Technical Memorandum

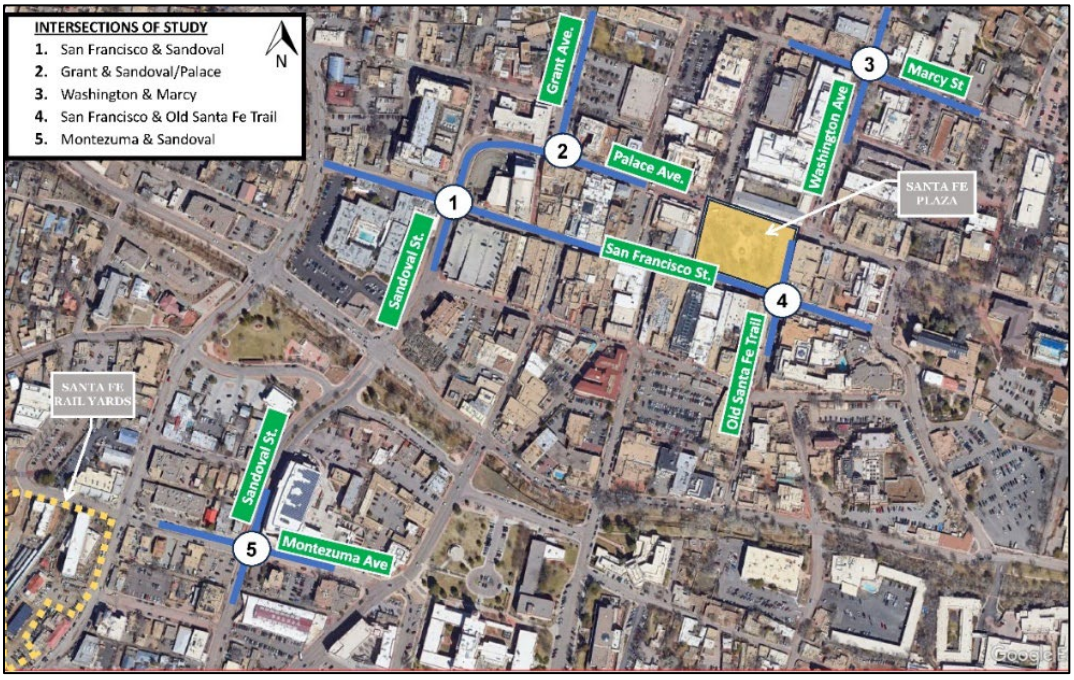
To: Erick Aune, AICP
Director, Santa Fe MPO
From: Adam Miera, PE WHPacific
Data: November 18, 2024
Re: Downtown Multimodal Analysis of Five Signalized Intersection – Santa Fe, NM

This memorandum presents a summary of the analysis conducted for five signalized intersections located in Downtown Santa Fe and identifies the potential in removing the signalization for a more multimodal focus as outlined in various planning documents including the City of Santa Fe's General Plan. The following memo discusses the project background/purpose, traffic and crash data collected, signal warrant analysis, capacity analysis, and alternative traffic control measures assessed for the five intersections of study.

Background

This analysis is conducted for The Santa Fe Metropolitan Planning Organization (SFMPO) in conjunction with the City of Santa Fe at five signalized intersections within the Santa Fe Downtown area at the locations shown in the image below:

Figure 1: Intersections of Study



The Downtown area of Santa Fe is unique in that it is a historic and cultural destination for visitors as well as a hub of local businesses and municipal buildings serving local residents. The area is pedestrian oriented with posted speed limits of 20 mph with street signs throughout the area indicating a "Pedestrian Zone".

Because the public often views traffic signals as a cure-all for traffic problems at intersections, traffic signals have often been installed at intersections where less restrictive traffic control would have been more appropriate and effective. The purpose of this analysis is to review the existing need of signalization and challenge the dominant focus on vehicles to identify the current needs of all travelers including pedestrians and bicyclists at these five intersections. This purpose is a direct application of the City of Santa Fe's General Plan. Chapter 6 of the General Plan titled, Transportation, identifies a guiding policy of "*Give people priority over cars. The Plan emphasizes dedicated bike and pedestrian access and shared use of roadways."* As a result of this, nearly all city adopted integrating plans identify the need to encourage alternatives to automobile travel and provide pedestrians and bicyclists the same if not higher priority as automobiles. These adopted plans include:

- City of Santa Fe Land Use and Urban Design Plan
- Santa Fe 2020-2045 Metropolitan Transportation Plan
    - Santa Fe Metropolitan Pedestrian Master Plan
- Santa Fe Multimodal Transition Plan
- Local Orad Safety Plan
- Bicycle Master Plan

This study is inspired by the success of the *2014 Albuquerque, New Mexico Downtown Walkability Analsysis* which led to several downtown signals to be bagged and treated as all-way stops. In conversation with Jeff Speck, the author of the 2014 analysis, he explained that upon the first go of bagging the lights and putting up stop signs, there was a backlash from the community. City leaders decided to remove the stop signs and go back to signalization. This was then followed by community backlash again as drivers discovered that they actually moved more quickly through downtown and as a result the City permananetly installed all-way stops at several intersections.

As cited in the 2014 analysis:

"For many years, cities inserted traffic signals at their intersections as a matter of pride, with the understanding that a larger number of signals meant that a place was more modern and cosmopolitan. Recently, that dynamic has begun to change, as concerns about road safety have caused many to question whether signals are the appropriate solution for intersections experiencing moderate traffic. Research now suggests that four-way stop signs, which require motorists to approach each intersection as a negotiation, turn out to be much safer than signals. Unlike at signalized intersections, there is considerable eye-contact among users. Drivers slow down, but never have to wait for more than a few seconds, and pedestrians and bicyclists are generally waved through first.

While it would be useful to have more research, the one study on this subject is compelling. It is described in Persaud et. al.: "Crash Reductions related to Traffic Signal Removal in Philadelphia" (1997). This study recounts the 1978 removal of 462 traffic signals due to a 1977 state ruling stating that signals were not warranted on intersections with an annual average daily traffic of less than 9000 on the major street or less than 2500 on the minor street. 199 of these signals had adequate data to make it into the study, and 71 non converted intersections were identified as a control group.

In almost all cases, the signals were replaced by all-way stop signs. The overall reduction in crashes was 24 percent. Severe injury crashes were reduced 62.5 percent overall. Severe pedestrian injury crashes were reduced by 68 percent.

While some pedestrians and drivers prefer signalized intersections, this data is too conclusive to ignore. Until a contradicting study is completed, cities should be compelled to conduct an audit of current signalization regimes to determine which signals may be eliminated."

The approach to this study includes the following:

1. **Field Visit** – Observe existing travel conditions of vehicles, bicyclists, and pedestrians at all intersections.
2. **Traffic Data Collection** – Collect vehicular turning movement volumes and speeds, pedestrian volumes, and bicycle volumes over a 3-day period for each intersection.
3. **Crash Data Collection** – Collect the most recent 5-years of crash data to identify number of crash occurrences and crash severity to identify crash types related to both stop-controlled intersections and signalized intersections.
4. **Signal Warrant Analysis** – Following MUTCD guidelines, perform signal warrant analysis at all five intersections to determine if signalization is currently justified.
5. **Traffic Capacity Analysis** – Assess current and projected intersection capacity of the signalized intersections to determine the Levels of Service of vehicles, pedestrians, and bicyclists.
6. **Alternative Traffic Control Analysis** – Identify alternative traffic control configurations including non-signalized alternatives and assess current and projected intersection capacity.
7. **Identify Recommendations** – Should alternative traffic control measures be a viable alternative, identify recommendations that would lead to their implementation.

Field Review

The study team performed a field review on August 15th to observe existing travel conditions of vehicles, bicyclists, and pedestrians while noting signal phasing and intersection geometric configurations. Attachment A contains an inventory of pictures taken at each intersection. Below are the team members in attendance of the field review.

Table 1: Project Team Members

Team Member	Agency
Erick Aune, Leah Yngve, Hannah Burnham	Santa Fe MPO
Mike Dalmolin, Jose Lerma	City of Santa Fe
Shannon Glendenning	NMDOT
Amanda Herrera, Adam Miera	NV5

Traffic Data Collection

Traffic data consisting of turning movement counts were collected over a 3-day period from Thursday, August 1st , to Saturday, August 3rd, 2024. Additionally, volumes and speed were collected over a 2-day period from Thursday to Friday. The following was collected:

Turning Movement Counts

Intersection turning movement counts were collected using video camera counting equipment at the five study intersections. 13-hours of data were collected each day in an effort to capture the summer peak periods of pedestrians, bicycles, and vehicles. The table below identifies the peak hours for each day counted. The data collected over the three days showed that peak hour traffic volumes and travel patterns for each intersection were closely related for each day, however counts on Saturday were generally lower than the mid week counts. The exception to this was at the intersections of San Francisco & Old Santa Fe Trail, along with Sandoval & Montezuma. Taking a conservative approach, the analysis used the greater values from pedestrians, bicycles, and vehicles for each day to create one AM Peak hour of analysis and one PM Peak hour of analysis for each intersection. The exhibits on the following pages display the turning movement volumes, pedestrian volumes, and bicycle volumes analyzed for each intersection. All traffic count data collected can be found in Attachment B.

