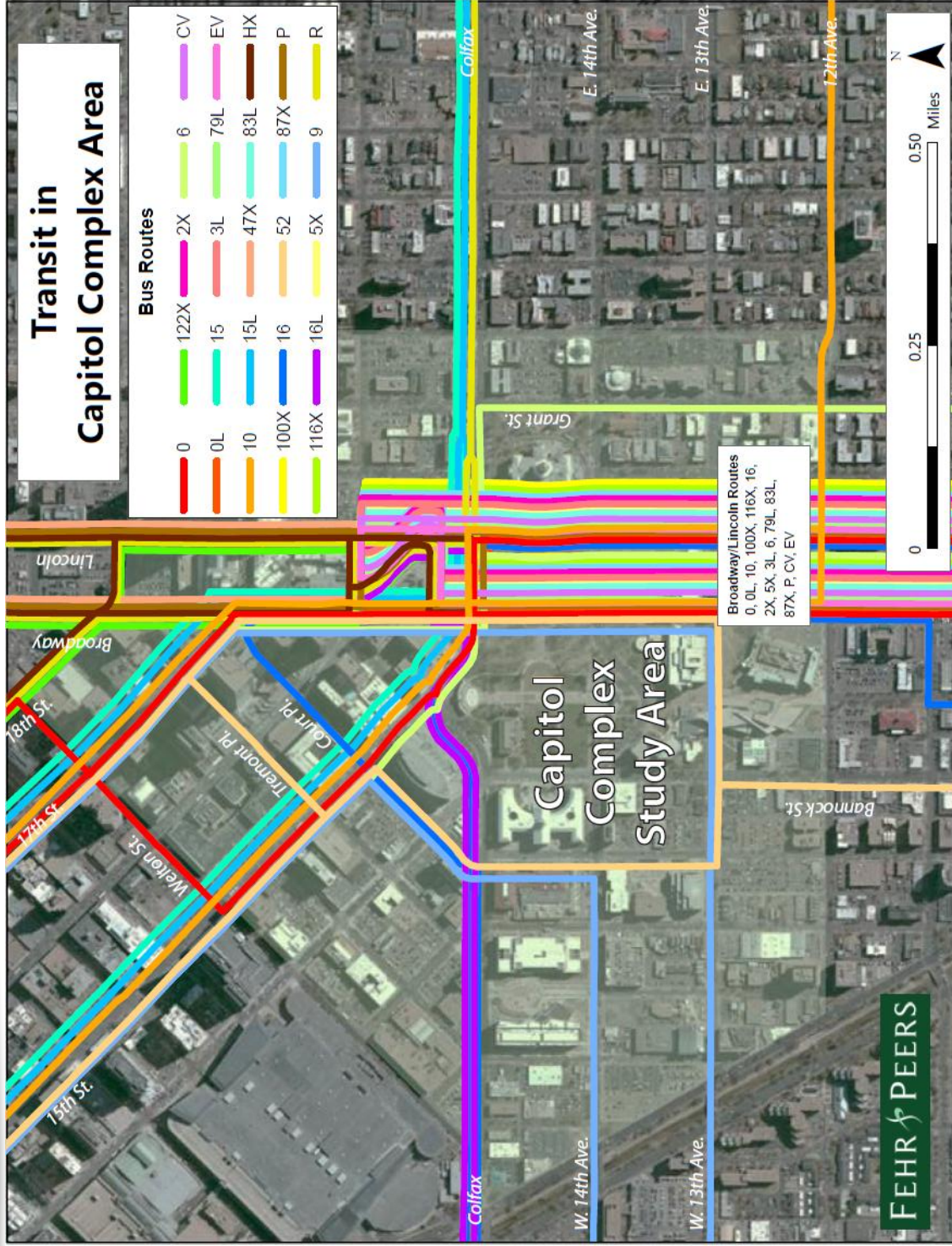


Figure 4: Transit in Study Area



Bicycle Facilities

Many of the roads surrounding the Capitol Complex area are designated to facilitate bicycle traffic, as shown in **Figure 7**. Sherman Street, which intersects the driveway surrounding the Capitol, features sharrows (shared bike lane markings) in both directions. East-west bike traffic is facilitated by a bike lane on 16th Avenue and bike routes/sharrows on 12th Avenue. Connections into the CBD are provided by the bike lane on 16th Avenue and cycle track on Bannock Street, in front of the City and County of Denver building.

To encourage bicycling mode share, adequate bike parking facilities are recommended. Currently, employees working in the Capitol Complex are allowed to register for bike lockers. In designing the new underground parking garage, appropriate, long-term bike parking should be included within the design. Long-term bike parking for employees and visitors should provide controlled access, weather protection, and higher security. These facilities may include bike lockers, an indoor cage, or a bicycle room. Examples of long-term bike parking are shown in **Figures 5 and 6**.



