



Intermodal Transportation

NEW APPLICATION



0000152652

ORIGINAL

Jennifer Toth, State Engineer
Robert Samour, Senior Deputy State Engineer, Operations
Dallas Hammit, Senior Deputy State Engineer, Development

RECEIVED
AZ CORP COMMISSION
DOCKET CONTROL

March 3, 2014

Arizona Corporation Commission
Office of Railroad Safety
Attn: Chris Watson
1200 W Washington Street
Phoenix, AZ 85007

2014 MAR 4 PM 2 20

Arizona Corporation Commission
DOCKETED

MAR - 4 2014

RE: Application to upgrade existing railroad signals
Project: Broadway Road in Tempe, Arizona
Federal Project # STP-TMP-0(209)A
ADOT Tracs # 0000 MA TMP SR233 01C
Broadway Rd. Crossing AAR/DOT # 741-565L

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RR-03639A-14-0078

Mr. Watson,

Please find enclosed the original and 13 copies of the application to allow UPRR to furnish and install 2 gate and flasher units and 1 cantilever on the outside edge and 2 gate and flasher units in the new raised medians along Broadway Road. Also enclosed is an excerpt from City of Tempe final plans (Pages 5 & 6) and pictures of both road approaches to this crossing for reference.

Feel free to contact me if you have any questions.

Sincerely,

Jason Pike
Railroad and Utility Coordinator
Arizona Department of Transportation
205 S. 17th Ave, Room 357 MD 618E
Phoenix, AZ 85007
Phone: 602-712-7149
jpike@azdot.gov



Intermodal Transportation

Janice K. Brewer, Governor

John S. Halikowski, Director

Jennifer Toth, State Engineer

Robert Samour, Senior Deputy State Engineer, Operations

Dallas Hammit, Senior Deputy State Engineer, Development

March 3, 2014

Arizona Corporation Commission
Office of Railroad Safety
Attn: Chris Watson
1200 W Washington Street
Phoenix, AZ 85007

RE: Application to upgrade existing railroad signals and surface
Project: Broadway Road in Tempe, Arizona
Federal Project #STP-TMP-0(209)A
ADOT TRACS # 0940 MA TMP SR233 01C
Broadway Road Crossing DOT # 741-565L

Mr. Watson,

This application is being submitted to allow the Union Pacific Railroad (UPRR) to furnish and install 4 gate and flasher units, one cantilever and constant warning circuitry on Broadway Road.

1. Project Location and Description

The project is located at the crossing of UPRR on Broadway Rd. in Tempe, Arizona. This crossing consists of one mainline with daily usage and one siding for UPRR. Broadway is an at-grade roadway and is used for 2 way traffic, consisting of 3 thru eastbound lanes, 1 two way left turn lane, and 2 thru westbound lanes.

The project consists of installing two gate and flasher units and one cantilever on the outside edge of Broadway, installing two new gate and flasher units within new raised medians, and installing constant warning. The City of Tempe will also construct civil improvements including adjusting sidewalks, installing raised medians, re-striping, and improving the road approaches. These civil improvements will help facilitate the necessary railroad safety improvements at the crossing.

2. Why the crossing is needed

Based on the 2008 crossing improvement array, the Broadway crossing was selected for upgrades by installing lights and gates on the outside edges of the roadway and within proposed raised medians and constant warning.

3. Construction Phasing

Once the utility, environmental, and right-of-way clearances are obtained, ADOT can apply for and receive FHWA construction authorization and authorize UPRR to order their signal materials and authorize the City of Tempe to construct their civil improvements. Once an Opinion and Order is issued and the City of Tempe constructs the civil improvements on Broadway, UPRR will install the signal equipment. The railroad signal improvements will be installed by UPRR within 24 months of the receipt of an Opinion and Order from the ACC.

4. Maintenance of the crossing

UPRR will be responsible for installing and maintaining the railroad signal and surface equipment. The City of Tempe will be responsible for maintaining the road approaches outside of UPRR responsibility, sidewalks and medians.

5. Project Funding

100% of the funding will be provided thru the Federal Highway Administration thru their Section 130/Highway-Railroad Crossing Safety Improvement Program.

Costs are as follows:

Preliminary and Construction Engineering	\$47,000.00
UPRR Furnish and Install Flashers and Gates and Constant Warning	\$550,000.00
City of Tempe Construction of Civil Improvements	<u>\$125,000.00</u>
Total Cost	\$722,000.00

6. Other information (based on typical Staff Data Requests):

1. Provide Average Daily Traffic Counts for each of the locations.
Per City of Tempe:
Broadway Road-2013 Traffic Count = 26,396 vehicles per day
2. Please describe the current Level of Service (LOS) at each intersection.
The City of Tempe stated that Broadway Rd. has a current Level of Service of B.
3. Provide any traffic studies done by the road authorities for each area.
A CMAQ project on Broadway Rd. between Mill Ave and Rural Road, was completed recently. Study attached as part of this application.
4. Provide the population of the City the crossing is located in.
2010 census: 161,719 persons.

5. Provide what warning devices are currently installed at the crossing.
 Currently there are flashing lights, gates and single lane cantilevers on the outside edges of the roadway for both eastbound and westbound traffic. These lights do not cover all of the lanes currently at the crossing.

6. Provide distances in miles to the next public crossing on either side of the proposed project location. Are any of these grade separations?
 Southern Ave. (741 568G) is an at-grade crossing one mile to the south. University Dr. (741 560C) is an at-grade crossing one mile to the north. Mill Ave (741 584R) is a grade separated crossing 0.2 miles east and 0.5 miles north. Alameda Dr. (748 300H) is an at-grade pedestrian crossing ½ mile south of the Broadway crossing.

7. How and why was grade separation not decided on at this time? Please provide any studies that were done to support these answers.
 Grade separation was not considered as part of this Section 130 safety upgrade due to the proximity of the crossing to the Arizona State University campus and Mill Avenue a major street in Tempe and the overall high cost to complete a grade separation at this location.

8. If this crossing was grade separated, provide a cost estimate of the project.
 Estimate \$30,000,000++ due to urbanized location.

9. Please describe what the surrounding areas are zoned for near this intersection. i.e. Are there going to be new housing developments, industrial parks etc.
 The areas adjacent to the Broadway Road railroad crossing are zoned as Commercial, Educational and Residential.

10. Please supply the following: number of daily train movements through the crossing, speed of the trains, and the type of movements being made (i.e. thru freight or switching). Is this a passenger train route?
 Per UPRR, there are 2 train movements over the crossing at this time, including 0 switching movements and 2 daytime thru movements. The trains move over the crossing at speeds between 15 and 20 mph, with a maximum time table speed of 20mph.

 This is not a passenger train route.

11. Please provide the names and locations of all schools (elementary, junior high and high school) within the area of the crossing.

▪ Tempe High School	1730 S. Mill Ave. Tempe
▪ Gilliland Middle School	1025 S. Beck Ave., Tempe
▪ Tempe Academy of Intl Studies	2250 S. College Ave., Tempe
▪ ASU (Arizona State University)	1111 S. Union Dr., Tempe
▪ McKemy Middle School	3205 S. Rural Rd., Tempe
▪ Our Lady of Mt, Carmel School	2117 S. Rural Rd., Tempe

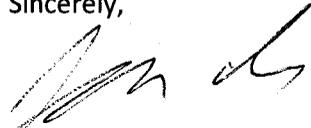
12. Please provide school bus route information concerning the crossing, including the number of times a day a school bus crosses this crossing.
Per Tempe Union High School District and Tempe Elementary School District, school buses utilize this crossing 39 times per day.
13. Please provide information about any hospitals in the area and whether the crossing is used extensively by emergency service vehicles.
 - Tempe St. Luke's Hospital – 1500 South Mill Avenue, Tempe Broadway Rd. is a major emergency service route for the hospital.
14. Please provide total cost of the railroad improvements to each crossing.
Cost described above.
15. Provide any information as to whether vehicles carrying hazardous materials utilize this crossing and the number of times a day they might cross it.
The City of Tempe stated that the City is not aware of any vehicles carrying hazardous materials that utilize this crossing.
16. Please provide the posted vehicular speed limit for the roadway.
Broadway Road = 40 MPH
17. Do any buses (other than school buses) utilize the crossing, and how many times a day do they cross the crossing.
The City of Tempe stated that Valley Metro Bus Route 45 crosses the tracks a total of 107 times a day on weekdays, 77x/day on Saturday and 66x/day on Sunday.
18. Please indicate whether any spur lines have been removed within the last three years inside a 10 mile radius of any crossings covered in this application. Please include the reason for the removal, date of the removal and whether an at-grade crossing or crossings were removed in order to remove the spur line.
None
19. Please fill in the attached FHWA Grade Separation Guidelines Table, (from FHWA's 2007 revised second edition Railroad Highway Grade-Crossing Handbook, page 151) with a yes or no answer as to whether each item applies. Also, please provide all information to support your answers of yes or no (i.e. vehicle delay numbers, any calculations that were performed to get the answers).