Table 2: Turning Movement Peak Hours

INTERSECTION		DATE	AM PEAK HOUR	PM PEAK HOUR
1	San Francisco & Sandoval	8/1	11:00	4:30
		8/2	11:00	4:30
		8/3	10:45	3:15
2	Grant & Sandoval/Palace	8/1	11:00	4:30
		8/2	11:00	4:30
		8/3	10:45	3:30
3	Washington & Marcy	8/1	11:00	5:00
		8/2	11:00	12:30
		8/3	11:00	5:00
4	San Francisco & Old Santa Fe Trail	8/1	11:00	2:15
		8/2	10:45	1:45
		8/3	11:00	4:15
5	Montezuma & Sandoval	8/1	11:00	4:30
		8/2	11:00	4:45
		8/3	10:45	12:30

Figure 2: 2024 Turning Movement Counts

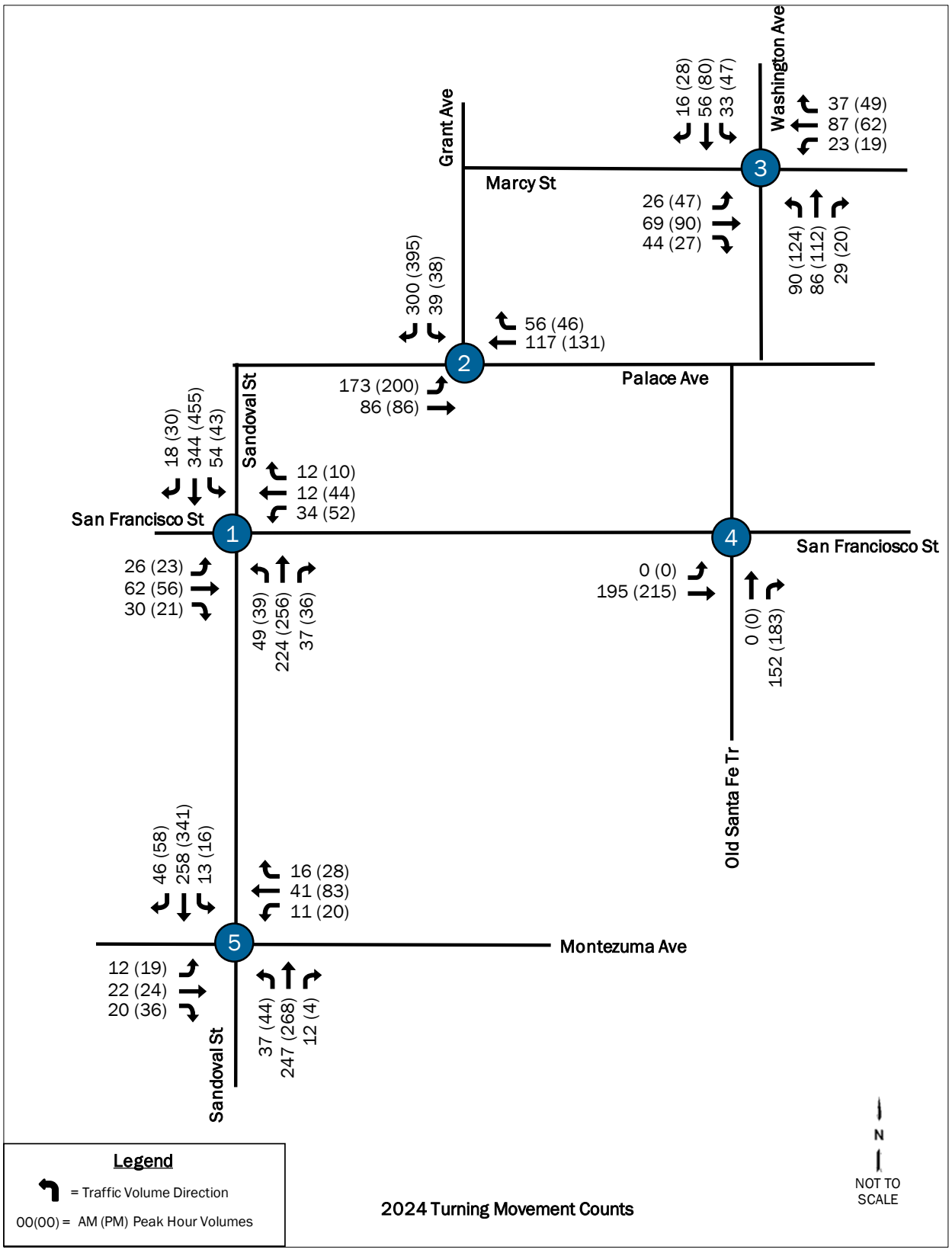


Figure 3: 2024 Pedestrian Counts

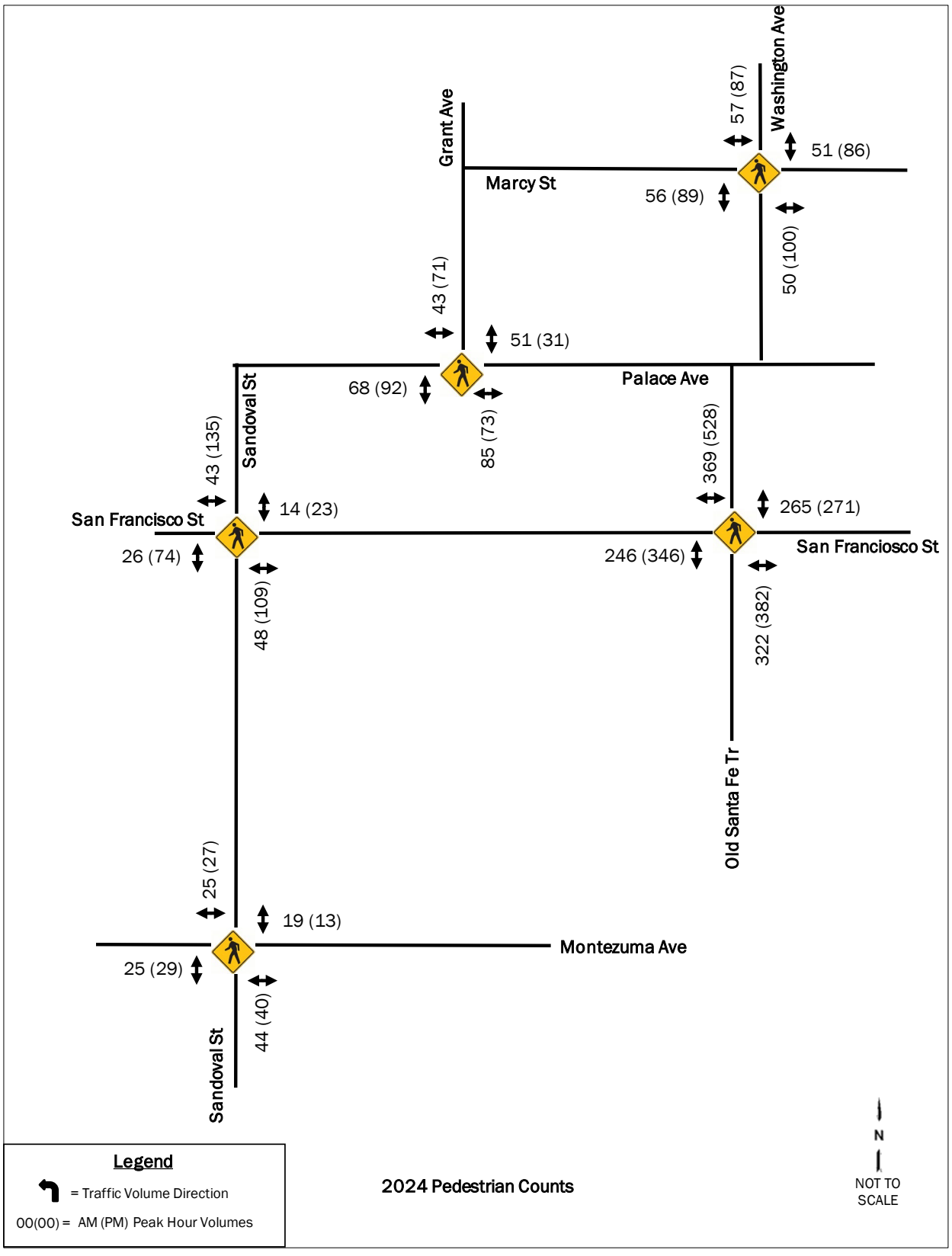
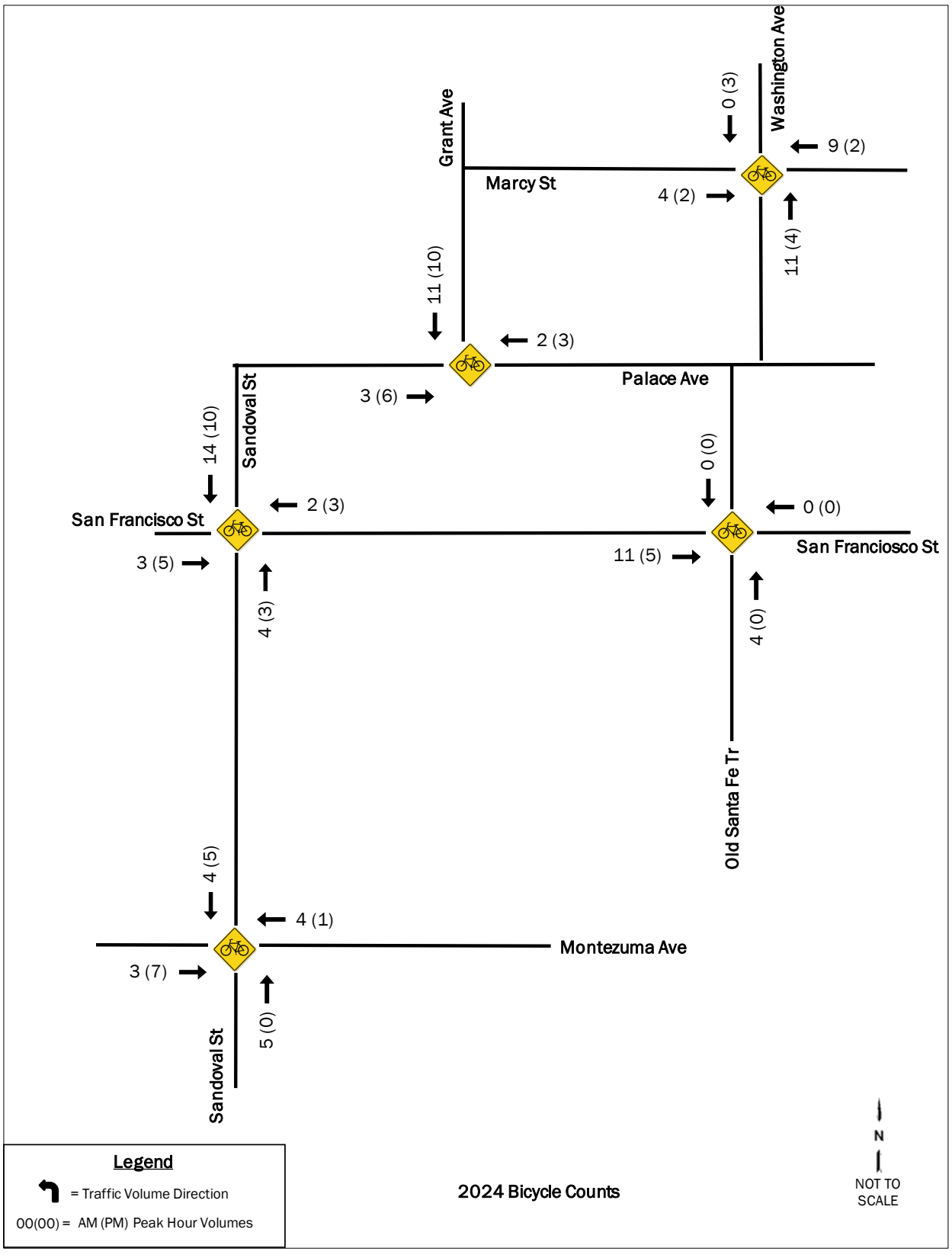