Figure 5: Bike Locker (University of Texas at Austin)



Figure 6: Indoor Bike Cage (Seattle, Washington)



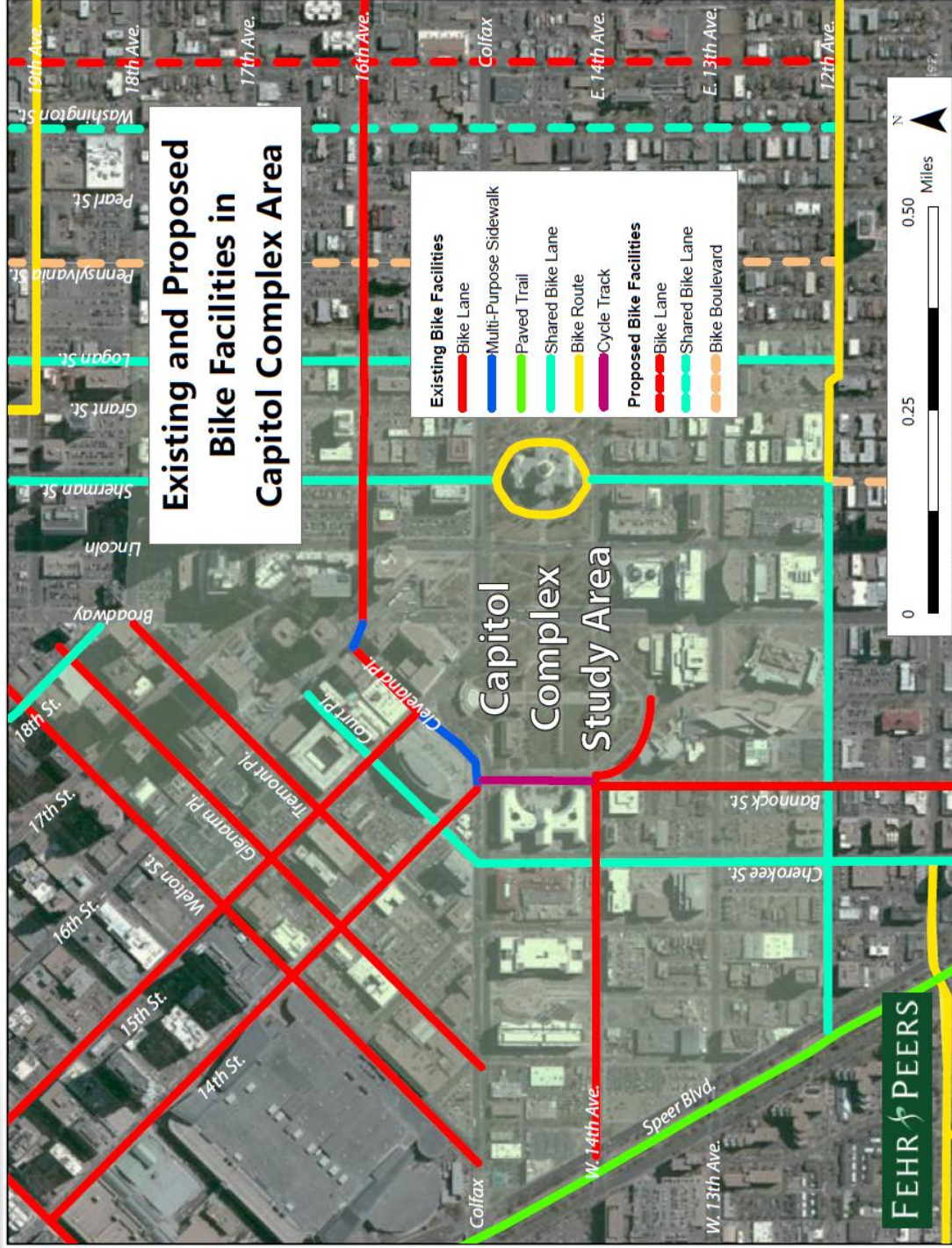


Figure 7: Existing and Proposed Bike Facilities



Pedestrian Facilities

Located adjacent to Civic Center Park, the downtown CBD, and multiple attractions, the Capitol Complex experiences high volumes of pedestrian traffic. In preliminary design concepts for the Capitol Complex Master Plan, the west lawn of the Capitol would bridge over and connect with the current park between Broadway and Lincoln. The block of Lincoln Street between Colfax and 14th Avenue would become a subgrade tunnel for vehicular traffic; thus, allowing for pedestrians to cross-over Lincoln via the expanded park and foot path.

Currently, all of the intersections surrounding the Capitol have pre-timed pedestrian phases. These signals allow for regular pedestrian movements, while accommodating vehicular traffic. Crosswalks are clearly marked in all of the intersections, providing a designated area for pedestrians to cross. To facilitate heavy pedestrian traffic, the Capitol Complex Master Plan should consider improvements to the existing pedestrian facilities. Wide sidewalks and easy street crossings can help build a safe, visible environment for pedestrians. Below is a list of potential pedestrian improvements that could enhance the Capitol Complex area:

- **Advance Stop Lines** place a stop bar about 4 feet back from a sidewalk. As shown in **Figure 8**, the sight triangle for vehicles in the second lane opens up, improving visibility for both the pedestrian and the drivers.