20. Based on the current single track configuration at the crossings specified by this application, please provide the current traffic blocking delay per train. Please indicate the time in which vehicular traffic is delayed (1) to allow the train to pass at a crossing and (2) due to trains stopped on the track for any purpose. The delay is measured from the point that the warning devices are activated at the crossing to the time after the train has cleared the crossing and the warning devices are reset.

The City of Tempe stated that the delay at the crossing is really a function of the average length of the train and the average speed that is traveling.

FOR EXAMPLE: 7,000 ft. train traveling 30mph (44 fps) would result in 160 seconds or a little over 3.5 minutes of delay.

Sincerely,



Jason Pike
Railroad and Utility Coordinator
Arizona Department of Transportation
205 S. 17th Ave, Room 357 MD 618E
Phoenix, AZ 85007
Phone: 602-712-7149
jpike@azdot.gov

FHWA - GRADE SEPARATION GUIDELINES

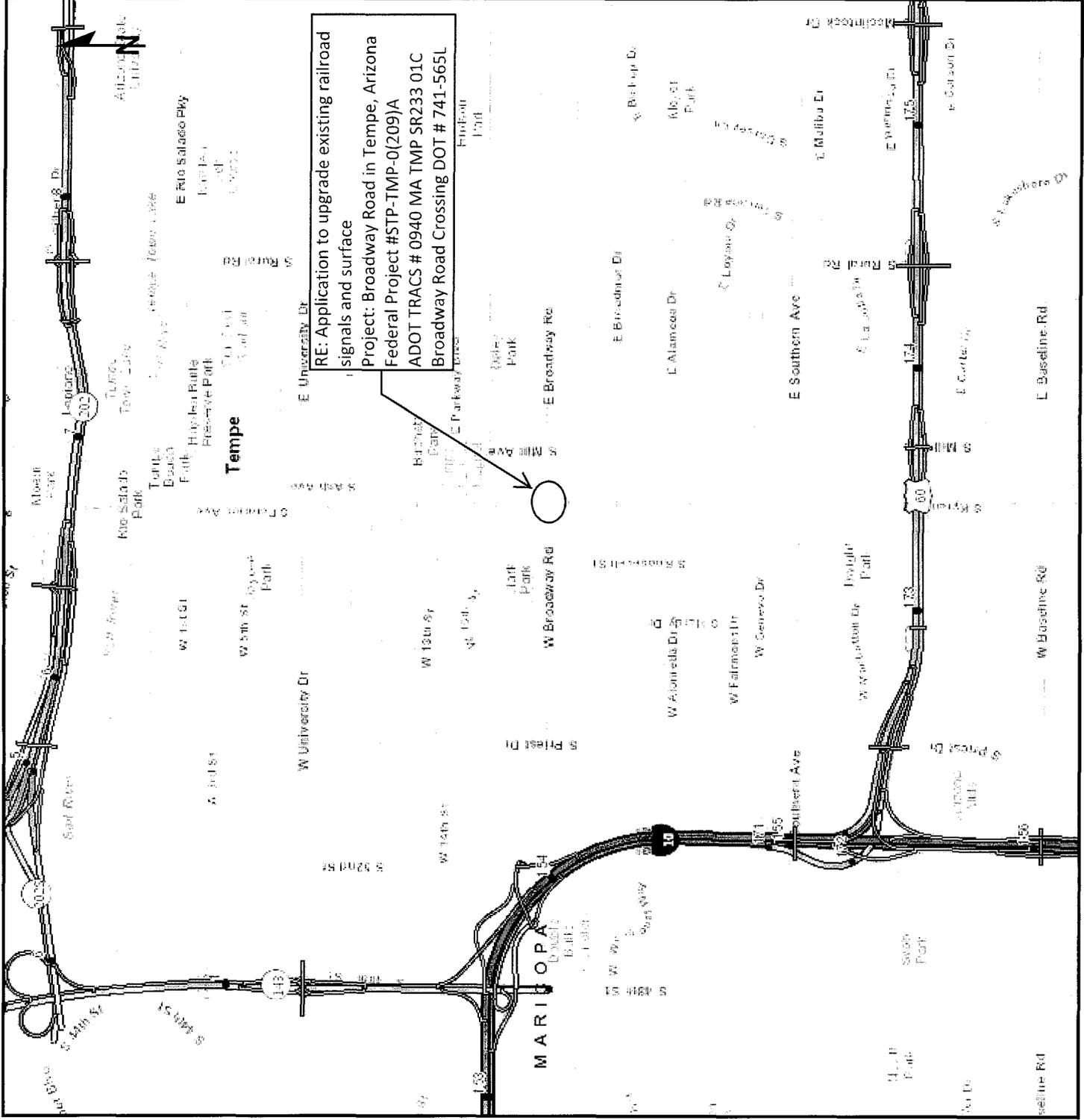
Highway-rail grade crossings should be considered for grade separation or otherwise eliminated across the railroad right of way whenever one or more of the following conditions exist:

		Broadway Dr
The highway is a part of the designated Interstate Highway System	Crossing Currently meets the criteria	N
The highway is otherwise designed to have full controlled access	Crossing meets the criteria by 2030	N
The posted highway speed equals or exceeds 70 mph	Crossing Currently meets the criteria	N
	Crossing meets the criteria by 2030	N
AADT exceeds 100,000 in urban areas or 50,000 in rural areas	Crossing Currently meets the criteria	N
	Crossing meets the criteria by 2030	N
Maximum authorized train speed exceeds 110 mph	Crossing Currently meets the criteria	N
	Crossing meets the criteria by 2030	N
An average of 150 or more trains per day or 300 million gross tons/year	Crossing Currently meets the criteria	N
	Crossing meets the criteria by 2030	N
Crossing exposure (trains/day x AADT) exceeds 1M in urban or 250k in rural; or passenger train crossing exposure exceeds 800k in urban or 200k in rural	Crossing Currently meets the criteria	N
	Crossing meets the criteria by 2030	N
Expected accident frequency for active devices with gates, as calculated by the US DOT Accident Prediction Formula including five-year accident history, exceeds 0.5	Crossing Currently meets the criteria	N
	Crossing meets the criteria by 2030	N
Vehicle delay exceeds 40 vehicle hours per day	Crossing Currently meets the criteria	N
	Crossing meets the criteria by 2030	N



Broadway Rd. @ UPRR

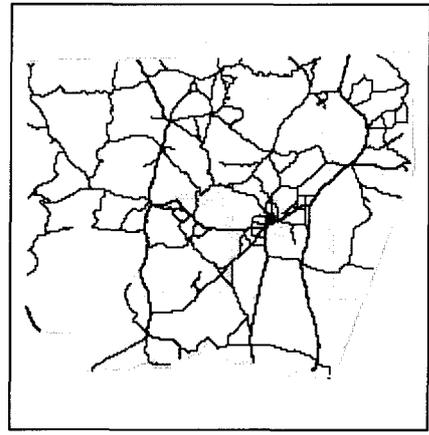
Railroad Crossing at Broadway
Rd. and UPRR, for Section 130
Safety Improvements



RE: Application to upgrade existing railroad signals and surface
Project: Broadway Road in Tempe, Arizona
Federal Project #STP-TMP-0(209)A
ADOT TRACS # 0940 MA TMP SR233 01C
Broadway Road Crossing DOT # 741-565L



