

Appendix E

Traffic Study

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DENVER FEDERAL CENTER MASTER PLAN AND EIS

Add Services for Transportation

Final Report

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The logo for EDAW, featuring the letters "EDAW" in a white, serif font centered within a solid purple rectangular background.

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1) INTRODUCTION

In 2003, Representative Bob Beauprez, Republican-Arvada, and Senator Ben Nighthorse Campbell, Republican-Colorado, introduced legislation that would allow private development on the Denver Federal Center (DFC) site. Since then, planning and design has proceeded on the following major developments:

- St. Anthony Central Hospital expects to break ground on a new Central Hospital Campus on the DFC site in the near future and open the hospital's doors to patients in 2010.
- The Regional Transportation District's (RTD) West Corridor Light Rail Transit (LRT) line is scheduled to open in 2014. As part of this project, the existing Cold Springs park-n-Ride facility will be closed and replaced with a LRT station on the DFC site.

Rather than responding to these development changes on a piecemeal basis, the General Services Administration (GSA) began a comprehensive planning process to develop a Site Master Plan. This Site Master Plan will provide a new 20-year vision and development strategy for the 670-acre secured DFC site.

The purpose of the study is to assess the cumulative effects of all proposed developments on the DFC transportation system (including but not limited to the St. Anthony Hospital relocation, the Federal Center LRT station and possible changes to the DFC site) and to identify improvements that will mitigate expected impacts. This study is intended to compliment the *West Central Subarea Transportation Study* currently being conducted by the City of Lakewood.

2) EXISTING CONDITIONS/PROGRAMMED IMPROVEMENTS

Roadway Network

Figure 1 illustrates the roadway system that serves the DFC. As shown, the DFC is bounded by four major roadways (6th Avenue on the north, Kipling Street on the east, Alameda Avenue on the south, and Union Boulevard on the west). Sixth Avenue (U.S. 6) is a six lane controlled access freeway. Kipling Street is a four lane arterial with a posted speed limit of 45 mph and has a partial cloverleaf interchange with 6th Avenue. It also is designated as State Highway 391 and is classified as a non-rural regional highway (NR-A). Alameda Avenue also is a four lane arterial with a posted speed limit of 45 mph. Union Boulevard is a six lane arterial with a posted speed limit of 40 mph and has a diamond interchange with 6th Avenue.

The DFC has five functional access points. Two gates (1 and 2) are off of Kipling Street, one gate (7) is off of Alameda Avenue, and two gates (4 and 5) are off of Union Boulevard. All gates are secured entrances.

The majority of the street system within the Denver Federal Center is two lanes with two-way traffic. Portions of Main, Center and North Avenues and all of 7th Street, however, have four lanes with two-way traffic.