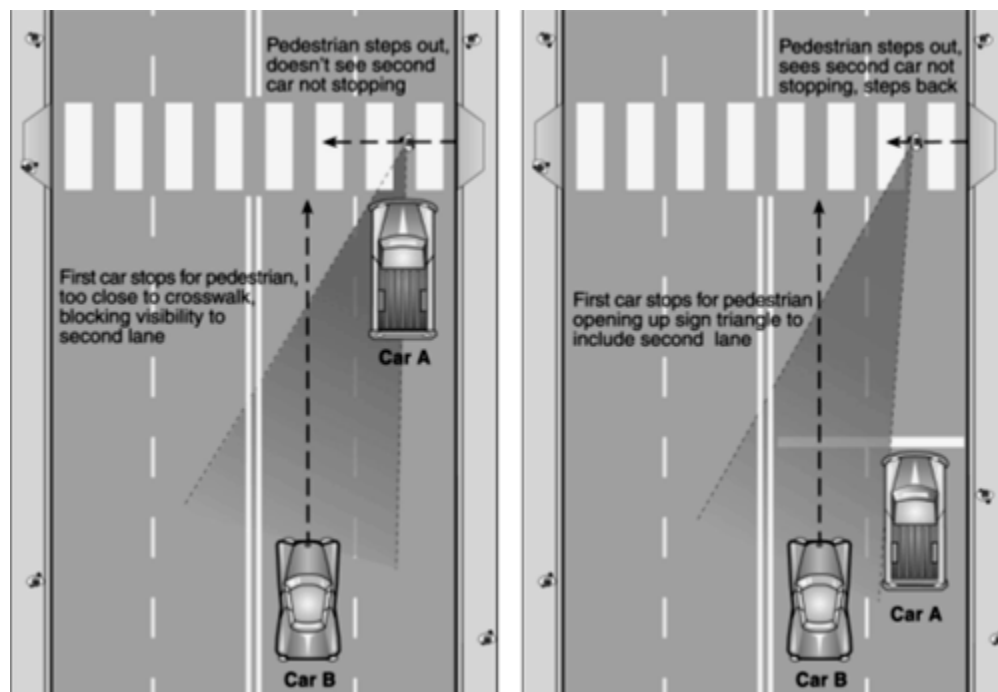


Figure 8: Advance Stop Line Sight Triangle Comparison



- **Pedestrian Refuge Islands** can be incorporated or retrofitted into existing medians as a way to break the the crossing for wider streets. This may be useful at the intersection of Lincon Street and Colfax Avenue.
- **High Visibility Crosswalks** allow for drivers to clearly delineate pedestrian zones. These designated crossing areas are typically painted with a series of wide stripes parallel to the curb, as shown in **Figure 9**. Continental crosswalks should be placed to avoid wheel paths, which will reduce long-term maintenance needs.

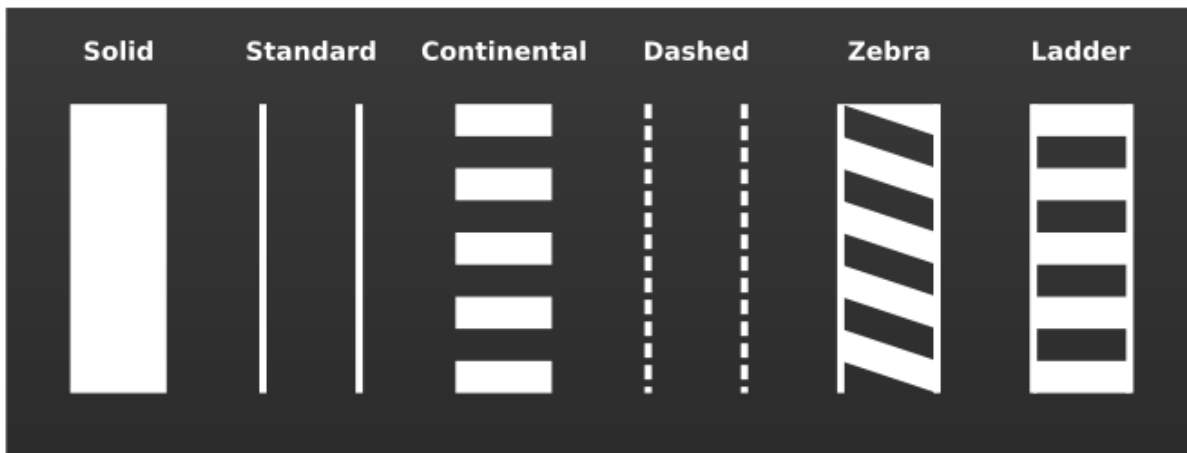


Figure 9: High Visibility Crosswalk Treatments