1:36,112



DEMOLITION NOTES	
1	REMOVE EXISTING CONCRETE SIDEWALK PER DETAIL 1 ON SHEET 6
2	REMOVE EXISTING ASPHALT PAVEMENT PER DETAIL 1 ON SHEET 6
3	DEBRIS EXISTING STRIPING BY WATER BLASTING

CONSTRUCTION NOTES	
1	CONCRETE SIDEWALK PER MAG STD DETAIL 230, DIMENSIONED PER DETAIL 1 ON SHEET 6
2	VERTICAL CURB AND GUTTER PER MAG STD DETAIL 230-1, TYPE "A", H/F
3	ASPHALT PAVEMENT PER SECTION ON SHEET 6 REPLACEMENT PER CITY OF TEMPE STD DETAIL T-450
4	CONCRETE MEDIAN PER COT STD DET T-300.1 CONCRETE TO BE INSTALLED PER THE DETAIL AT A RECESSED ELEVATION TO RECEIVE PAVERS. PAVERS WILL BE INSTALLED BY OTHERS.
5	TYPE 3 OBJECT MARKER (OM-3) AND INSTALLATION PER LATEST VERSION OF THE MUTCD
6	SKIN POST PER MAG STD DETAIL 131 TYPE 'B'
7	NEW STRIPING PER MCDOT 2008 SUPPLEMENT TO MAG STD SPEC SECTION 461