Denver Federal Center
SITE PLAN STUDY

LEGEND

- FREEWAY
- 6 - LANE ARTERIAL
- 4 - LANE ARTERIAL
- TRAFFIC SIGNAL
- INTERCHANGE
- 4 - LANE STREET
- 2 - LANE STREET

Source:
Matrix Design Group Inventory,
2005



0 150 300 450 600
January 2007
14.000

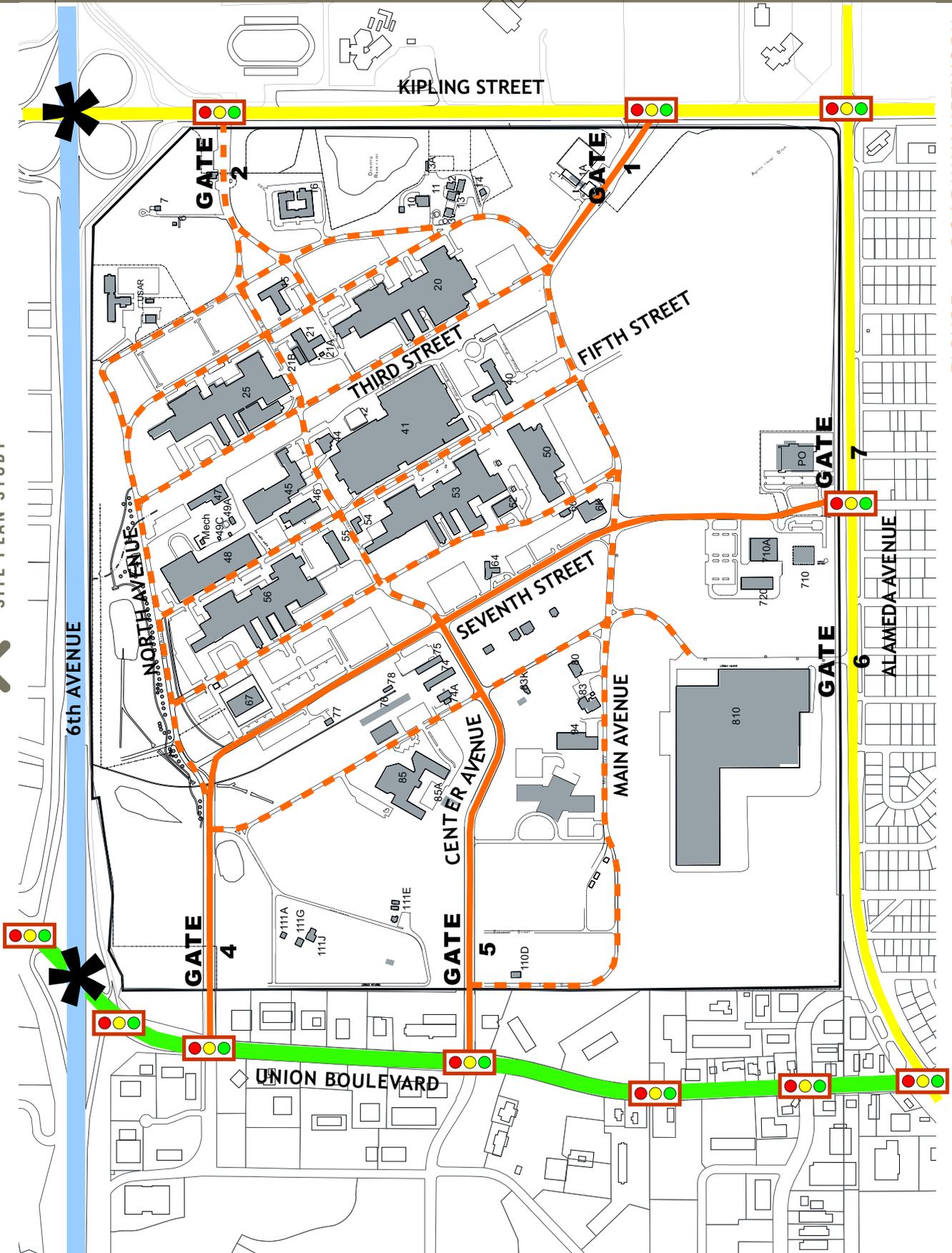


FIGURE 1: ROADWAY NETWORK

Figure 2 shows the existing traffic volumes on both the perimeter streets and at each entrance to the DFC. To determine how efficiently and effectively the existing roadway network accommodates the existing traffic volumes, all of the signalized access points to the DFC were analyzed. The results are shown as Levels of Service (LOS). Letters designate each level, from A to F, with LOS A representing the best operating conditions and LOS F the Worst. LOS A, B and C represent the intersection status as under capacity. LOS D is near capacity, LOS E is at capacity, and LOS F is over capacity. LOS D is the desired performance and LOS E is the minimum acceptable level of service at signalized intersections.

Table 1 shows the results of the intersection operations analysis. As shown, all of the intersections operate at acceptable service levels in both peak periods.

Table 1 - Existing Levels of Service

Intersection	AM	PM
Union Blvd & 4 th Ave (Gate 4)	C	C
Union Blvd & 2 nd Ave (Gate 5)	B	B
Alameda Ave & Oak St (Gate 7)	C	D
Kipling St & Gate 1	A	A
Kipling St & Gate 2	A	B

Transit Service

As shown in Figure 3, the DFC is directly served by two Regional Transportation District (RTD) routes. Service from the east is provided by Route 14 (Florida). Regional Route GS is available from Boulder and Golden. An additional 15 routes serve the Cold Springs park-n-Ride, which is located in the northwest corner of the DFC. This facility has 646 parking spaces and offers excellent service to all major destinations throughout the metropolitan area.

The West Corridor Light Rail Transit Line is scheduled to open in 2014. The West Corridor is 12.1 miles in length and extends from downtown Denver to the Jefferson County Government Center in Golden. Figure 4 illustrates the alignment through the DFC. As shown, the current configuration crosses over 6th Avenue from the north into the DFC. It then crosses North Avenue at-grade and proceeds south to the new Federal Center station. At the station, the line then loops back to the north and crosses under North Avenue and Union Boulevard as it proceeds to the west.

The Federal Center station replaces the Cold Springs park-n-Ride. The station will have 1,000 parking spaces (354 net new spaces) and 15 bus bays. Twenty-three percent of the riders are forecast to access the station by automobile, 58 percent by bus, and 19 percent by walking.

Fifteen bus routes will serve the station (a maximum of 95 buses per hour). These routes will consist of local, express, regional, and new feeder services. As shown in Figure 4, none of these routes will penetrate the DFC per the current practice. Access to the station will be from both Union Boulevard and Alameda Avenue via the new Routt Street. As part of the West Corridor project, RTD will build Routt Street from Alameda Avenue to the station. These improvements also include the signalized intersection at Alameda Avenue.



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45,400 AVERAGE DAILY TRAFFIC
← 850 DAILY TRAFFIC INTO SITE
787 → DAILY TRAFFIC OUT OF SITE

Source:
Denver Regional Council of
Governments, 2005
City of Lakewood Traffic Counts,
2001