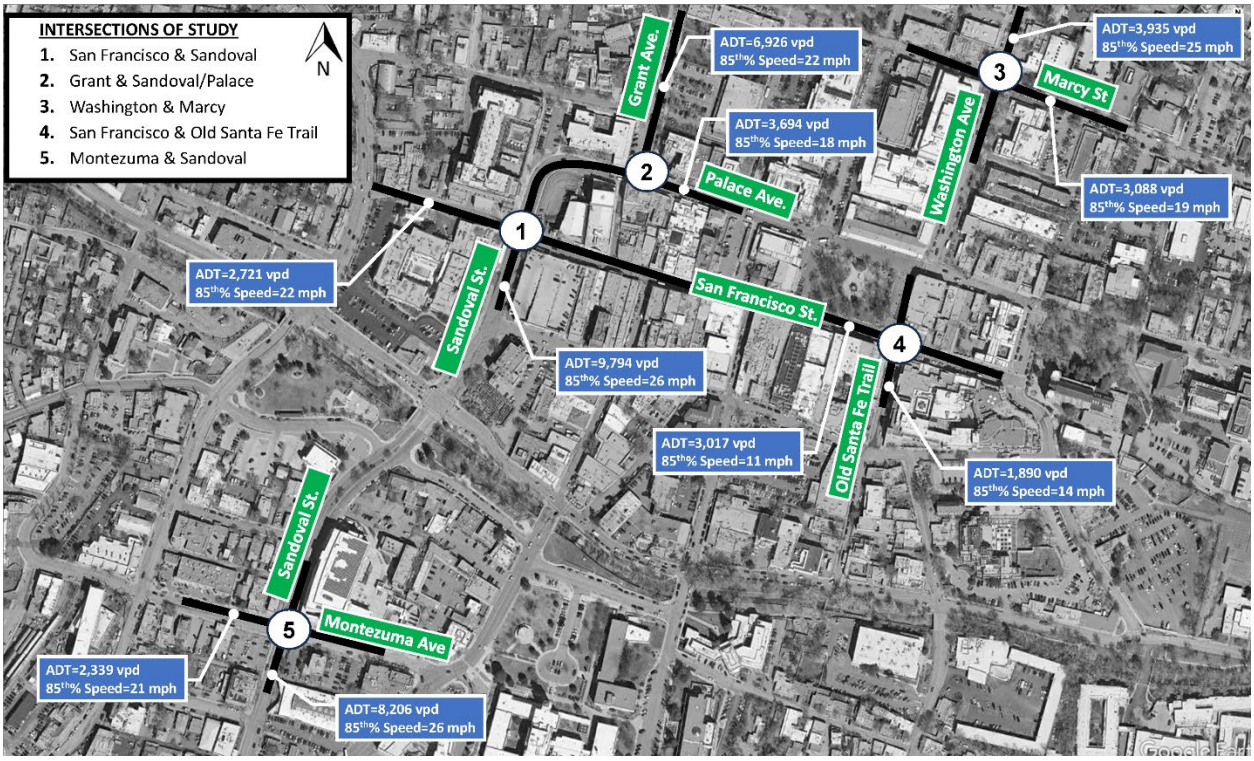
Figure 4: 2024 Bicycle Counts



Traffic Volume ADT and Speed

Traffic volumes and speed were collected over a 48-hour period using traffic counting tube equipment. Speed is recorded as 85th percentile speed which is the speed at which 85% of drivers travel or below on a given road. The posted speed limit in the study area is 20 mph. The figure below summarizes the data collected:

Figure 5: ADT and Speed Data



As seen in the figure above, most drivers travel the study area near the posted speed limit. The exceptions are Sandoval Street and Washington Avenue where speeds were collected at or greater than 5 miles per hour over the posted speed limit.

Traffic Forecasts

This study will analyze both existing conditions and forecasted conditions to ensure that any decisions made now will not negatively impact conditions in the future. Annual compounded growth rates have been applied to the existing traffic, pedestrian, and bicyclist volumes over a period of 20 years. The Santa Fe County Sustainable Growth Management Plan as well as the Santa Fe MPO's 2020-2045 Metropolitan Transportation Plan reference growth in the range of 0.7% to 0.82%. Being conservative, a 1% growth rate was agreed upon by the study team for use in this analysis. The exhibit on the next page displays the turning movement volumes, pedestrian volumes, and bicycle volumes forecasted 20 years at each intersection.