SF	1030
SY	47
SF	415
EA	2
EA	2
LF	990

LEGEND

EXISTING SIDEWALK TO BE REMOVED

NOTES

1. ALL MEASUREMENTS ARE FROM FACE-OF-CURB TO FACE-OF-CURB.

2. EXISTING RAILROAD GATE TO BE REMOVED AND REPLACED WITH NEW GATE BY UPRR.

3. NEW RAILROAD GATE TO BE INSTALLED BY UPRR.

4. NEW RAILROAD CONTROLLER TO BE INSTALLED BY UPRR.



PROJECT # S405380 TRACS# SR23301C DS# EN#

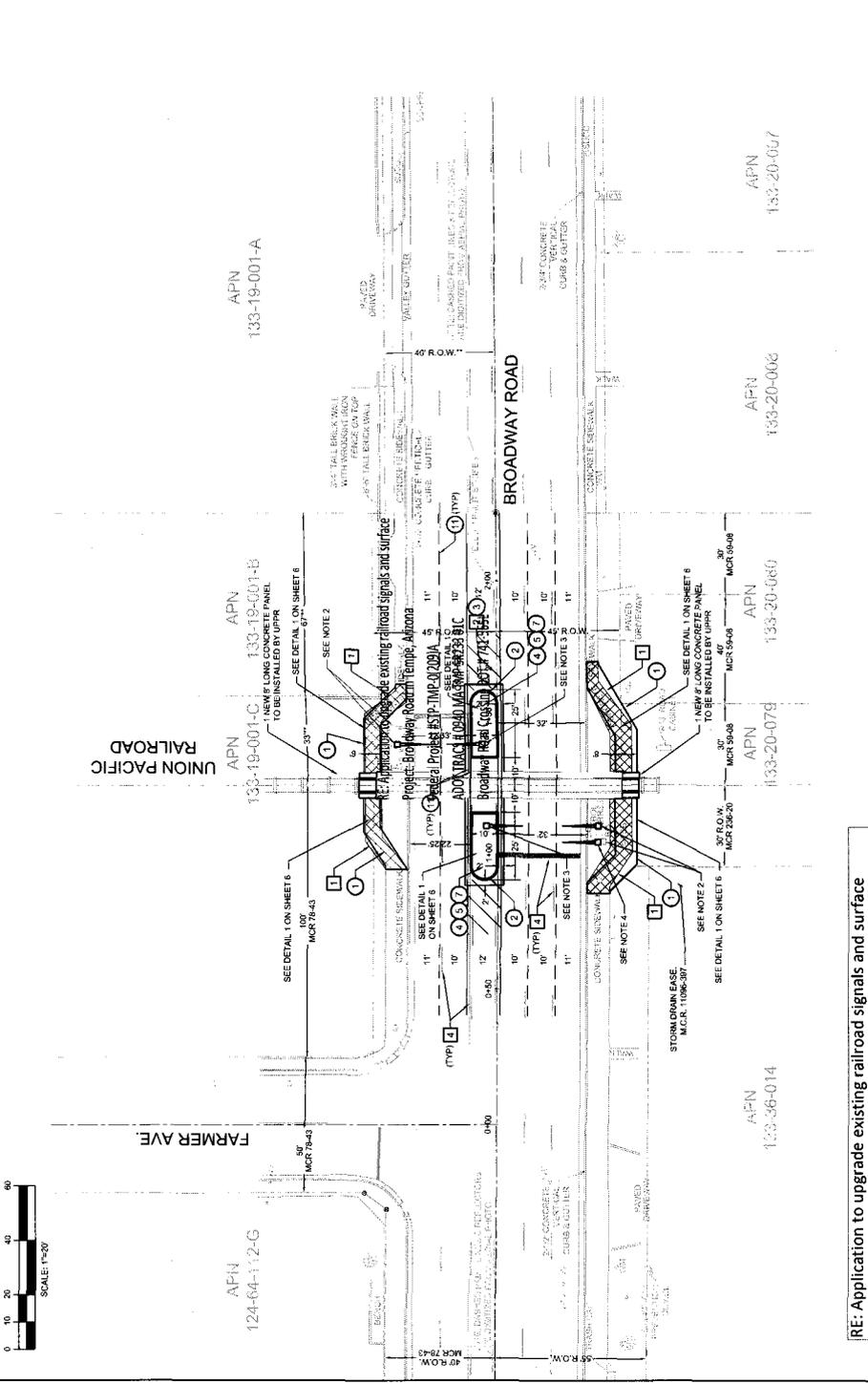
TITLE: RAILROAD CROSSING SAFETY IMPROVEMENTS AT BROADWAY ROAD

CITY OF TEMPE
DIVISION OF ENGINEERING

PROJECT NO. 12272012
PROJECT NO. 65269
DATE: 12/27/12

RAILROAD CROSSING SAFETY IMPROVEMENTS
BROADWAY RD

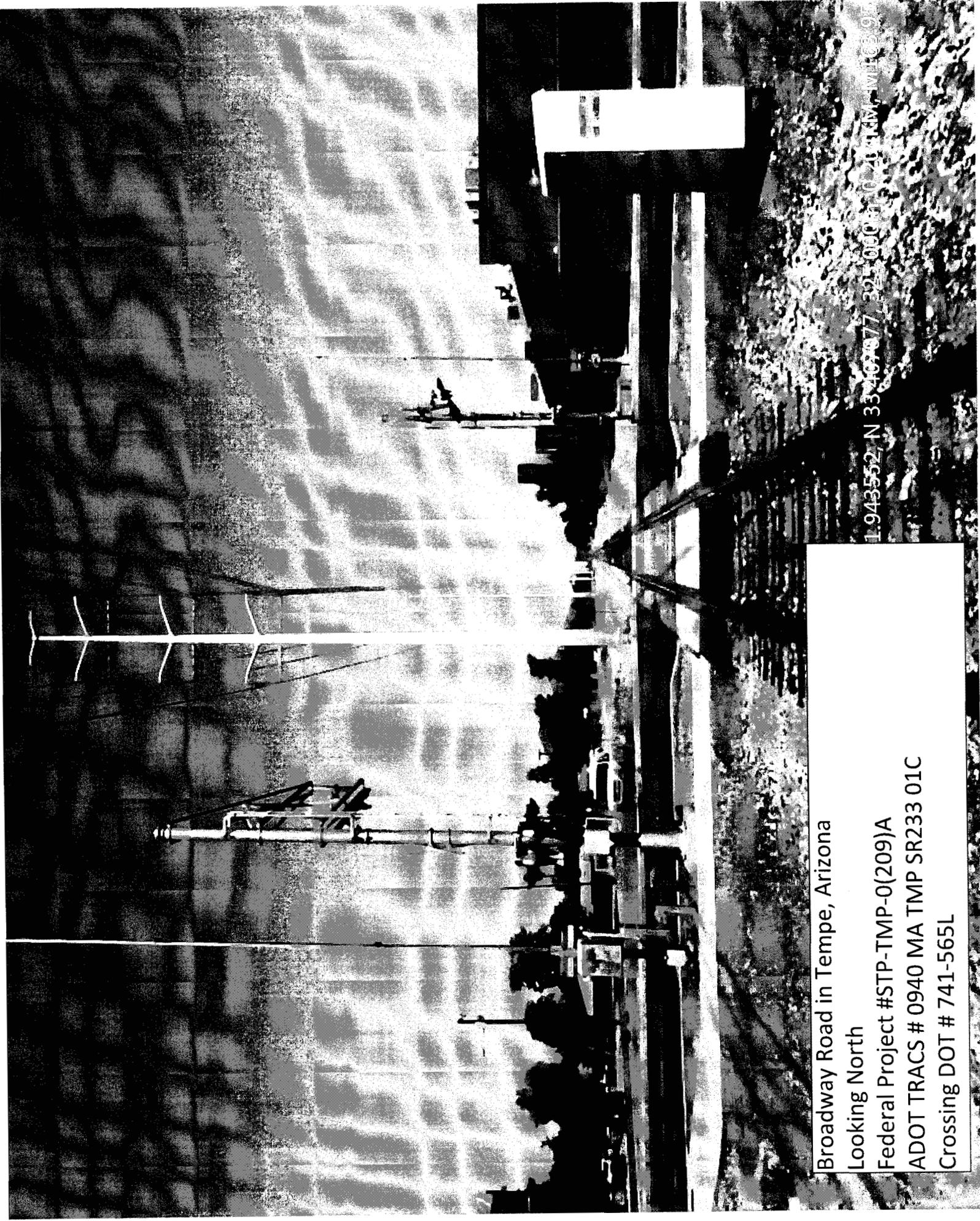
DATE: 12/27/12
SHEET 5 OF 6



RE: Application to upgrade existing railroad signals and surface
Project: Broadway Road in Tempe, Arizona
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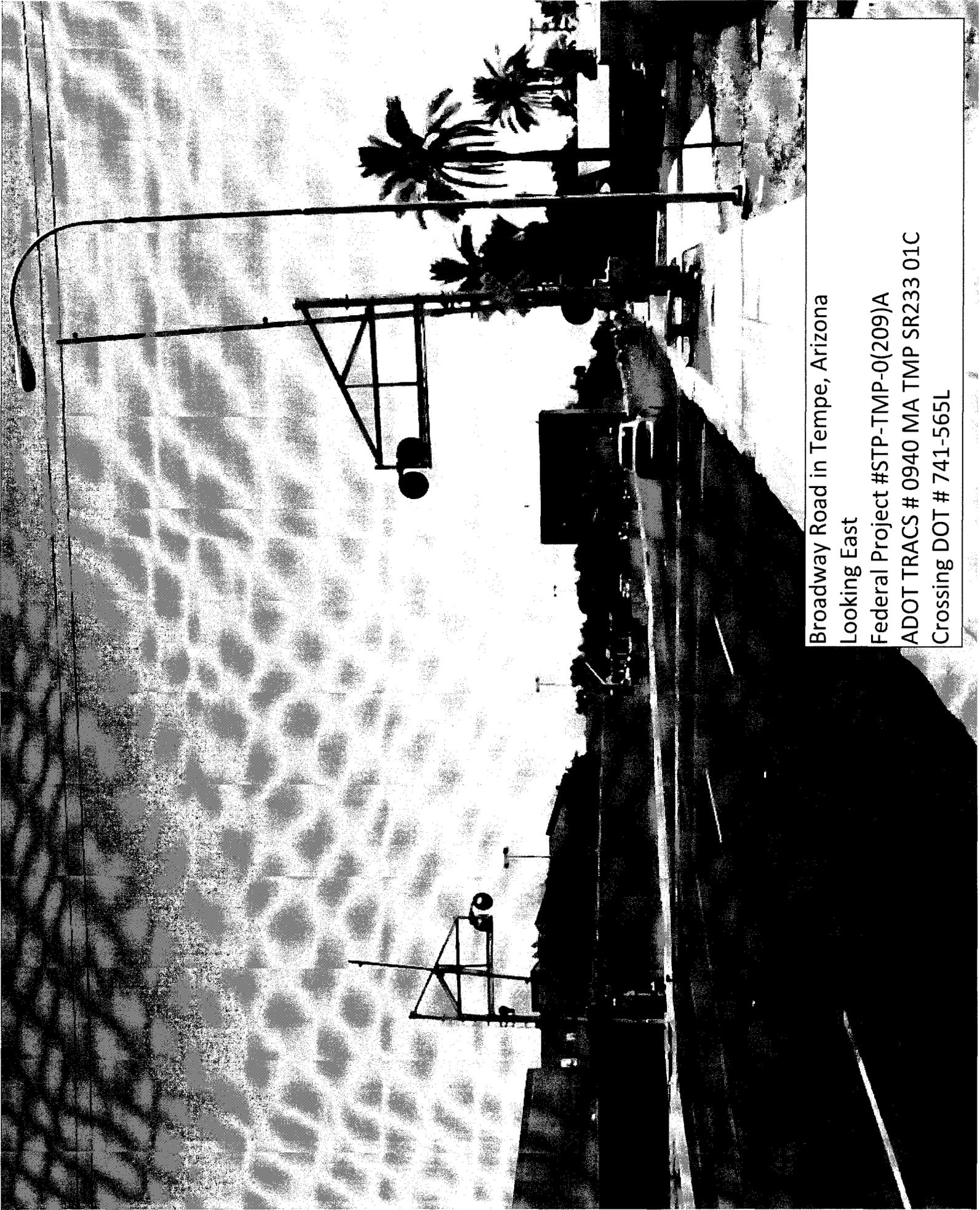
APN 133-19-001-A
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APN 133-19-001-C
APN 133-19-001-D
APN 133-19-001-E
APN 133-19-001-F
APN 133-19-001-G
APN 133-19-001-H
APN 133-19-001-I
APN 133-19-001-J
APN 133-19-001-K
APN 133-19-001-L
APN 133-19-001-M
APN 133-19-001-N
APN 133-19-001-O
APN 133-19-001-P
APN 133-19-001-Q
APN 133-19-001-R
APN 133-19-001-S
APN 133-19-001-T
APN 133-19-001-U
APN 133-19-001-V
APN 133-19-001-W
APN 133-19-001-X
APN 133-19-001-Y
APN 133-19-001-Z

Gannett Fleming
4722 N. 24th Street, Suite 250, Phoenix, AZ 85016-6532
Phone: (602) 555-8817 Fax: (602) 555-3816 Web: www.gannett.com