FIGURE 2: EXISTING DAILY TRAFFIC



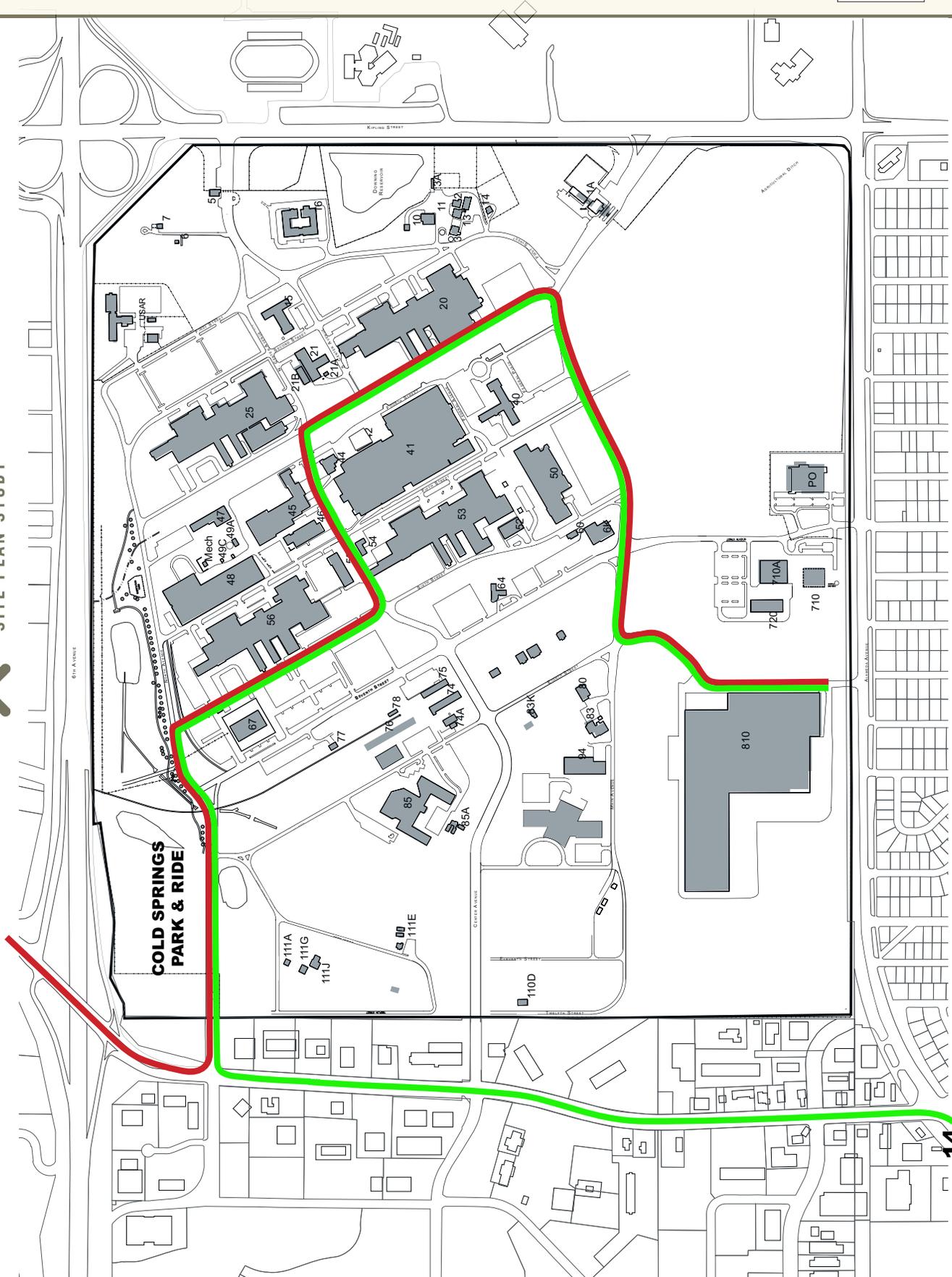
Denver Federal Center SITE PLAN STUDY

GS

LEGEND

GS BUS ROUTE

14 BUS ROUTE



Source:
Regional Transportation District
Route Maps, 2006



FIGURE 3: EXISTING TRANSIT ROUTES

Bicycle Facilities

Currently, bicycle paths are located along three of the DFC's perimeter streets (Kipling Street, Alameda Avenue, and Union Boulevard). The City of Lakewood has plans to better connect the DFC to the rest of Lakewood through a number of bike lane and path extensions. Figure 5 shows the proposed improvements that are contained in the *Lakewood Bicycle System Master Plan*. Key investments include:

- Underpass of Alameda Avenue at Simms Street
- Overpass of 6th Avenue as part of the future Routt Street extension
- A bike path along McIntyre Gulch with an underpass of future Routt Street

3) FUTURE TRAVEL DEMAND

Model Development

Future traffic for the DFC was forecast using a travel demand model. The platforms for the travel demand model were the Denver Regional Council of Government's (DRCOG) 2005, 2015 and 2030 regional transportation models. The first step in creating the travel model involved splitting select traffic analysis zones (TAZ) and relocating some of the centroid connectors to reflect the actual access locations. Table 2 shows the zones that were split in the DFC and the corresponding new TAZ ID.

Original Zone ID	New Zone ID
682	682
	2666
	2667
	2668
	2671
683	683
	2665
	2669
	2670

The increase in the number of TAZ's in the model required the modification of a number of input files so that the calculations and results properly reflect the zone changes. The TAZ's that were added to the model required the modification of the land use, highway, transit base, and TAZ geographic files. Moreover, transit routes were updated to run on new roadway links where appropriate in order to provide better connectivity to the additional zones. The intrazonal travel timetable and the k-factor matrices were expanded to include the additional zones. For the trip distribution model step, final speeds from DRCOG's speed balanced runs were used as input speeds in the subarea model runs. The speed balancing procedure was used on the initial model runs for each of the model years; subsequent model runs did not include speed balancing to provide a direct comparison between the model runs.