Figure 6: 2044 Turning Movement Counts

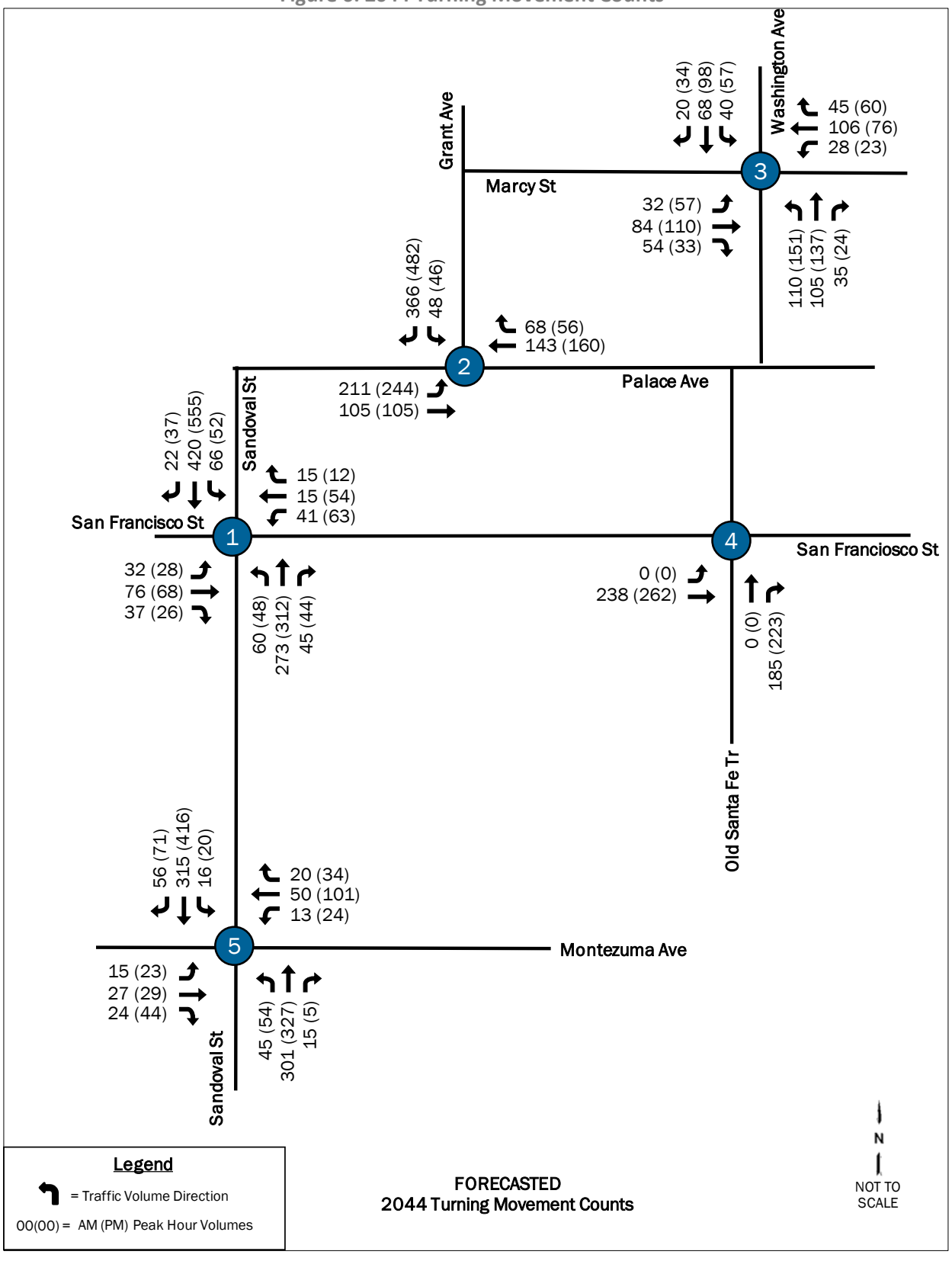


Figure 7: 2044 Pedestrian Volumes

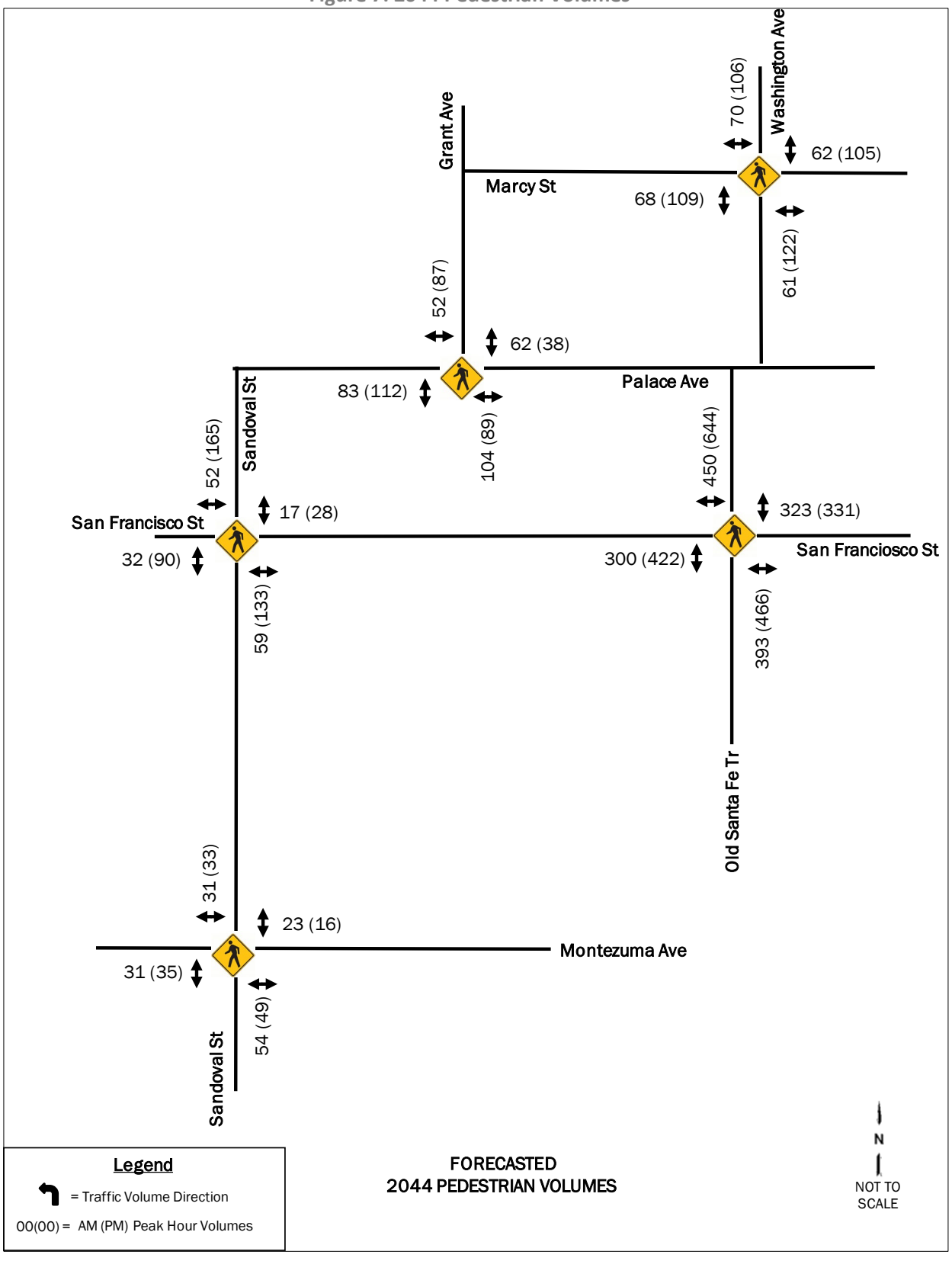
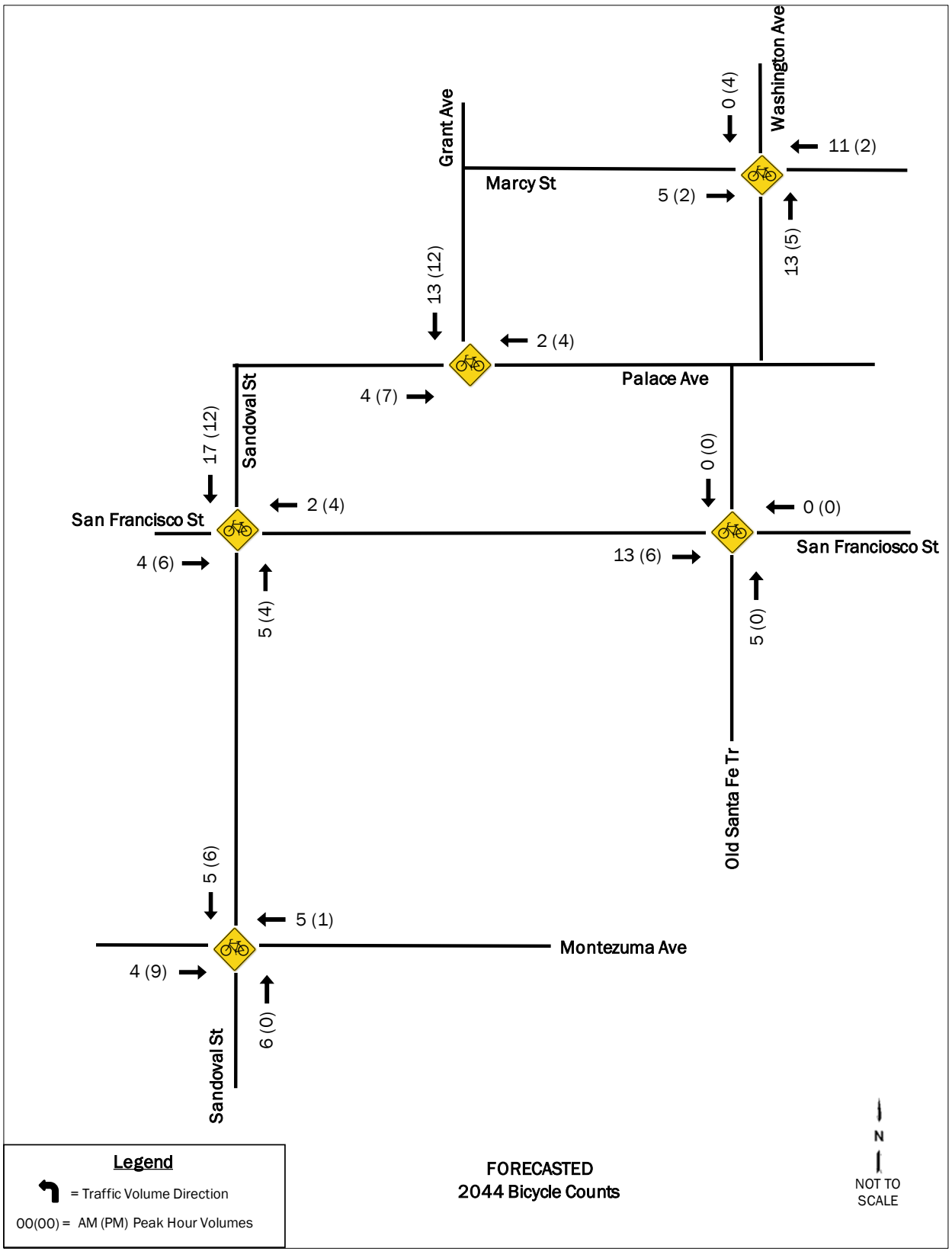


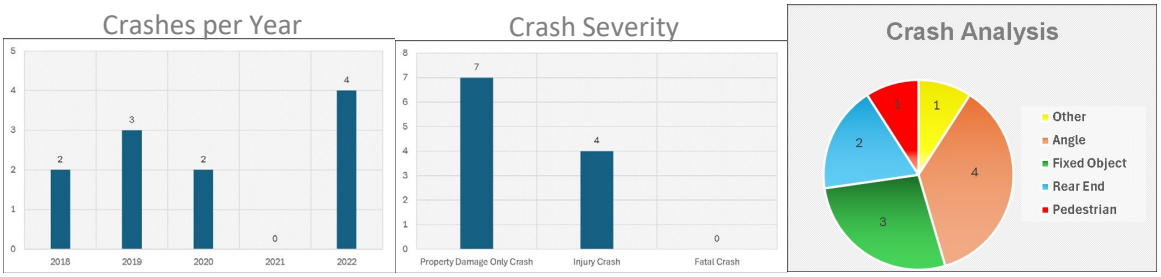
Figure 8: 2044 Bicycle Counts



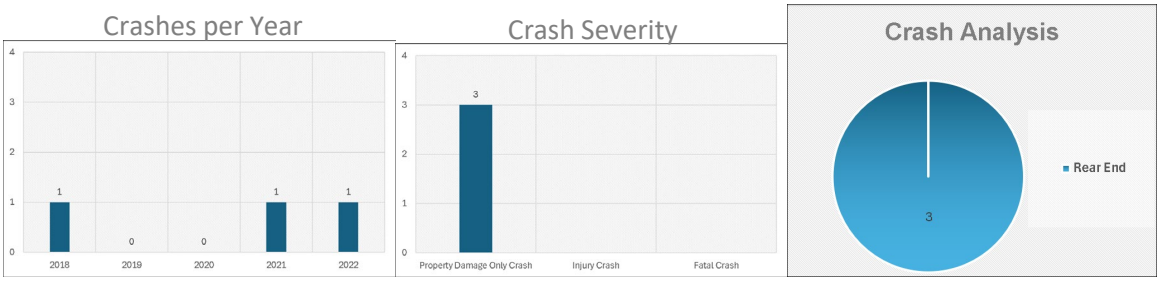
Crash Data

Crash data information for the study area was obtained from the Santa Fe MPO and consisted of data from 2010 to 2022. This data was filtered to identify the most recent 5-years to perform a signal warrant analysis discussed in the next section. The crashes were summarized to include crashes per year, crash severity, and crash analysis type for the period from January 2018 to December 31, 2022. All crash data is provided in Attachment C. Crash summary charts for each intersection are provided below.