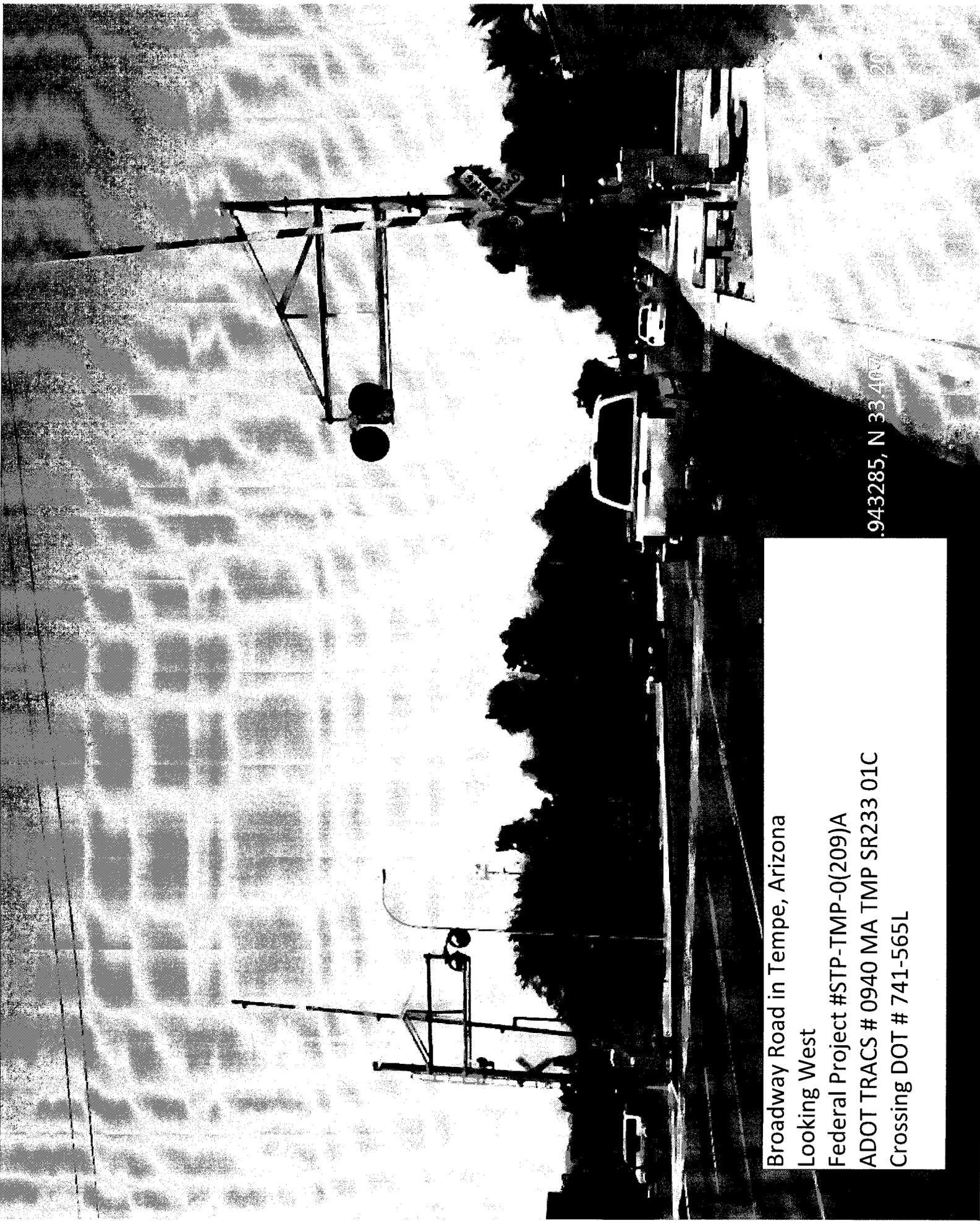


Broadway Road in Tempe, Arizona
Looking North
Federal Project #STP-TMP-0(209)A
ADOT TRACS # 0940 MA TMP SR233 01C
Crossing DOT # 741-565L

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Broadway Road in Tempe, Arizona
Looking East
Federal Project #STP-TMP-0(209)A
ADOT TRACS # 0940 MA TMP SR233 01C
Crossing DOT # 741-565L



Broadway Road in Tempe, Arizona
Looking West
Federal Project #STP-TMP-0(209)A
ADOT TRACS # 0940 MA TMP SR233 01C
Crossing DOT # 741-565L

.943285, N 33 40 77

20

Date: February 20, 2013

To: Mr. Eric Iverson, City of Tempe

From: Parsons Brinckerhoff

Subject: Broadway Road Streetscape Project | Traffic Study Update

STUDY PURPOSE

The City of Tempe is currently in conceptual design phase of implementing pedestrian and bicycle improvements on Broadway Road between Mill Avenue and Rural Road. These streetscape improvements are proposed in the vicinity of residential neighborhoods and may be accomplished with a lane reduction on eastbound Broadway Road (from three to two travel lanes).

This traffic study is an update to the previous analysis completed in 2009. The objectives of the study update are to:

- Provide a historical perspective of Average Annual Daily Traffic Volumes on Broadway Road from 2004 to 2012.
- Compare Broadway Road traffic volumes to similar arterials within the City of Tempe.
- Determine existing and future year (2017) peak hour traffic operations for the study area intersections.

STUDY AREA

Broadway Road is an east-west arterial passing through the City of Tempe and provides access to the Maricopa Freeway (I-10) and Price Freeway (SR101L). Broadway Road currently has five travel lanes between Priest Drive and Rural Road (three eastbound and two westbound), six travel lanes west of Priest Drive, and east of Rural Road within the City limits. Broadway Road is characterized by a mix of land uses along the corridor ranging from residential neighborhoods, commercial development, and industrial land use. The posted speed limit on Broadway Road is 40 mph and reduced to 35 mph in the school zones.

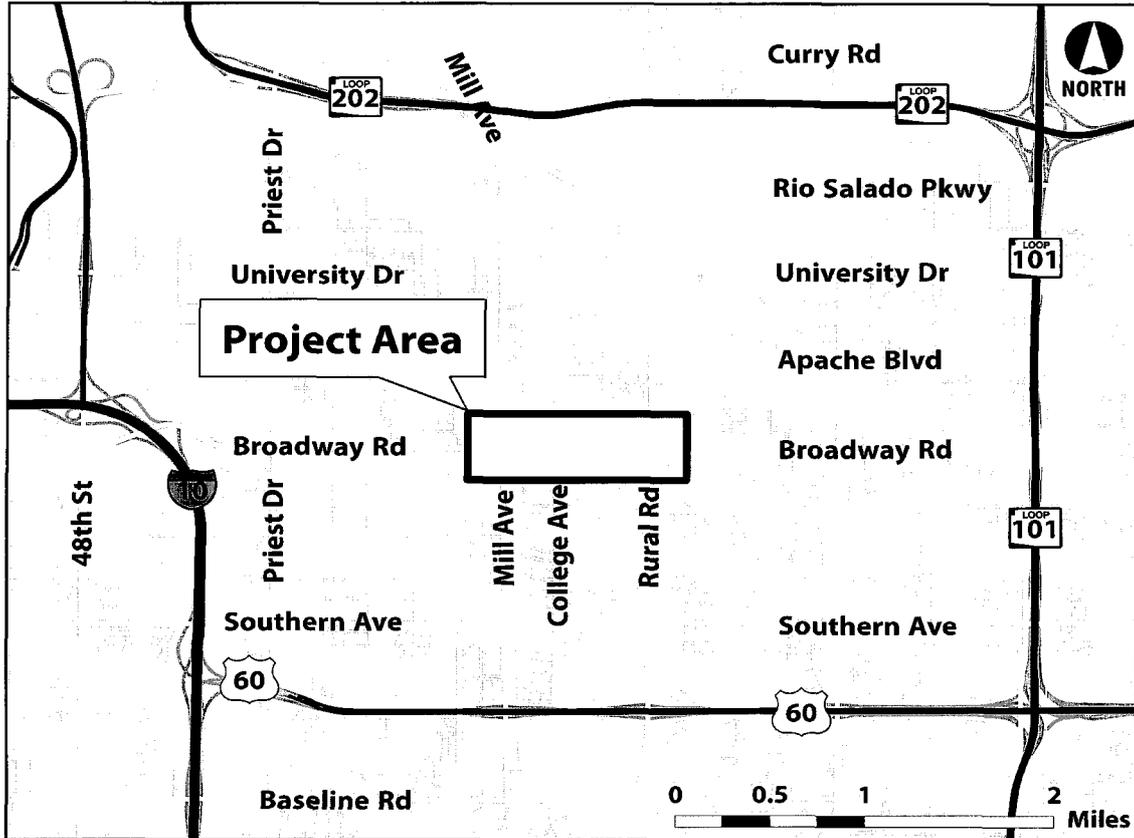
Figure 1 illustrates the project corridor and the study area. The following major streets intersect Broadway Road within the project limits, which are controlled with traffic signals:

Mill Avenue is a four-lane arterial within the City limits and extends from Baseline Road on the south to Red Mountain Freeway (SR202L) on the north with a service interchange at Superstition Freeway (US 60).

College Avenue is a two-lane collector within the City limits and extends from north of Superstition Freeway in the south to Apache Boulevard on the north.