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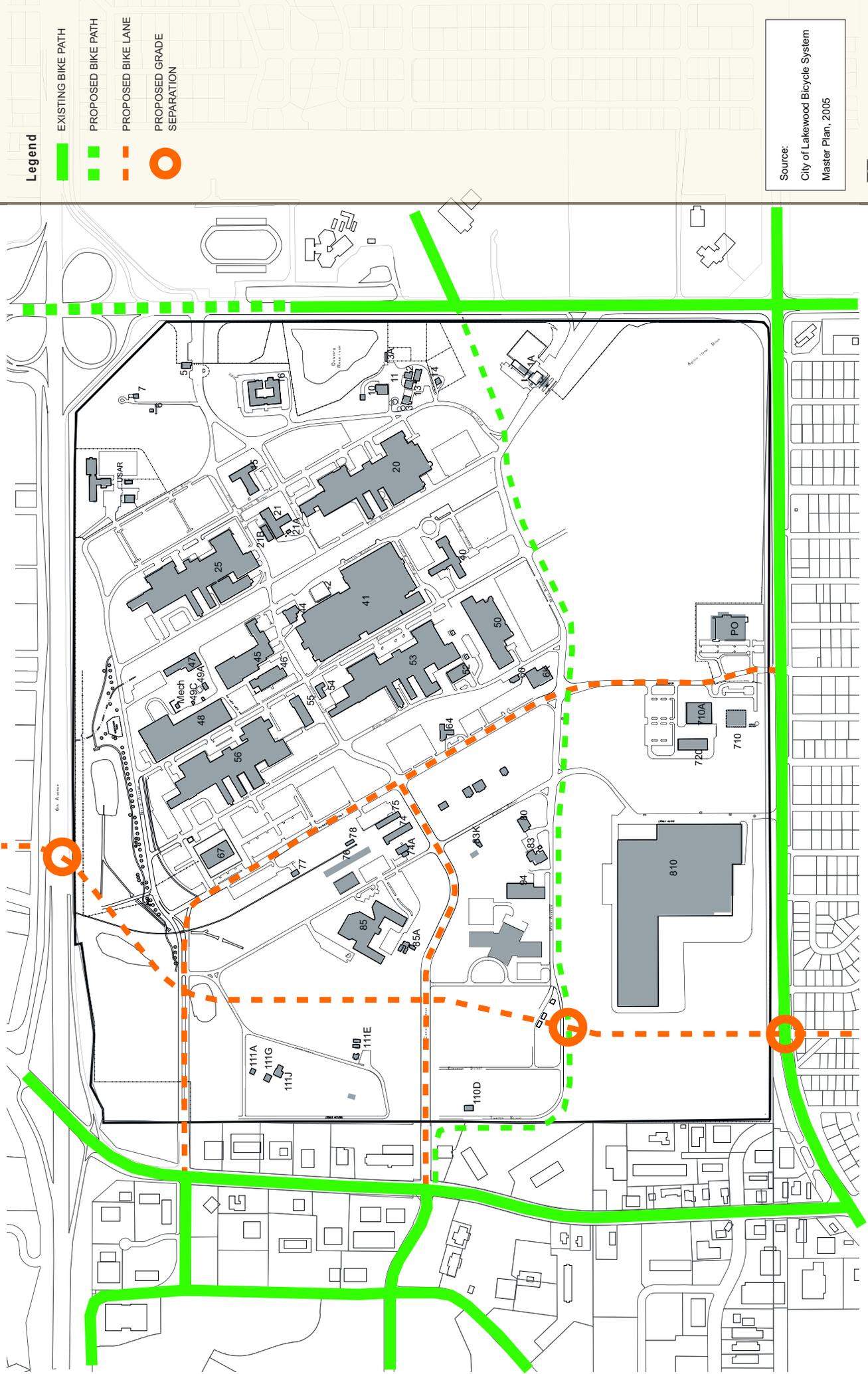


FIGURE 5: PLANNED BICYCLE SYSTEM

DRCOG’s land use files were modified to include the St. Anthony Hospital development and the two DFC development alternatives. Table 3 provides a summary of the two DFC development alternatives. The defining characteristic of the Mall Alternative is the creation of a linear “Federal Mall” connecting Union Boulevard, the St. Anthony Central Hospital Campus, and the Federal Core. Figure 6 illustrates this concept and shows how the various land uses are distributed throughout the site. The defining characteristic of the Quad Alternative is the central “quad” located in the center of the DFC site. Figure 7 illustrates this concept and shows how the various land uses are distributed throughout the site

Table 3 - Development Summary by Alternative

Land Use	Mall	Quad
Office (SF)	950,000	400,000
Research and Development (SF)	446,500	633,000
Retail (SF)	250,000	212,000
Residential (Units)	1,400	290
Lodging (Rooms)	200	200
Federal Center (SF)	4,700,776	4,636,927

As shown in Table 3, the Mall Alternative has significantly more office square footage and residential units but less research and development square footage. The size of the other land uses is either identical or comparable between the two alternatives.

Model Output

Table 4 presents the trip generation from the subarea travel model. In 2015, it was assumed there would be no change to the existing DFC uses and the St. Anthony Hospital Campus would include the hospital, physician offices, and a cancer care facility. The LRT station includes 1,000 parking spaces and 15 bus bays. In 2030, the St. Anthony Hospital Campus includes both the hospital and related medical office buildings. The DFC site also is built-out by alternative. Transit oriented development associated with the LRT station is included in the DFC alternatives.

Today, the DFC site generates approximately 15,900 vehicle trips per day. By comparison, the 2030 trips will be between six and seven times greater, depending on the alternative.



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FIGURE 7: FEDERAL QUAD ALTERNATIVE

Table 4 - Trip Generation

	Daily Trips
2015	
▪ St. Anthony	19,320
▪ LRT Station	2,694
▪ DFC	15,369
▪ Total	37,383
2030	
▪ St. Anthony	19,320
▪ Medical Offices	12,192
▪ LRT Station	2,694
▪ DFC - Mall	75,577
▪ Total	109,783
2030	
▪ St. Anthony	19,320
▪ Medical Offices	12,192
▪ LRT Station	2,694
▪ DFC - Quad	61,319
▪ Total	95,525

The next step in the process involved running the subarea travel model. Model outputs were adjusted based on the procedure provided in *National Cooperative Highway Research Program Report (NCHRP) 255*, Transportation Research Board, 1982. This refinement procedure involves comparing model output to existing daily traffic counts to calibrate the model results for future year traffic forecasts. In this case, the 2005 model run output was compared to actual 2005 daily traffic volumes. The NCHRP process involves two adjustment methods: percentage adjustments and difference adjustments. The percentage method adjusts the future year output (2015 or 2030) by a ratio of the existing count to the base year model output. The difference method adjusts the future year output by the difference between the existing count and the base year model output. The reported daily traffic volume is typically the average of the two adjusted numbers. However, in cases where the ratio method yields unreasonable results, engineering judgment is applied to determine a reasonable forecast.

Figure 8 shows the 2015 daily traffic forecasts for the DFC. These daily link volumes were used to determine a growth rate for each intersection in the study area. This growth rate was then applied to the existing peak hour volumes entering and exiting each intersection. The entering and exiting volumes were converted to turning movements utilizing guidance contained in *NCHRP 255 Highway Traffic Data for Urbanized Area Project Planning and Design*, 1982. This report provides an iterative process for determining peak hour volume projections by balancing the entering and exiting traffic at an intersection until an acceptable level of closure is reached. The study area intersections were “seeded” with existing peak hour turning movement volumes to serve as a baseline condition, and then manual adjustments were made where appropriate, based on engineering judgment. Figure 9 shows the 2015 peak hour intersection volumes for the DFC.