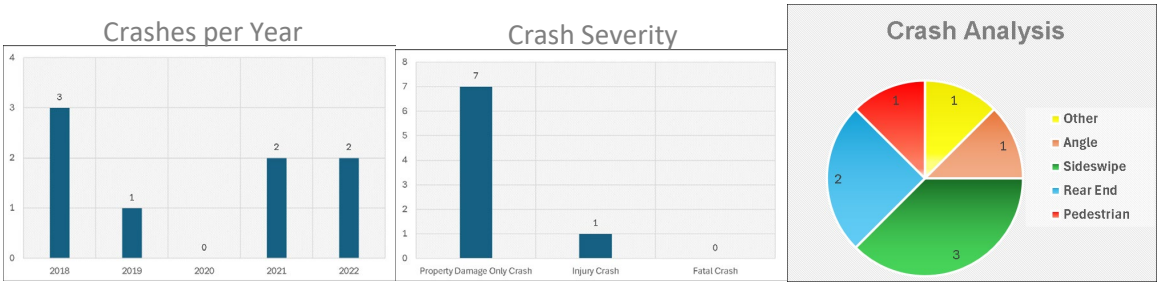
1. San Francisco & Sandoval



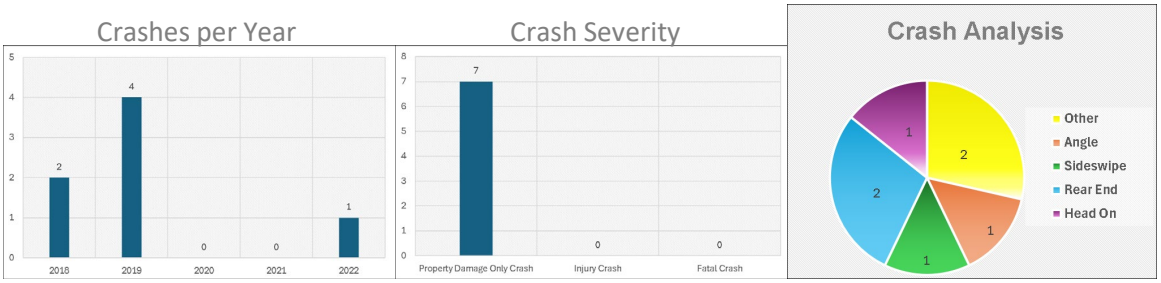
2. Grant & Sandoval/Palace



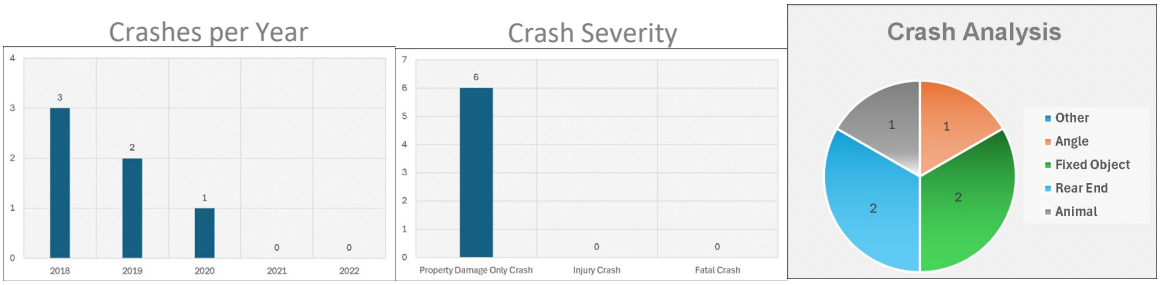
3. Washington & Marcy



4. San Francisco & Old Santa Fe Trail



5. Sandoval & Montezuma



Crashes of a particular concern for this analysis include angle crashes as well as rear-end crashes, as traffic signals generally reduce the number of angle crashes but may inadvertently increase the number of rear-end crashes. As seen in the charts, both angle crashes and rear-end crashes are generally low over the five-year period for each intersection possibly indicating appropriate placement of the traffic signal at these locations.

Also of concern are crashes involving pedestrians as well as crashes involving fatalities and injuries due to angle crashes. The Manual of Uniform Traffic Control Devices has a signal warrant pertaining to crash experience which will be visited in the next section. This warrant reviews the number of angle crashes, pedestrian crashes, fatal crashes, and injury angle crashes.

Signal Warrant Analysis

The Manual on Uniform Traffic Control Devices (MUTCD) specifies nine "traffic control signal needs studies", known as warrants. These warrants are primarily based on vehicular volume, pedestrian activities, and crash experience records. If one or more of the following 9 signal warrants is met, a signal may be justified; however, satisfaction of 1 warrant in and of itself is not necessarily sufficient justification.

1. Eight-Hour Vehicular Volume
   The Eight-Hour Vehicular Volume signal warrant is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal, or where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict when entering or crossing the major street.
2. Four-Hour Vehicular Volume
   The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.
3. Peak Hour
   The Peak Hour signal warrant is intended for use at a location where conditions are such that for a minimum of one hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.
4. Pedestrian Volume
   The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.
5. School Crossing
   The School Crossing signal warrant is intended for application where the fact that school children crossing the major street is the principal reason to consider installing a traffic control signal.
6. Coordinated Signal System
   The Coordinated Signal System warrant is intended for application where the progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals. This warrant applies to intersections where traffic control signals would not otherwise be needed in order to maintain proper platooning of vehicles.
7. Crash Experience
   The Crash Experience signal warrant conditions are intended for application when the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.
8. Roadway Network
   The Roadway Network signal warrant is intended for application where installing a traffic control signal might be justified to encourage concentration and organization of traffic flow on a roadway network.
9. Intersection Near a Grade Crossing
   The Intersection Near a Grade Crossing signal warrant is intended for use at a location where none of the conditions described in the other eight signal warrants are met, but the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic signal.

The table below identifies if the signal warrants for each intersection were met. Each warrant was analyzed for both existing (2024) and forecasted (2044) scenarios. A copy of all signal warrants is provided in Attachment D.

Table 3: Signal Warrant Analysis

INTERSECTION		YEAR	WARRANT NUMBER MET?								
			1	2	3	4	5	6	7	8	9
1	San Francisco & Sandoval	2024	No	No	No	No	No	No	No	No	No
		2044	No	No	No	No	No	No	No	No	No
2	Grant & Sandoval/Palace	2024	No	No	No	No	No	No	No	No	No
		2044	No	Yes	No	No	No	No	No	No	No
3	Washington & Marcy	2024	No	No	No	No	No	No	No	No	No
		2044	No	No	No	No	No	No	No	No	No
4	San Francisco & Old Santa Fe Trail	2024	No	No	No	No	No	No	No	No	No
		2044	No	No	No	No	No	No	No	No	No
5	Montezuma & Sandoval	2024	No	No	No	No	No	No	No	No	No
		2044	No	No	No	No	No	No	No	No	No

As shown, a single warrant was met for the Four-Hour Vehicular Volume during the 2044 forecasted scenario at the Grant & Sandoval/Palace intersection. While further analysis will be presented, it is again noted that just because nearly all warrants have not been met, does not mean traffic signal control is unnecessary and should be removed. Rather, alternatives may be considered after further engineering evaluation.

Traffic Capacity Analysis

Intersection Level of Service

To assess current and projected intersection capacity for signalized and unsignalized intersections, Level of Service (LOS) is the most widely accepted measure of traffic operational capacity. LOS A represents the best operating conditions from the driver's perspective and LOS F the worst. According to the City of Santa Fe's Transportation Impact Analysis Guidelines (August 29,2024), LOS D or better is required for both signalized and unsignalized intersections. Intersection LOS was evaluated using the Highway Capacity Manual (HCM) 7th Edition methodology and Synchro 12 software. Each of the intersections within the study area were evaluated under existing traffic control, lane configuration and peak hour volumes using current signal timings provided by the City of Santa Fe for the 2024 and 2044 forecasted conditions. A copy of all Synchro reports and inputs are provided in Attachment E.

A summary of the existing conditions analysis is shown below. Movements that appear highlighted in red are LOS F and those in orange are LOS E.

Table 4: Existing 2024 Intersection LOS

ID	Intersection	Control	Movement	AM		PM	
				LOS	Delay	LOS	Delay
1	San Francisco & Sandoval	Signal	**Overall**	**A**	**8.8**	**B**	**13.1**
			EB	A	7.9	A	9.7
			WB	A	7.6	A	9.7
			NB	A	8.7	B	12.4
			SB	A	9.3	B	14.8
2	Sandoval/Palace & Grant	Signal	**Overall**	**A**	**8.8**	**B**	**10.9**
			EB	A	5.2	A	7.2
			WB	B	11.0	B	13.2
			SB	B	10.4	B	12.4
3	Washington & Marcy	Signal	**Overall**	**B**	**10.2**	**B**	**11.6**
			EB	B	10.8	B	11.6
			WB	B	10.9	B	11.4
			NB	A	9.4	B	11.1
			SB	B	10.3	B	12.3
4	San Francisco & Old Santa Fe	Signal	**Overall**	**B**	**11.4**	**B**	**11.2**
			EB	B	19.8	B	19.9
			NB	A	0.8	A	1.0
5	Sandoval & Montezuma	Signal	**Overall**	**A**	**5.2**	**A**	**5.9**
			EB	B	11.0	B	10.9
			WB	B	11.2	B	11.5
			NB	A	3.9	A	4.0
			SB	A	4.2	A	4.7

The summary of the forecasted 2044 analysis is shown below. Movements that appear highlighted in red are LOS F and those in orange are LOS E.

Table 5: Forecasted 2044 Intersection LOS

ID	Intersection	Control	Movement	AM		PM	
				LOS	Delay	LOS	Delay
1	San Francisco & Sandoval	Signal	**Overall**	**A**	**9.4**	**B**	**15.5**
			EB	A	9.1	B	10.5
			WB	A	8.6	B	10.6
			NB	A	9.1	B	13.2
			SB	A	9.8	B	18.9
2	Sandoval/Palace & Grant	Signal	**Overall**	**A**	**9.8**	**B**	**13.3**
			EB	A	6.4	A	9.2
			WB	B	12.8	B	16.3
			SB	B	10.9	B	14.8
3	Washington & Marcy	Signal	**Overall**	**B**	**10.7**	**B**	**12.2**
			EB	B	11.2	B	12.3
			WB	B	11.2	B	12.0
			NB	A	9.9	B	11.6
			SB	B	10.9	B	13.0
4	San Francisco & Old Santa Fe	Signal	**Overall**	**B**	**11.8**	**B**	**11.6**
			EB	C	20.2	C	20.4
			NB	A	1.0	A	1.4
5	Sandoval & Montezuma	Signal	**Overall**	**A**	**5.8**	**A**	**6.6**
			EB	B	11.0	B	11.0
			WB	B	11.2	B	11.7
			NB	A	4.5	A	4.6
			SB	A	5.0	A	5.7

As shown in both tables, all signalized intersections operate at acceptable levels of service during both existing and forecasted conditions. Note that the lane geometry at the intersection of San Francisco & Old Santa Fe Trail only includes eastbound through movements and northbound right turn movements. This configuration changes through the year depending on the season for special use events.

Pedestrian Intersection Level of Service

Pedestrian Space LOS at signalized intersections can be defined as space available per pedestrian at sidewalk corners (curb ramps) and within crosswalks and is determined using pedestrian volumes as well as the effective walking space available. Pedestrian LOS at signalized intersections is based on a pedestrian LOS score model that incorporates conflicting motorized vehicle volumes and speeds, crosswalk length, average pedestrian delay, and the presence of right-turn channelizing islands. Pedestrian LOS improves with lower motorized vehicle volumes and speeds, shorter crosswalk lengths, lower delay, and the provision of right-turn channelizing islands. The two tables below provide the threshold levels for both types of LOS.