Rural Road is a six-lane arterial within the City limits and extends north into the City of Scottsdale and south into the City of Chandler with service interchanges at Red Mountain Freeway and Superstition Freeway.

Figure 1 Broadway Road Study Area



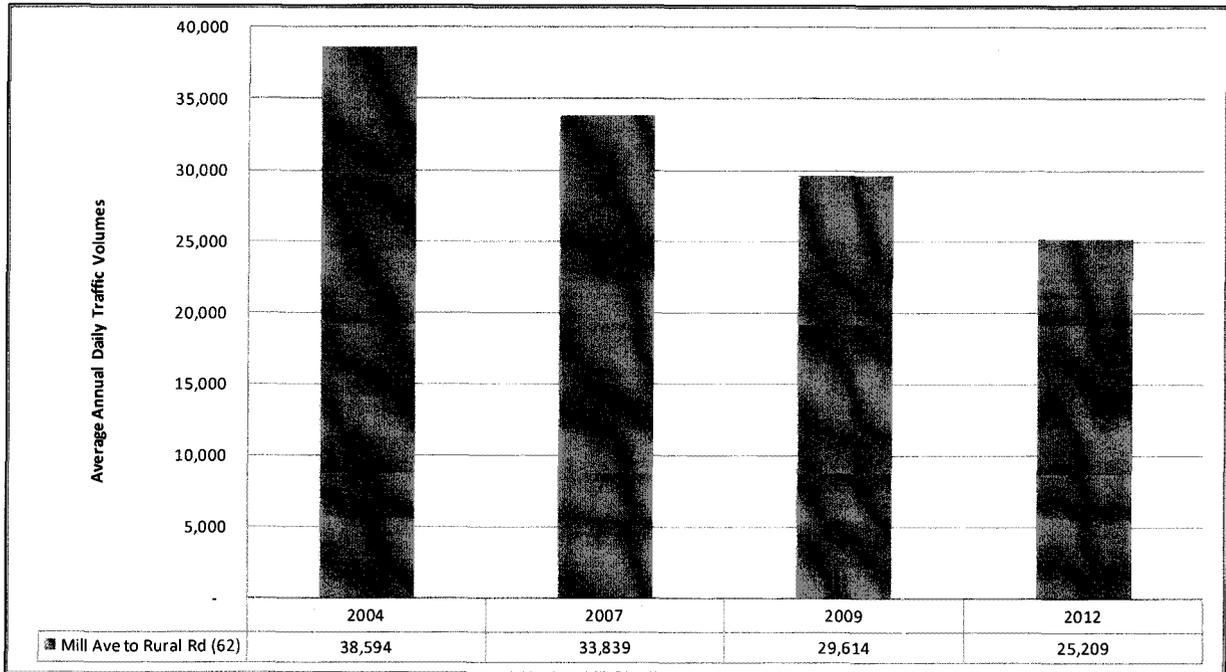
AVERAGE ANNUAL DAILY TRAFFIC VOLUMES (AADT)

Historical AADT: Figure 2 shows the historical AADT volume trend on Broadway Road. As shown in the figure, the AADT on Broadway Road has been decreasing over the years. This is consistent with observed reduction of traffic volumes on other arterials within the City of Tempe.

The main reason for the gradual decrease in traffic volumes on the arterials is the capacity improvements completed over the years to the regional freeway system surrounding the City of Tempe. These improvements include general purpose lane widening on Superstition Freeway (two lanes in each direction), High Occupancy Vehicle (HOV) lanes on Price Freeway, general purpose lanes on Red Mountain Freeway (one lane in each direction) and westbound lane addition on Maricopa Freeway from Superstition Freeway to SR143 (one auxiliary lane). In addition *Maricopa Association of*

Governments (MAG) Regional Transportation Plan (RTP) identifies future capacity improvements on I-10. As the regional freeway network expands, commuter traffic experience shorter travel times using the freeways and tends to avoid arterials with traffic signals.

Figure 2: Broadway Road AADT by year



Source: City of Tempe Traffic Counts Map October 2012, March 2008

2012 Existing AADT: Broadway Road currently serves a daily traffic volume of 25,209 vehicles between Mill Avenue and Rural Road.

2012 Travel Demand with four-lanes on Broadway Road: The MAG Travel Demand Model was utilized to determine the daily traffic volumes on Broadway Road with four-lanes between Mill Avenue and Rural Road.

With capacity reduction on eastbound Broadway Road from three to two lanes, the traffic volumes reduce by 10.5 percent to 22,483 vehicles per day. This 10.5 percent of traffic volume is anticipated to use other parallel arterials to travel to their destinations. City of Tempe has existing four-lane arterials that carry similar daily traffic volumes. Table 1 compares the existing traffic volumes on four-lane roadways within the City of Tempe with proposed four-lanes on Broadway Road. As shown in Table 1, segments of four-lane University Drive and Mill Avenue carry similar or higher daily traffic volumes.

Table 1: AADT Comparison of 4-lane Arterials in City of Tempe

Roadway	Segment	2012 AADT
University Drive	SR143 to Priest Dr	28,048
	Priest to Mill Avenue	25,152
	Mill Avenue to Rural Road	22,559
	Rural Road to McClintock Dr	27,360
	McClintock Dr to Price (SR101L)	30,115
Mill Avenue	Apache Blvd to Broadway Road	26,010
	Southern Avenue to Superstition (US60)	34,139
Broadway Road (with 4-lanes)	Mill Avenue to Rural Road	22,483*

City of Tempe Traffic Counts Map October 2012

*Estimated from MAG Travel Demand Model

2017 Travel Demand with five and four-lanes on Broadway Road: As discussed in the previous section, the AADT volumes on Broadway Road and other City arterials have been reducing as the regional freeway network is expanding. However, for conservative analysis a growth rate derived from the MAG Travel Demand Model was used to identify the future year traffic volumes.

MAG Travel Demand Model estimates that the daily traffic volumes on Broadway Road will increase by 14 percent from 2009 to 2030. This represents an annual growth rate of 0.5 percent. This growth rate was applied to 2012 volumes to determine 2017 traffic volumes.

Broadway Road with existing five-lanes will carry 25,840 vehicles per day. Broadway Road with four-lanes will carry 23,045 vehicles per day. The existing 4/5-lane arterials currently serve similar traffic volumes.

PEAK HOUR TRAFFIC OPERATIONS

A signalized intersection Level of Service (LOS) analysis was completed for the Broadway Road study intersections with Mill Avenue, College Avenue and Rural Road using the methodologies presented in the *Highway Capacity Manual (TRB, Special Report 209, revised 2000)*. This analysis uses the critical volumes passing through the intersection in one hour and compares those volumes to the capacity of the intersection and defines an associated delay. The analysis incorporates the effects of traffic volumes, geometry, traffic signal operation, truck and local bus volumes, pedestrian activity associated with the peak traffic hours. The result is a LOS determination for each approach and for the intersection as a whole. The capacity criteria, in terms of Average Vehicle Delay, are presented in Table 2.

Table 2: HCM Signalized Intersection Capacity Criteria

Level of Service (LOS)	Average Vehicle Delay (sec/veh)
A	≤ 10
B	> 10-20
C	> 20-35
D	> 35-55
E	> 55-80
F	> 80

Source: 2000 Highway Capacity Manual

LOS D is generally considered as the threshold of acceptable operational conditions in an urban area and was selected for this study.

Broadway Road has predominantly directional traffic flow during the morning and afternoon peak hours. The directional flow is higher in the westbound direction during the morning peak hour and higher in the eastbound direction during the afternoon peak hour.

The peak hour analysis for this study was limited to the afternoon (PM) peak hour as the capacity reduction is proposed in eastbound direction only and the traffic impacts would be predominantly in the eastbound direction. *Synchro 8.0* signal timing program was used to determine the intersection LOS.