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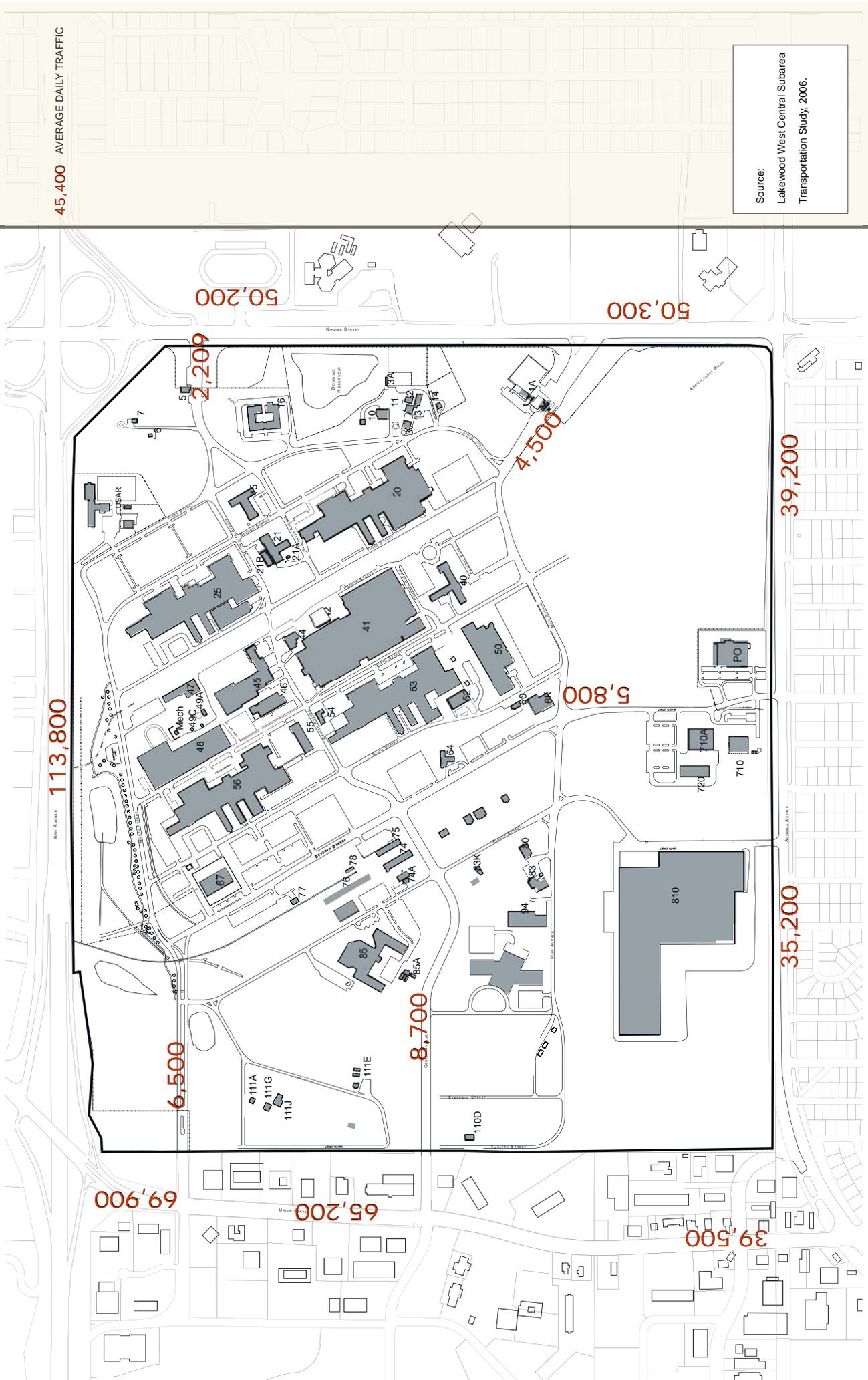


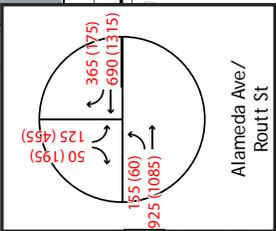
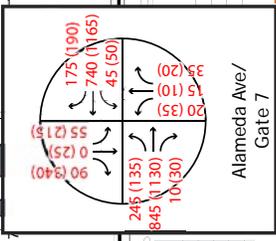
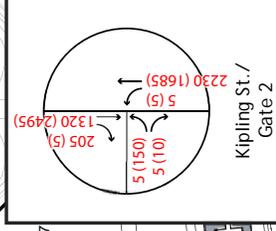
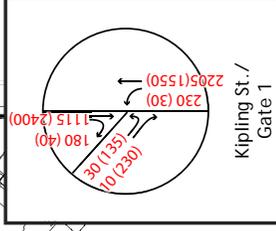
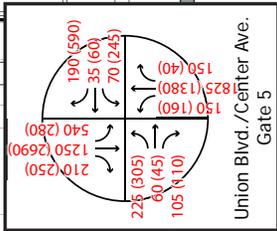
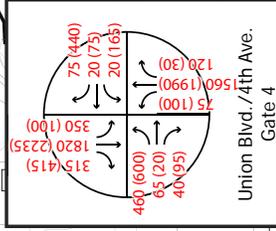
FIGURE 8: 2015 TRAFFIC FORECASTS



Denver Federal Center SITE PLAN STUDY

Legend

55 (150) AM PEAK (PM PEAK)
PEAK HOUR VOLUMES



Source:
Lakewood West Central Subarea
Transportation Study, 2006.

FIGURE 9: 2015 PEAK HOUR VOLUMES

Figures 10 and 11 show the 2030 daily and peak hour intersection traffic volumes for the Mall Alternative, respectively. Figures 12 and 13 show the 2030 daily and peak hour intersection traffic volumes for the Quad Alternative, respectively. The process described above was repeated to convert the daily link volumes to peak hour intersection volumes in both cases.