Table 6: Pedestrian Space LOS Criteria

Ped Space (sf/p)	LOS
>60	A - Ability to move in desired path, no need to alter movements
>40-60	B - Occasional need to adjust path to avoid conflicts
>24-40	C - Frequent need to adjust path to avoid conflicts
>15-24	D - Speed and ability to pass slower pedestrians restricted
>8-15	E - Speed restricted, very limited ability to pass slower peds
≤8	F - Speed severely restricted, frequent contact with other users.

Table 7: Ped LOS Criteria

LOS	LOS Score
A	≤2.00
B	>2.00-2.75
C	>2.75-3.50
D	>3.50-4.25
E	>4.25-5.00
F	>5.00

The analysis of Pedestrian Space LOS and Pedestrian LOS is summarized below. Results are presented for the sidewalk Corners (corner space), X-walk (crosswalk space), and Ped (delays). Movements that appear highlighted in red are LOS F and those in orange are LOS E.

Table 8: Existing Pedestrian LOS

ID	Intersection	Control	Movement	AM			PM		
				Corner	X-Walk	Ped	Corner	X-Walk	Ped
1	San Francisco & Sandoval	Signal	EB	A	A	B	A	A	B
			WB	A	A	B	A	A	B
			NB	A	A	B	A	A	B
			SB	A	A	B	A	A	B
2	Sandoval/Palace & Grant	Signal	EB	A	A	B	A	A	B
			WB	A	A	B	A	A	B
			SB	A	A	B	A	A	B
3	Washington & Marcy	Signal	EB	A	A	B	B	A	B
			WB	B	A	B	C	A	B
			NB	A	A	B	B	A	B
			SB	B	A	B	C	A	B
4	San Francisco & Old Santa Fe	Signal	EB	F	F	B	F	F	B
			NB	F	F	B	F	F	B
5	Sandoval & Montezuma	Signal	EB	A	A	B	A	A	B
			WB	A	A	B	A	A	B
			NB	A	A	B	A	A	B
			SB	A	A	B	A	A	B

The summary of the forecasted 2044 conditions pedestrian analysis is shown below. Results are presented for the sidewalk Corners (corner space), X-walk (crosswalk space), and Ped (delays). Movements that appear highlighted in red are LOS F and those in orange are LOS E.

Table 9: Forecasted 2044 Pedestrian LOS

ID	Intersection	Control	Movement	AM			PM		
				Corner	X-Walk	Ped	Corner	X-Walk	Ped
1	San Francisco & Sandoval	Signal	EB	A	A	B	B	A	B
			WB	A	A	B	A	A	B
			NB	A	A	C	A	A	C
			SB	A	A	B	A	A	B
2	Sandoval/Palace & Grant	Signal	EB	A	A	B	A	A	B
			WB	A	A	B	B	A	B
			SB	A	A	B	A	A	B
3	Washington & Marcy	Signal	EB	A	A	B	C	A	B
			WB	C	A	B	D	A	B
			NB	A	A	B	C	A	B
			SB	C	A	B	D	A	B
4	San Francisco & Old Santa Fe	Signal	EB	F	F	B	F	F	B
			NB	F	F	B	F	F	B
5	Sandoval & Montezuma	Signal	EB	A	A	B	A	A	B
			WB	A	A	B	A	A	B
			NB	A	A	B	A	A	B
			SB	A	A	B	A	A	B

As shown in both tables, all intersections operate at acceptable levels of service during both existing and forecasted conditions with exception of the San Francisco & Old Santa Fe intersection. The heavy pedestrian volumes along with the effective sidewalk widths at this location restrict the speed of users and cause frequent contact with one another during peak hours. Note that while pedestrians may be congested at this location, they are still able to cross with relatively low delays.

Although the pedestrian space LOS indicates ample room for pedestrians at the remaining intersections, it is worth noting that nearly all corners (curb ramps) are not ADA and PROWAG compliant.

Bicycle Intersection Level of Service

Bicycle LOS at signalized intersections is based on a bicycle LOS score model that incorporates perceived separation from motorized vehicle traffic, motorized vehicle volumes, cross-street width, and presence and utilization of on-street parking. The bicycle LOS score is an indication of the typical bicyclist's perception of the overall crossing experience. Bicycle LOS improves with greater perceived separation from motorized vehicle traffic, lower motorized vehicle volumes, shorter cross-street widths, and reduced on-street parking conflicts.

Table 10: Bicycle LOS Criteria

LOS	LOS Score
A	≤1.50
B	>1.50-2.50
C	>2.50-3.50
D	>3.50-4.50
E	>4.50-5.50
F	>5.50

A summary of the existing conditions bicycle analysis is shown below. Movements that appear highlighted in red are LOS F and those in orange are LOS E.

Table 11: Existing 2024 Bicycle LOS

ID	Intersection	Control	Movement	AM		PM	
				LOS	Delay	LOS	Delay
1	San Francisco & Sandoval	Signal	EB	C	2.69	C	2.58
			WB	B	2.40	B	2.41
			NB	C	2.52	C	3.01
			SB	C	2.66	C	3.36
2	Sandoval/Palace & Grant	Signal	EB	C	2.54	C	2.62
			WB	B	2.42	B	2.45
			SB	C	2.71	C	2.93
3	Washington & Marcy	Signal	EB	B	2.35	B	2.41
			WB	B	2.37	B	2.35
			NB	B	2.28	B	2.40
			SB	B	2.11	B	2.22
4	San Francisco & Old Santa Fe	Signal	EB	B	2.10	B	2.11
			NB	B	2.20	B	2.25
5	Sandoval & Montezuma	Signal	EB	B	2.22	B	2.25
			WB	B	2.25	B	2.34
			NB	C	2.54	B	2.47
			SB	C	2.59	C	2.65

A summary of the forecasted 2044 conditions bicycle analysis is shown below. Movements that appear highlighted in red are LOS F and those in orange are LOS E.

Table 12: Forecasted 2044 Bicycle LOS

ID	Intersection	Control	Movement	AM		PM	
				LOS	Delay	LOS	Delay
1	San Francisco & Sandoval	Signal	EB	C	2.73	C	2.61
			WB	B	2.42	B	2.45
			NB	C	2.64	C	3.15
			SB	C	2.82	D	3.58
2	Sandoval/Palace & Grant	Signal	EB	C	2.64	C	2.74
			WB	B	2.49	C	2.52
			SB	C	2.85	C	3.11
3	Washington & Marcy	Signal	EB	B	2.41	B	2.48
			WB	B	2.42	B	2.40
			NB	B	2.36	C	2.51
			SB	B	2.15	B	2.28
4	San Francisco & Old Santa Fe	Signal	EB	B	2.14	B	2.15
			NB	B	2.26	B	2.31
5	Sandoval & Montezuma	Signal	EB	B	2.25	B	2.28
			WB	B	2.28	B	2.39
			NB	C	2.68	C	2.60
			SB	C	2.73	C	2.81

Alternative Traffic Control Analysis

Three alternative traffic control measures were analyzed for each of the five intersections including:

Alternative 1 – Signalized Control with Single Lane Approach in All Directions

Alternative 2 – Two-way Stop Control (TWSC) at the Minor Street

Alternative 3 – All-way Stop Control (AWSC)

Each of the alternatives are discussed below:

Alternative 1 – Signalized Control with Single Lane Approach in all Directions

This alternative analyzes each intersection with signal control and reconfigures lane geometry to include one lane of travel in each direction.

Advantages of this may include:

A. The possibility to shorten crosswalk distance by installing curb extensions (bulbouts).
B. Improve visibility between pedestrians, bicyclists, and vehicles.
C. Curb extensions narrow the roadway, emphasizing slower speed of vehicles.
D. Exclusive pedestrian phases can be programmed into signal timings which may have less impact on vehicle delays as less time will be required for pedestrians to cross the roadway.
E. Pedestrian Space LOS can be improved with greater sidewalk area.
F. Pedestrian LOS can be improved with less crossing delay experienced for pedestrians.
G. Signals can reduce the number of angle collisions at an intersection.

Disadvantages of this may include:

A. Greater operating and maintenance costs.
B. Signals can increase the number of rear-end collisions at an intersection.
C. Excessive delays to minor movements can be experienced.
D. Removal of turn lanes may increase delays for vehicles wanting to turn.

Capacity Analysis

A capacity analysis has been performed for this alternative. For simplicity, a table is displayed on the next page with side-by-side LOS comparison of 2024 and 2044 scenarios. To accommodate the change in geometry signal timings have been optimized to evenly distribute delays. A proper signal timing exercise will be required to determine true capacity and delays.

Table 13: LOS for Signalized Control w/Single Lane Approach in All Directions

ID	Intersection	Control	Movement	2024		2044	
				AM	PM	AM	PM
				LOS	LOS	LOS	LOS
1	San Francisco & Sandoval	SIGNAL	EB	A	A	A	B
			WB	A	A	A	B
			NB	A	B	A	A
			SB	A	B	B	A
2	Sandoval/Palace & Grant	SIGNAL	EB	A	A	A	B
			WB	A	A	A	A
			SB	B	B	B	C
3	Washington & Marcy	SIGNAL	EB	A	A	A	A
			WB	A	A	A	A
			NB	A	A	A	B
			SB	A	A	A	A
4	San Francisco & Old Santa Fe	SIGNAL	EB	C	C	C	C
			NB	A	A	A	A
5	Sandoval & Montezuma	SIGNAL	EB	B	B	B	B
			WB	B	B	B	B
			NB	A	A	A	A
			SB	A	A	A	A

As shown in the table, all intersection approaches perform above acceptable levels of service with Alternative 1. This is in part due to generally low traffic volumes, existing low pedestrian volumes, and low posted speed limits. While the intersection of San Francisco & Old Santa Fe Trail contains large pedestrian volumes, its current configuration as an eastbound one-way and northbound one-way provides the acceptable levels of services shown.

Queuing Analysis

In addition to the LOS analyzed above, 95th percentile queuing lengths have been calculated for each approach to the intersections and are shown in the table on the next page. While turn lane storage lengths are not an issue for this alternative, the distance to other nearby intersections has been considered to avoid having them blocked by traffic during peak hours.