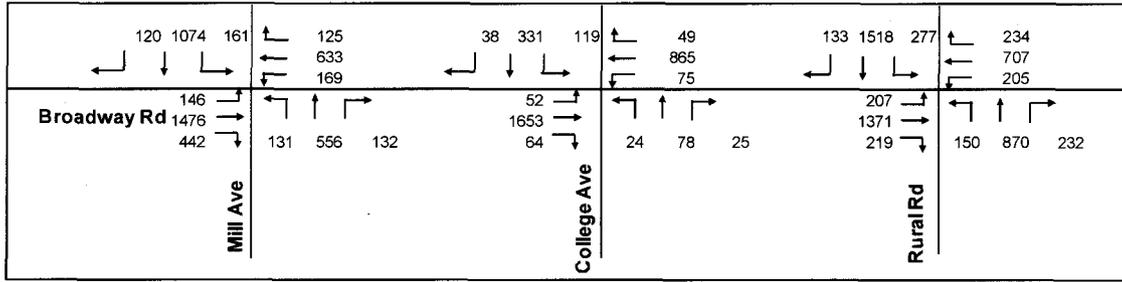
The peak hour analysis was completed for two analysis years with and without the proposed improvements. They are:

- 2012 Intersection LOS with existing five-lane Broadway Road.
- 2012 Intersection LOS with four-lane Broadway Road.
- 2017 Intersection LOS with five-lane Broadway Road.
- 2017 Intersection LOS with four-lane Broadway Road.

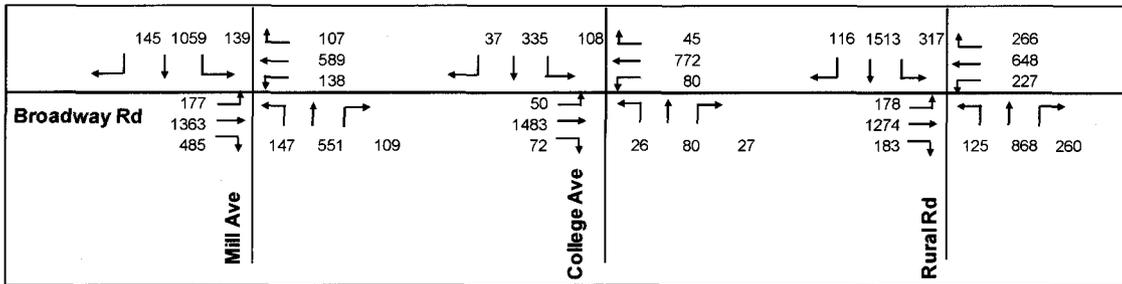
The peak hour turning movement counts for the study area intersections were collected and provided by the City of Tempe. The data was collected between 2009 and 2011. An annual growth rate of 0.5 percent was applied to these volumes to obtain 2012 peak traffic volumes.

The MAG Travel Demand Model was used to model the project alternatives. Each alternative daily segment volumes from the model were balanced using the existing peak hour turning movement volumes to obtain the alternative peak hour traffic volumes. Figures 3 and 4 show the 2012 and 2017 PM peak hour traffic volumes with and without the proposed improvements.

Figure 3 2012 PM Peak Turning Movement Volumes

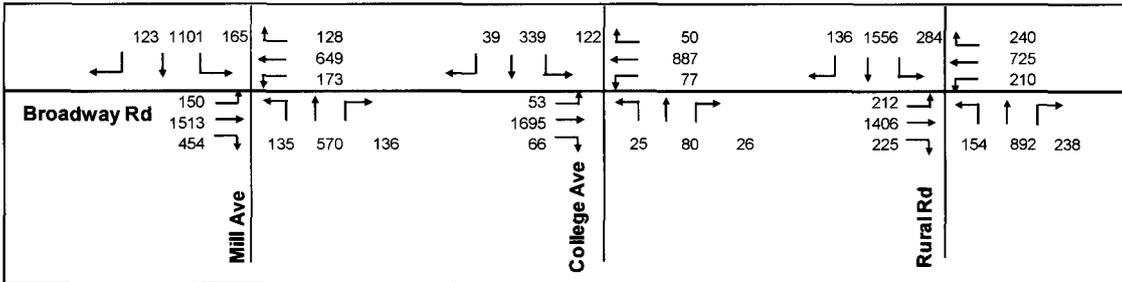


5-Lane Broadway Road

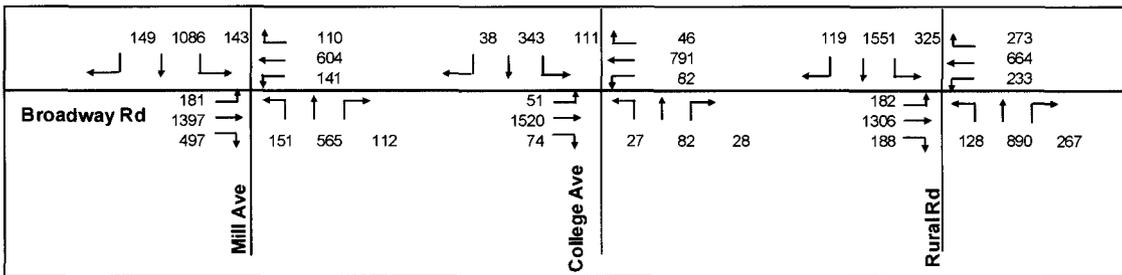


4-Lane Broadway Road

Figure 4 2017 PM Peak Turning Movement Volumes



5-Lane Broadway Road



4-Lane Broadway Road

Source: 2012 Existing Traffic counts-City of Tempe
2012 and 2017 alternatives developed using MAG Travel Demand Model

2012 Existing Peak Hour Intersection LOS: Table 2 summarizes the existing LOS for the study intersections.

Table 2: 2012 Existing Intersection PM Peak Hour LOS

Intersection	PM Peak Hour		
	Delay	LOS	v/c Ratio
Broadway Road & Mill Avenue	63.8	E	1.04
Broadway Road & College Avenue	12.0	B	0.84
Broadway Road & Rural Road	69.1	E	1.06

LOS was calculated using City of Tempe existing signal timing settings for the study intersections.
v/c ratio: Volume-Capacity Ratio

The intersection of Broadway Road and Mill Avenue is currently operating at reduced LOS (E) during afternoon peak hour due to high approach volumes on both intersecting streets. College Avenue intersection currently operates at LOS B. The intersection of Broadway Road and Rural Road is operating at reduced LOS (E) due to high traffic volumes on both intersecting streets.

Table 3 summarizes the PM peak hour intersection LOS for the improvement alternatives for existing and future year alternatives.

2017 Peak Hour Intersection LOS with five-lanes on Broadway Road: As shown in Table 3, the intersections of Mill Avenue and Rural Road with Broadway Road will continue to operate at reduced LOS E with 2017 traffic volumes. College Avenue intersection will operate at LOS B.

2012 Peak Hour Intersection LOS with four-lanes on Broadway Road: As shown in Table 3, Mill Avenue intersection will operate at reduced LOS F with two through lanes on eastbound Broadway Road. College Avenue intersection will operate at LOS B. Rural Road intersection will operate at LOS E however there is lower delay due to reduced through volumes approaching Rural Road intersection and metering of traffic at Mill Avenue.

2017 Peak Hour Intersection LOS with four-lanes on Broadway Road: As shown in Table 3, the intersection LOS at Mill Avenue will reduce to LOS F and higher delays with two through lanes on eastbound Broadway Road. College Avenue intersection will operate at LOS B. Rural Road intersection will operate at LOS E with lower delay due to decreased through volumes approaching Rural Road intersection and metering of traffic at Mill Avenue.