4) FUTURE NEEDS ASSESSMENT

2015 Assessment

To determine how efficiently and effectively the existing roadway network accommodates the 2015 peak hour volumes shown in Figure 9, the signalized access points to the DFC were analyzed. Table 5 presents the results of this analysis. As shown, all of the intersections in the AM peak hour operate at acceptable service levels. In the PM peak hour, all but one of the intersections operates at acceptable service levels. The Union Boulevard and 4th Avenue intersection is expected to operate at capacity.

Table 5 - 2015 Levels of Service

Intersection	AM	PM
Union Blvd & 4 th Ave (Gate 4)	C	E
Union Blvd & 2 nd Ave (Gate 5)	D	D
Alameda Ave & Routt St	C	B
Alameda Ave & Oak St (Gate 7)	C	D
Kipling St & Gate 1	A	B
Kipling St & Gate 2	A	B

2030 Assessment (Mall Alternative)

To determine how efficiently and effectively the existing roadway network accommodates the 2030 peak hour volumes shown in Figure 11, all of the signalized access points to the DFC were analyzed. Table 6 presents the results of this analysis.

As shown, four of the intersections in the AM peak hour and all of the intersections in the PM peak hour fail to meet the minimum acceptable service levels established by the City of Lakewood.

Table 6 - 2030 Levels of Service for Mall Alternative

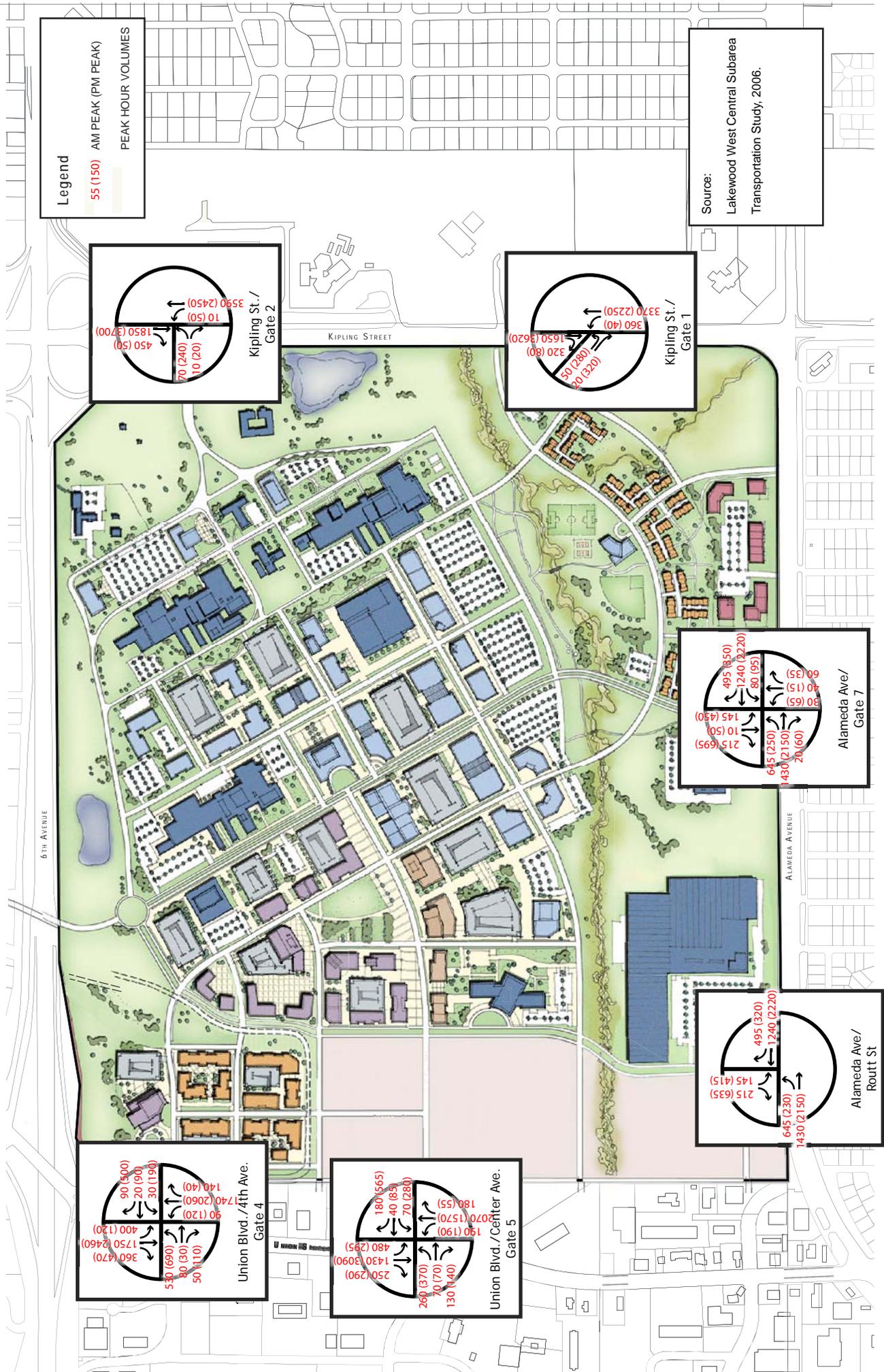
Intersection	AM	PM
Union Blvd & 4 th Ave (Gate 4)	C	F
Union Blvd & 2 nd Ave (Gate 5)	F	F
Alameda Ave and Routt St	F	F
Alameda Ave & Oak St (Gate 7)	F	F
Kipling St & Gate 1	D	F
Kipling St & Gate 2	F	F



Denver Federal Center SITE PLAN STUDY



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Legend
 55 (150) AM PEAK (PM PEAK)
 PEAK HOUR VOLUMES

Source:
 Lakewood West Central Subarea
 Transportation Study, 2006.