Table 14: 95th Percentile Queues for Signalized Intersections w/Single Lane Approaches

ID	Intersection	Control	Movement	Storage Length	2024 Queue Length		2044 Queue Length	
					AM	PM	AM	PM
1	San Francisco & Sandoval	SIGNAL	EB	397*	48	48	63	69
			WB	345*	30	56	37	82
			NB	230*	78	91	108	88
			SB	423*	112	168	159	178
2	Sandoval/Palace & Grant	SIGNAL	EB	423*	87	114	152	212
			WB	250*	39	44	48	74
			SB	150*	37	40	41	92
3	Washington & Marcy	SIGNAL	EB	250*	37	69	53	82
			WB	524*	40	48	58	54
			NB	190*	49	88	71	125
			SB	336*	25	45	34	61
4	San Francisco & Old Santa Fe	SIGNAL	EB	275*	131	139	161	170
			NB	280*	0	0	0	0
5	Sandoval & Montezuma	SIGNAL	EB	375*	20	26	20	26
			WB	400*	25	43	25	44
			NB	240*	102	110	132	149
			SB	240*	105	143	132	229

* Storage lengths shown at these locations indicate the distance to the next intersection to ensure queues do not block other intersections.

As shown in the table, queuing for this alternative does not impose conflicts of queued traffic blocking other intersections.

Pedestrian and Bicycle Level of Service

Pedestrian LOS for Alternative 1 mimic the results displayed previously for existing conditions with slight enhancements to LOS due to fewer travel lanes being crossed. If curb extensions are constructed the Pedestrian Space LOS is expected to result in better LOS values. As with Pedestrian LOS, the Bicycle LOS will also show improvements to LOS due to fewer travel lanes being crossed.

Intersection Sight Distance

Intersection sight distance criteria pertaining to Case D-Intersections with Traffic Signal Control has been evaluated for each intersection with this alternative using the 7th Edition of A Policy on Geometric Design of Highways and Streets. Case D indicates that at signalized intersections, the first vehicle stopped on one approach should be visible to the driver of the first vehicle stopped on each of the other approaches. Left-turning vehicles should have sufficient sight distance to select gaps in oncoming traffic and complete left turns. All intersection approaches within this analysis are clearly visible to other approaches and left-turning vehicles do have sufficient sight distance. Therefore, all criteria for intersection sight distance are met for this alternative.

Alternative 2 –
Two-Way Stop Control (TWSC) at the Minor Street

This alternative analyzes each intersection with stop control at the minor street approaches. Lane geometry is reconfigured to include one lane of travel in each direction.

Advantages of this may include:

A. Shortening crosswalk distance by installing curb extensions (bulbouts).
B. Improve visibility between pedestrians, bicyclists, and vehicles.
C. Curb extensions narrow the roadway, emphasizing slower speed of vehicles.
D. Pedestrian Space LOS can be improved with greater sidewalk area.
E. Pedestrian LOS can be improved with less crossing delay experienced for crossing pedestrians.
F. No operating costs and lower maintenance costs.

Disadvantages of this may include:

A. Right-of-way conflicts between vehicles and pedestrians.
B. Inadequate intersection sight distance for the minor approach.
C. Excessive delays to minor movements can be experienced.
D. Conflict points resulting in a variety of crash types arise within or near the intersection due to a combination of traffic volumes, operating speeds, and turning movements.

Capacity Analysis

A capacity analysis has been performed for this alternative. For simplicity, a table is displayed below with side-by-side LOS comparison of 2024 and 2044 scenarios.

Table 15: LOS for TWSC W/Single Lane Approach in all Directions

ID	Intersection	Control	Movement	2024 AM LOS	2024 PM LOS	2044 AM LOS	2044 PM LOS
1	San Francisco & Sandoval	TWSC	STOP EB	D	F	F	F
			STOP WB	D	F	F	F
			NB	A	A	A	A
			SB	A	A	A	A
2	Sandoval/Palace & Grant	TWSC	EB	A	A	A	A
			WB	A	A	A	A
			STOP SB	C	D	C	F
3	Washington & Marcy	TWSC	STOP EB	C	F	D	F
			STOP WB	C	E	D	F
			NB	A	A	A	A
			SB	A	A	A	A
4	San Francisco & Old Santa Fe	TWSC	EB	A	A	A	A
			STOP NB	F	F	F	F
5	Sandoval & Montezuma	TWSC	STOP EB	C	C	D	E
			STOP WB	C	D	D	F
			NB	A	A	A	A
			SB	A	A	A	A

As shown in the table above, only two intersections perform at acceptable levels of service during the 2024 condition. During the 2044 condition, all delays increase, and each intersection will experience unacceptable levels of service for one or two approaches.

Queuing Analysis

In addition to the LOS analyzed above, 95th percentile queuing lengths have been calculated for each approach to the intersections and are shown below. While turn lane storage lengths are not an issue for this alternative, the distance to other nearby intersections has been considered to avoid having them blocked by traffic during peak hours.

Table 16: 95th Percentile Queues for TWSC Intersections with Single Lane Approaches

ID	Intersection	Control	Movement	Storage Length	2024 Queue Length		2044 Queue Length	
					AM	PM	AM	PM
1	San Francisco & Sandoval	TWSC	EB	397*	61	93	136	415
			WB	345*	33	192	83	956
2	Sandoval/Palace & Grant	TWSC	SB	150*	101	293	198	619
3	Washington & Marcy	TWSC	EB	250*	43	190	80	402
			WB	524*	47	88	86	223
4	San Francisco & Old Santa Fe	TWSC	NB	280*	85	193	138	310
5	Sandoval & Montezuma	TWSC	EB	375*	19	27	37	58
			WB	400*	21	57	52	125

* Storage lengths shown at these locations indicate the distance to the next intersection to ensure queues do not block other intersections.

As shown in the table, queuing is a significant issue for the southbound approach at the intersection of Grant & Sandoval/Palace during the 2024 condition. Queuing continues to be an issue during the 2044 condition with the exception of the Sandoval & Montezuma intersection.

Pedestrian Level of Service

Pedestrian LOS at TWSC intersections is defined for pedestrians crossing a traffic stream not controlled by a stop sign. LOS criteria for pedestrians are given below:

Table 17: TWSC Pedestrian LOS Criteria

LOS	Control Delay (s/p)	Comments
A	0-5	Usually, no conflicting traffic
B	5-10	Occasionally some delay due to conflicting traffic
C	10-20	Delay noticeable to pedestrians, but not inconveniencing
D	20-30	Delay noticeable and irritating, increased likelihood of risk taking
E	30-45	Dealy approaches tolerance level, risk-taking behavior likely
F	>45	Delay exceeds tolerance level, high likelihood of pedestrian risk taking

The analysis of Pedestrian LOS is summarized in the table below. Movements that appear highlighted in red are LOS F and those in orange are LOS E.

Table 18: Alternative 2 - Pedestrian LOS for 2024 & 2044

ID	Intersection	Control	Movement	2024		2044	
				AM	PM	AM	PM
1	San Francisco & Sandoval	TWSC	NB	E	E	E	F
			SB	E	E	E	F
2	Sandoval/Palace & Grant	TWSC	EB	D	D	D	D
			WB	D	D	D	D
3	Washington & Marcy	TWSC	NB	D	D	D	D
			SB	D	D	D	D
4	San Francisco & Old Santa Fe	TWSC	EB	D	D	D	D
5	Sandoval & Montezuma	TWSC	NB	E	E	E	E
			SB	E	E	E	E

As shown in the table above, pedestrian levels of service are shown at LOS D and below. Its worth noting that these LOS are based off minimal crossing treatments including crosswalk markings only. Yield rates of motorists to pedestrians increase with other crossing treatments such as median refuges, rectangular rapid-flashing beacons (RRFB), or pedestrian hybrid beacons (HAWK) and result in improved levels of service.

Bicycle Level of Service

There is currently no LOS methodology specific to bicyclists at TWSC intersections. Bicyclists do not queue linearly like vehicles and often times, multiple bicycles will cross at the same time as the adjacent vehicle resulting in lower bicycle delays compared to vehicles.

Intersection Sight Distance

Using the 7th Edition of A Policy on Geometric Design of Highways and Streets, the following intersection sight distance criteria have been evaluated for this alternative:

- Case B1-Left Turn from Minor Roadway
- Case B2-Right Turn from Minor Roadway
- Case F-Left Turn from Major Roadway

The table on the next page provides a detailed analysis of the intersections analyzed and the result if minimum criteria is met.

Table 19: Alternative 2 - Intersection Sight Distance Analysis

INTERSECTION	POSTED SPEED (mph)	TURN MOVEMENT	ISD CRITERIA	MINIMUM ISD VALUE (ft)	ACTUAL ISD VALUE (ft)	MEETS CRITERIA	OBSTACLE
San Francisco & Sandoval	20	EBL	B1	280	113	No	Porch Posts
	15	EBR	B2	195	195	Yes	
	15	WBL	B1	225	133	No	Wall/Parking
	20	WBR	B2	240	145	No	Tree
		NBL	F	205	205	Yes	
		SBL	F	205	205	Yes	
Grant & Sandoval/Palace	15	SBL	B1	225	130	No	Building
	20	SBR	B2	240	120	No	Street Parking
		EBL	F	205	205	Yes	
Washington & Marcy	20	EBL	B1	280	280	Yes	
		EBR	B2	240	140	No	Street Parking
		WBL	B1	280	100	No	Street Parking
		WBR	B2	240	170	No	Street Parking
		NBL	F	205	205	Yes	
		SBL	F	205	205	Yes	
San Francisco & Old Santa Fe Trail	20	NBR	B2	240	50	No	Building/Peds
Montezuma & Sandoval	20	EBL	B1	280	155	No	Building
		EBR	B2	240	120	No	Tree/Parking
		WBL	B1	280	100	No	Pole/Tree
		WBR	B2	240	60	No	Pole/Parking
		NBL	F	205	205	Yes	
		SBL	F	205	205	Yes	

As shown in the table above, all intersections do not meet the minimum requirements for intersection sight distance on the minor street for both left turning vehicles and right turning vehicles. Most obstacles blocking the view of drivers are parked vehicles on the adjacent roadway. Other obstacles include trees and pedestrian standing areas. These are all items that can be addressed with changes to parking locations, maintenance of trees, and redesign of sidewalk ramps or design of curb extensions.