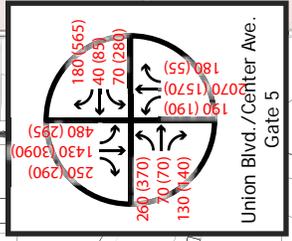
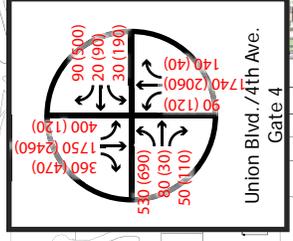
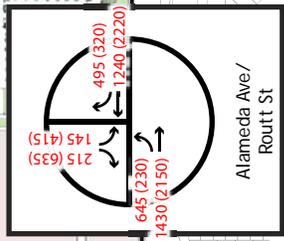
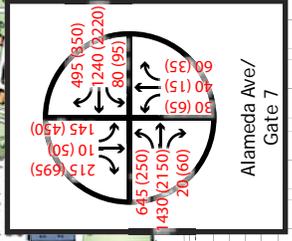
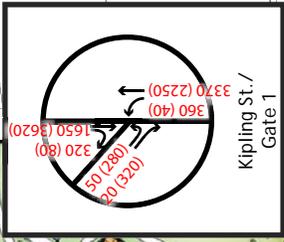
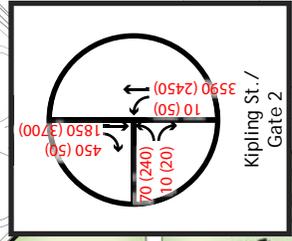


FIGURE 11: 2030 PEAK HOUR VOLUMES - MALL





Denver Federal Center SITE PLAN STUDY

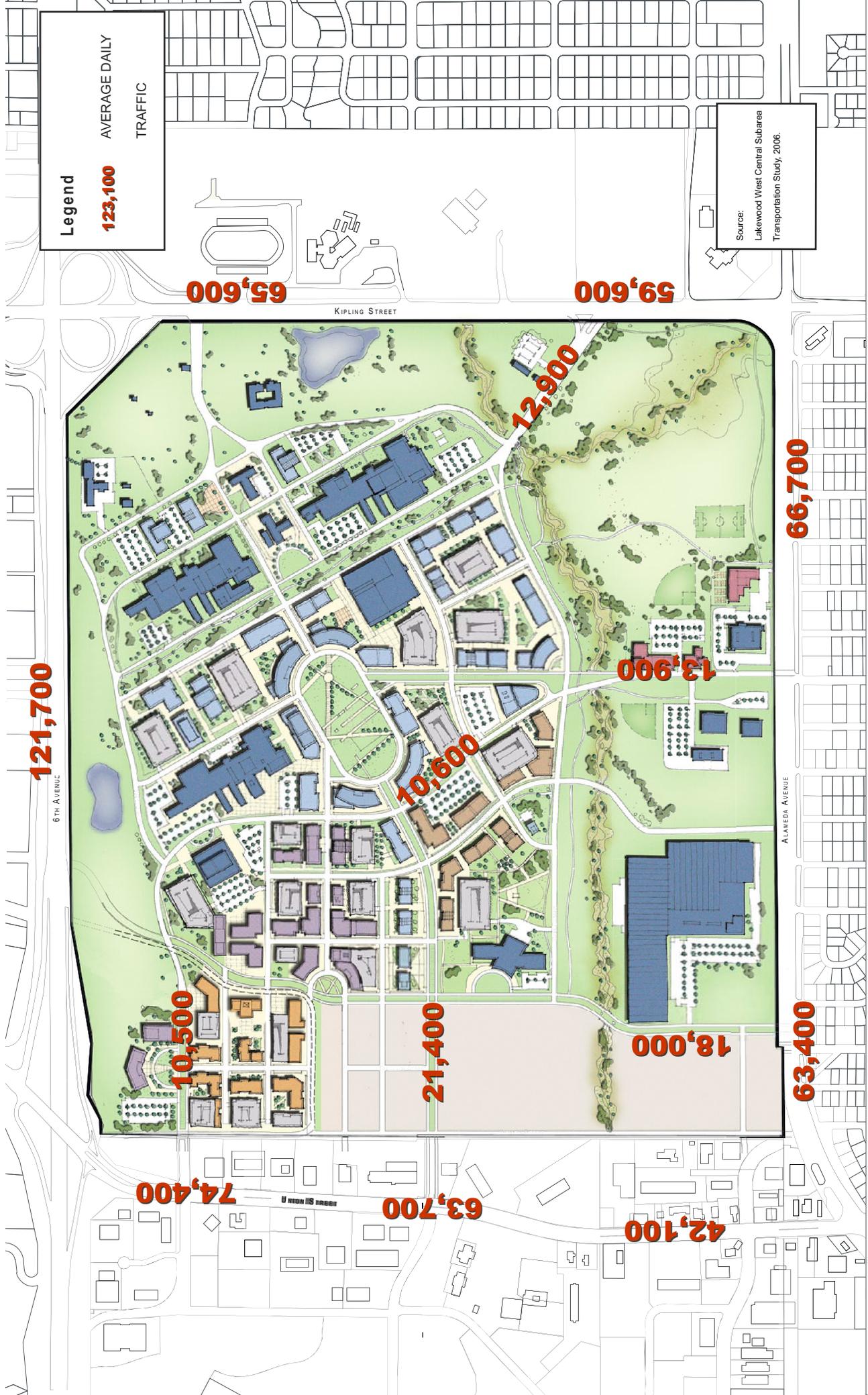


FIGURE 12: 2030 TRAFFIC FORECASTS - QUAD



FIGURE 13: 2030 PEAK HOUR VOLUMES - QUAD

2030 Assessment (Quad Alternative)

To determine how efficiently and effectively the existing roadway network accommodates the 2030 peak hour volumes shown in Figure 13, all of the signalized access points to the DFC were analyzed. Table 7 presents the results of this analysis.

As shown, three of the intersections in the AM peak hour and all of the intersections in the PM peak hour fail to meet the minimum acceptable service levels established by the City of Lakewood.

Table 7 - 2030 Levels of Service for Quad Alternative

Intersection	AM	PM
Union Blvd & 4 th Ave (Gate 4)	C	F
Union Blvd & 2 nd Ave (Gate 5)	D	F
Alameda Ave & Routt St	F	F
Alameda Ave & Oak St (Gate 7)	F	F
Kipling St & Gate 1	D	F
Kipling St & Gate 2	F	F

5) MITIGATION IMPROVEMENTS

The roadway improvements that will be needed to accommodate the 2030 travel demands are listed below. It should be noted these improvements apply to both the Quad and Mall alternatives.

- **Roadway Improvements**
 - Widen Alameda to six lanes from west of Union to Allison
 - Widen Kipling to six lanes from 6th Avenue to Mississippi
 - Extend the proposed Routt Street to the north over 6th Avenue and connect to Quail Street. Routt Street should have four through lanes from Alameda Avenue to 8th Avenue. Separate left turn lanes should be provided at all signalized intersections.
- **Intersection Improvements**
 - Provide two westbound right turn lanes at the intersection of Union and 4th
 - Provide two westbound right turn lanes, two southbound left turn lanes, and one southbound right turn lane at the intersection of Union and 2nd
 - Provide two eastbound left turn lanes, one southbound exclusive left turn lane and one shared left and right turn lane, and one westbound right turn lane at the intersection of Alameda Avenue and Routt Street.
 - Provide two eastbound left turn lanes, two southbound left turn lanes, two southbound right turn lanes, and one westbound right turn lane at the intersection of Alameda and Oak.
 - Provide a northbound left turn at the intersection of Kipling Street and Gate One. This will require a realignment of the access to the JeffCo stadium on the east side of Kipling Street.

- 6th Avenue and Union Interchange Improvements
 - Widen bridge by two lanes to accommodate double lefts from northbound to westbound and southbound to eastbound
 - Signalize the double right turns from the westbound off ramp to northbound Simms
 - Expand eastbound off ramp for double left turns and double right turns

The base roadway network with the above improvements was then analyzed. Table 8 provides the results. As shown, all of the intersections in the AM peak hour and the PM peak hour either meets or exceeds the minimum acceptable service levels for signalized intersections. The only location in the vicinity of the DFC that is over capacity is the intersection of Union and Alameda. Since widening Union Boulevard south of Alameda Avenue would be too disruptive to the residential neighborhood, a grade-separated facility at the intersection may be necessary to accommodate the 2030 traffic volumes.

Table 8 - 2030 Levels of Service with Improvements

Intersection	Mall		Quad	
	AM	PM	AM	PM
Union Blvd & 4 th Ave (Gate 4)	C	E	C	D
Union Blvd & 2 nd Ave (Gate 5)	C	E	C	E
Alameda Ave & Routt St	B	D	B	D
Alameda Ave & Oak St (Gate 7)	D	D	C	D
Kipling St & Gate 1	A	D	A	B
Kipling St & Gate 2	A	B	A	B

6) FINDINGS AND RECOMMENDATIONS

Based on the foregoing analyses, the following was concluded:

- Today, the DFC site generates approximately 15,900 vehicle trips per day. By comparison, the 2030 trips will be between six and seven times greater, depending on the alternative.
- The Existing Roadway Network either meets or exceeds the minimum acceptable service levels established by the City of Lakewood for 2015.
- The Existing Roadway Network is not capable of accommodating the 2030 travel demand at the minimum acceptable service levels established by the City of Lakewood.
- While the travel demand for the Mall Alternative is 15 percent higher than the Quad Alternative, the system performance of each is basically the same.
- Even with no changes to the existing 4,000,000 square feet of DFC buildings, one intersection in the AM peak hour and five intersections in the PM peak hour will be over capacity in 2030.
- The following roadway improvements will be required to meet the forecasted 2030 travel with both build alternatives:

Roadway Improvements

- Widen Alameda to six lanes from west of Union to Allison
- Widen Kipling to six lanes from 6th Avenue to Mississippi
- Extend the proposed Routt Street to the north over 6th Avenue and connect to Quail Street. Routt Street should have four through lanes from Alameda Avenue to 8th Avenue. Separate left turn lanes should be provided at all signalized intersections.

Intersection Improvements

- Provide two westbound right turn lanes at the intersection of Union and 4th
- Provide two westbound right turn lanes, two southbound left turn lanes, and one southbound right turn lane at the intersection of Union and 2nd
- Provide two eastbound left turn lanes, one southbound exclusive left turn lane and one shared left and right turn lane, and one westbound right turn lane at the intersection of Alameda Avenue and Routt Street.
- Provide two eastbound left turn lanes, two southbound left turn lanes, two southbound right turn lanes, and one westbound right turn lane at the intersection of Alameda and Oak.
- Provide a northbound left turn at the intersection of Kipling Street and Gate One. This will require a realignment of the access to the JeffCo stadium on the east side of Kipling Street.

6th Avenue and Union Interchange Improvements

- Widen bridge by two lanes to accommodate double lefts from northbound to westbound and southbound to eastbound
 - Signalize the double right turns from the westbound off ramp to northbound Simms
 - Expand eastbound off ramp for double left turns and double right turns
- The improved 6th and Union interchange will likely be needed within the next 10 years. All of the other improvements will be required when the DFC site builds out. The phasing of the remaining improvements will be subject to how fast and where development occurs.
 - Only the Union Boulevard and Alameda Avenue intersection will be over capacity. Since widening Union Boulevard south of Alameda Avenue would be too disruptive to the residential neighborhood, a grade-separated facility at the intersection may be necessary to accommodate the 2030 traffic volumes.
 - Both alternatives are consistent with all recommendations contained in the *Lakewood Bicycle Master Plan* (City of Lakewood, 2005) and compliment all transit plans for the area.