Alternative 3 –
All-Way Stop Control (AWSC)

This alternative analyzes each intersection with stop control at all approaches. Lane geometry is reconfigured to include one lane of travel in each direction.

Advantages of this may include:

G. Shortening crosswalk distance by installing curb extensions (bulbouts).
H. Improve visibility between pedestrians, bicyclists, and vehicles.
I. Curb extensions narrow the roadway, emphasizing slower speed of vehicles.
J. Pedestrian Space LOS can be improved with greater sidewalk area.
K. Pedestrian LOS can be improved with less crossing delay experienced for crossing pedestrians.
L. No operating costs and lower maintenance costs.

Disadvantages of this may include:

E. Right-of-way conflicts between vehicles and pedestrians.
F. Excessive delays to major movements can be experienced.
G. Conflict points resulting in a variety of crash types arise within or near the intersection due to a combination of traffic volumes, operating speeds, and turning movements.

Capacity Analysis

A capacity analysis has been performed for this alternative. For simplicity, a table is displayed below with side-by-side comparison of 2024 and 2044 scenarios.

Table 20: LOS for AWSC w/Single Lane Approach in all Directions

				2024		2044	
ID	Intersection	Control	Movement	AM	PM	AM	PM
				LOS	LOS	LOS	LOS
1	San Francisco & Sandoval	AWSC	EB	B	B	B	B
			WB	A	B	B	B
			NB	B	C	C	D
			SB	C	E	D	F
2	Sandoval/Palace & Grant	AWSC	EB	B	C	C	C
			WB	B	B	B	B
			SB	B	C	C	E
3	Washington & Marcy	AWSC	EB	A	B	A	B
			WB	A	A	B	B
			NB	A	B	B	B
			SB	A	A	A	B
4	San Francisco & Old Santa Fe	AWSC	EB	A	A	A	A
			NB	A	A	A	A
5	Sandoval & Montezuma	AWSC	EB	A	B	B	B
			WB	A	B	B	B
			NB	B	B	C	C
			SB	B	C	C	D

As shown in the table above, all intersections perform at acceptable levels of service during the 2024 condition with exception to the southbound approach at the intersection of San Francisco & Sandoval. Delays for this movement continue to increase during the 2044 condition resulting in a LOS F. Additionally the southbound approach for the intersection of Grant & Sandoval/Palace results in a LOS E due to increasing delays in 2044.

Queuing Analysis

In addition to the LOS analyzed above, 95th percentile queuing lengths have been calculated for each approach to the intersections. While turn lane storage lengths are not an issue for this alternative, the distance to other nearby intersections has been considered to avoid having them blocked by traffic during peak hours.

Table 21: 95th Percentile Queues for AWSC Intersections w/Single Lane Approaches

ID	Intersection	Control	Movement	Storage Length	2024 Queue Length		2044 Queue Length	
					AM	PM	AM	PM
1	San Francisco & Sandoval	AWSC	EB	397*	16	16	22	22
			WB	345*	8	18	10	26
			NB	230*	50	82	86	146
			SB	423*	88	228	166	526
2	Sandoval/Palace & Grant	AWSC	EB	423*	40	62	66	118
			WB	250*	22	28	32	46
			SB	150*	50	106	86	238
3	Washington & Marcy	AWSC	EB	250*	14	22	20	32
			WB	524*	16	16	22	24
			NB	190*	24	40	36	64
			SB	336*	10	20	14	30
4	San Francisco & Old Santa Fe	AWSC	EB	275*	20	22	26	30
			NB	280*	12	16	16	20
5	Sandoval & Montezuma	AWSC	EB	375*	8	10	10	14
			WB	400*	10	18	14	26
			NB	240*	56	52	100	96
			SB	240*	62	82	114	160

* Storage lengths shown at these locations indicate the distance to the next intersection to ensure queues do not block other intersections.

As shown in the table, queuing for the vast majority of this alternative does not impose conflicts of queued traffic blocking other intersections, with the exception of southbound traffic for both San Francisco & Sandoval, as well as Grant & Sandoval/Palace during the 2044 PM peak hour.

Pedestrian and Bicycle Level of Service

There is currently no LOS methodology specific to pedestrians at AWSC intersections as pedestrians have the right-of-way and are assumed to result in negligible delays. Additionally, there is currently no LOS methodology specific to bicyclists at AWSC intersections. Bicyclists do not queue linearly like vehicles and often times, multiple bicycles will cross at the same time as the adjacent vehicle resulting in lower bicycle delays compared to vehicles.

Intersection Sight Distance

Intersection sight distance criteria pertaining to Case E-Intersections with All-Way Stop Control which indicates that at intersections with all-way stop control, the first stopped vehicle of one approach should be visible to the drivers of the first stopped vehicles on each of the other approaches. All intersection approaches within this analysis are clearly visible to other approaches, therefore, all criteria for intersection sight distance are met for this alternative.

Conclusion and Recommendations

This analysis examined the existing conditions of the five signalized intersections located in downtown Santa Fe for study year 2024 and future year 2044. The study analyzed capacity, including delays and levels of service. It reviewed the 95th percentile queues, and also reviewed the intersection sight distance. A signal warrant analysis was performed for the five intersections for both existing and future years. As noted, only one intersection met the threshold volumes to warrant a signal but not until future year of 2044. This study reviewed proposed Alternative 1 consisting of Signalized control with single lane approaches in all directions, Alternative 2 consisting of two-way stop control (TWSC) at the minor street, and Alternative 3 consisting of all-way stop control (AWSC). A summary of the finding is presented below:

Existing Conditions – Signalized Control

- Vehicular levels of service and delays for both existing 2024 and future 2044 conditions are at acceptable LOS C or better.
- Pedestrian levels of service for both existing 2024 and future 2044 conditions are at LOS D or better with exception to the intersection of San Francisco & Old Santa Fe Trail which has failing levels of service due to pedestrian density.
- Bicycle levels of service for both existing 2024 and future 2044 conditions are at LOS D or better.
- Queuing of traffic is not a concern.
- Intersection sight distance is not a concern as oncoming traffic can be seen with adequate distance.

Alternative 1 – Signalized Control with Single Lane Approach in All Directions

- Vehicular levels of service and delays for both existing 2024 and future 2044 conditions are at acceptable LOS C or better.
- Pedestrian levels of service for both existing 2024 and future 2044 conditions are at LOS C or better with exception to the intersection of San Francisco & Old Santa Fe Trail which has failing levels of service due to pedestrian density. The reduction of through lanes would allow for the construction of wider sidewalks or curb extensions that would provide more space for pedestrians thus helping provide better levels of service.
- Bicycle levels of service for both existing 2024 and future 2044 conditions are at LOS C or better. Improvements to this LOS are due to fewer travel lanes being crossed.
- Queuing of traffic is not a concern.
- Intersection sight distance is not a concern as oncoming traffic can be seen with adequate distance.

Alternative 2 – Two-way Stop Control (TWSC) at the Minor Street

- Vehicular levels of service and delays for both existing 2024 and future 2044 conditions are at unacceptable levels of service.
- Pedestrian levels of service for both existing 2024 and future 2044 conditions are between LOS D and LOS F for all intersections.
- There is currently no LOS methodology specific to bicyclists at TWSC intersections. Bicyclists do not queue linearly like vehicles and often times, multiple bicycles will cross at the same time as the adjacent vehicle resulting in lower bicycle delays compared to vehicles.
- Queuing of traffic into other intersections is a concern for four of the five intersections.
- Intersection sight distance is a concern for all five intersections.

Alternative 3 – All-way Stop Control (AWSC)

- Vehicular levels of service and delays for both existing 2024 and future 2044 conditions are at acceptable LOS C or better, with exception of San Francisco & Sandoval during 2024 and 2044, as well as Sandova & Palace/Grant during 2044.
- There is currently no LOS methodology specific to pedestrians at AWSC intersections as pedestrians have the right-of-way and are assumed to result in negligible delays.
- There is currently no LOS methodology specific to bicyclists at AWSC intersections. Bicyclists do not queue linearly like vehicles and often times, multiple bicycles will cross at the same time as the adjacent vehicle resulting in lower bicycle delays compared to vehicles.
- Queuing for the vast majority of this alternative does not impose conflicts of queued traffic blocking other intersections, with the exception of southbound traffic for both San Francisco & Sandoval, as well as Grant & Sandoval/Palace during the 2044 PM peak hour.
- Intersection sight distance is not a concern as oncoming traffic can be seen with adequate distance.

In conclusion, to promote the City's interest to "Give people priority over cars" as outlined in the City's General Plan and echoed in various adopted integrating plans, implementing Alternative 3-All-way Stop Control of the five intersections would be a viable option for the present and near future and should be monitored over time and reevaluated with the increase or decrease of traffic volumes, pedestrian volumes, and bicycle volumes.

Recommendations to implement Alternative 3 All-way Stop Control (AWSC) include the following:

1. Execute a Design Directive via the Public Works Department Complete Streets Division Director, Public Works Director and Public Works Traffic Engineer to include Level of Service (LOS) targets specific to Downtown Santa Fe for pedestrians, bicyclists, and vehicles. There are currently no LOS targets. Many city agencies identify Intersection LOS E as acceptable for urban centers, central business districts (CBD), or downtown areas as congestion and delays are expected while priority and safety are geared towards pedestrians and bicyclists.

2. Identify and fund a priority project to temporarily bag the existing signal heads and install all-way stop signs.
    a. Re-stripe roadway approaches to include one lane of travel in each direction.
    b. Re-stripe crosswalks with high visibility continental pattern crosswalks.
    c. Install advanced signing of the stop condition including high visibility signing indicating a "change in traffic control ahead."
    d. Monitor progress through public outreach and periodic traffic analysis.

3. Should the implementation of AWSC be a success, further improvement should include:
    a. Remove signal mastarms and permanently install all-way stop signs.
    b. Improve and widen sidewalks and curb ramps to ensure ADA compliance.
    c. Consider the construction of curb extensions/bulbouts.
    d. Consider the construction of raised intersections which reinforce slow speeds and encourage motorists to yield to pedestrians at crosswalks.

4. Perform a pedestrian safety study for the Downtown center of Santa Fe to continue the City's interest to "Give people priority over cars" as outlined in the City's General Plan.