Table 3: PM Peak Hour LOS with Improvement Alternatives

Intersection	Alternative		Delay (sec)	LOS	V/C
Broadway Road & Mill Avenue	2012 - Existing	*	63.8	E	1.04
	2012 - 2 EB Lanes	*	98.1	F	1.15
	2012 - 3 EB Lanes + Downstream Lane Drop at Mill Avenue	**	58.4	E	0.96
	2012 - 2 EB Lanes + 2 EB/WB Left at Mill Avenue	**	65.3	E	1.05
	2017 - 3 EB Lanes	*	69.4	E	1.06
	2017 - 2 EB Lanes	*	105.8	F	1.18
	2017 - 3 EB Lanes + Downstream Lane Drop at Mill Avenue	**	60.7	E	0.99
	2017 - 2 EB Lanes + 2 EB/WB Left at Mill Avenue	**	70.0	E	1.08
Broadway Road & College Avenue	2012 - Existing	*	12.0	B	0.84
	2012 - 2 EB Lanes	*	15.5	B	0.91
	2012 - 3 EB Lanes + Downstream Lane Drop at Mill Avenue	**	18.8	C	0.85
	2012 - 2 EB Lanes + 2 EB/WB Left at Mill Avenue	**	21.4	B	0.85
	2017 - 3 EB Lanes	*	12.7	B	0.91
	2017 - 2 EB Lanes	*	16.9	B	1.01
	2017 - 3 EB Lanes + Downstream Lane Drop at Mill Avenue	**	20.0	C	0.93
	2017 - 2 EB Lanes + 2 EB/WB Left at Mill Avenue	**	22.5	C	0.93
Broadway Road & Rural Road	2012 - Existing	*	69.1	E	1.06
	2012 - 2 EB Lanes	*	56.9	E	1.04
	2012 - 3 EB Lanes + Downstream Lane Drop at Mill Avenue	**	49.2	D	1.00
	2012 - 2 EB Lanes + 2 EB/WB Left at Mill Avenue	**	51.0	D	1.00
	2017 - 3 EB Lanes	**	75.8	E	1.09
	2017 - 2 EB Lanes	**	65.7	E	1.12
	2017 - 3 EB Lanes + Downstream Lane Drop at Mill Avenue	**	59.8	E	1.07
	2017 - 2 EB Lanes + 2 EB/WB Left at Mill Avenue	**	61.4	E	1.07

* Existing Signal Timing (110 seconds)

** Optimized Signal Timing (120 seconds)

MILL AVENUE IMPROVEMENT ANALYSIS

Mill Avenue at Broadway Road is the first intersection on the eastbound approach where the proposed capacity reduction occurs and results in the reduced LOS F with existing and 2017 traffic volumes. Multiple alternatives were considered for Mill Avenue to improve this intersection LOS:

- Drop eastbound third through lane as a right turn lane with striping changes to channelize existing right turn lane.
- Extend eastbound third through lane past the intersection, merge to become two eastbound lanes, and retime the traffic signals.
- Drop eastbound third through lane as right turn lane, provide east-west dual left turn lanes, and retime the traffic signals.

Figure 5 shows the alternatives considered for Mill Avenue intersection. Table 3 in previous section summarizes intersection LOS at Mill Avenue with proposed alternatives.

As shown in Table 3, with one left turn lane, two through lanes and a right turn lane on eastbound Broadway Road, the intersection LOS reduces to LOS F from existing LOS E with existing and future traffic volumes.

As shown in Table 3, with three eastbound through lanes and optimized signal timing, Mill Avenue intersection LOS can be maintained at LOS E similar to existing conditions. The third through lane can be merged approximately 400 feet east of Mill Avenue intersection.

As shown in Table 3, with existing and future traffic volumes, Mill Avenue intersection LOS improves to LOS E with additional left turn lanes on east-west approaches and optimized intersection signal timing.

Figure 5: Mill Avenue Lane Configuration

	<p>Existing Eastbound Broadway Road Lane Configuration:</p> <ul style="list-style-type: none"> - One left turn lane - Two through lanes - One right turn lane
	<p>Two Eastbound Through Lanes, Drop third lane as right turn lane</p>
	<p>Merge 3rd EB Through Lane after Intersection</p>
	<p>Two Eastbound Through Lanes+ East-West Dual Left Turn Lanes+ Right turn lane</p>

EASTBOUND BROADWAY ROAD QUEUE LENGTHS

In addition to intersection LOS, the approach queue lengths provide an estimate of anticipated delay experienced by the stopping traffic at an intersection. The approach queue lengths were estimated using *Simtraffic* simulation program (associated with *Synchro 8*) after running the network model for one-hour to account for traffic variations. The simulation results were collected as average of five runs of each alternative. The results are summarized in Figure 6.

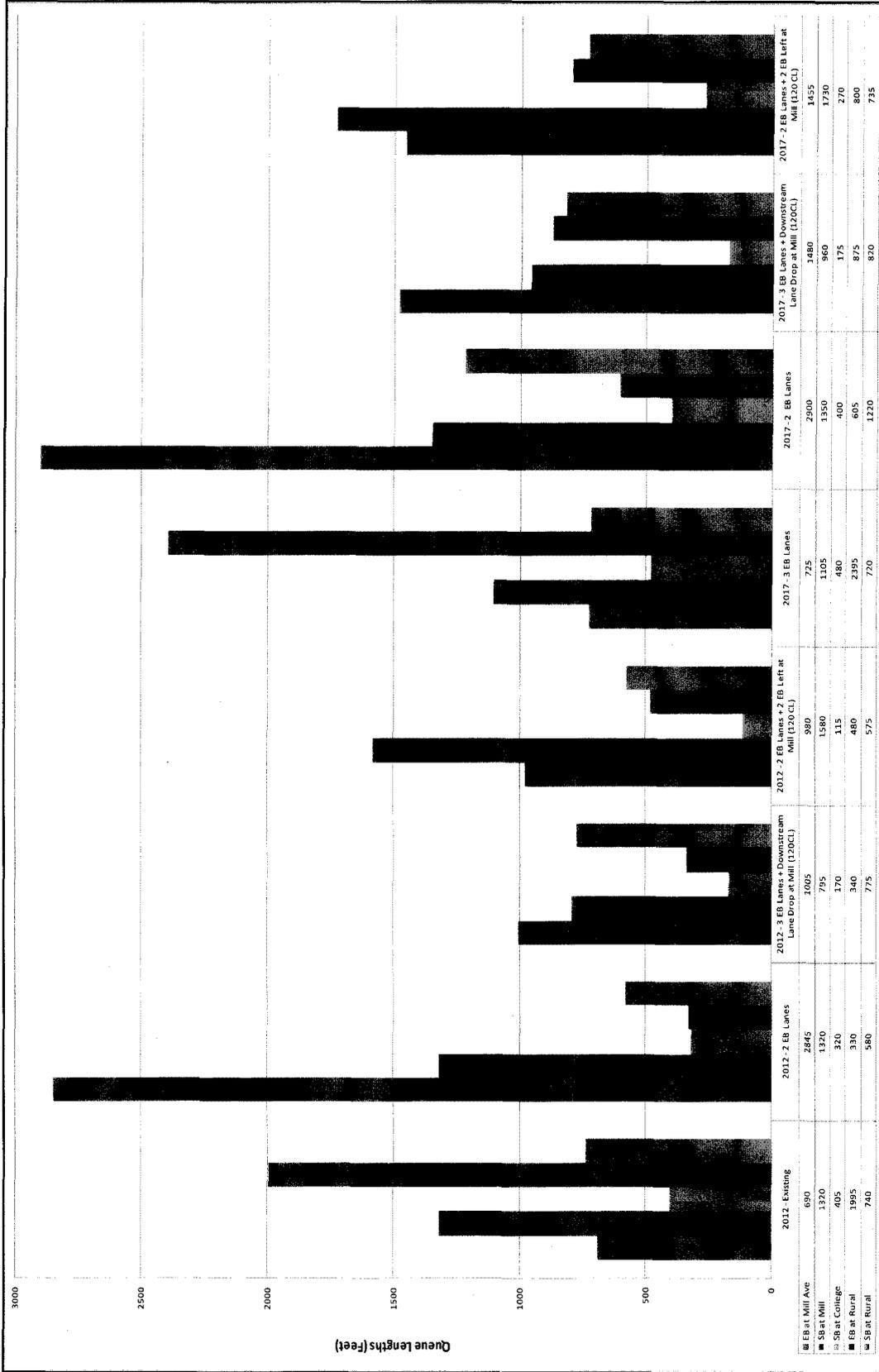
The current queue lengths on eastbound Broadway Road at Mill Avenue and Rural Road intersections are 690 and 1995 feet respectively during the PM peak hour. With two lane eastbound Broadway Road, the queue lengths will increase to 2845 feet at Mill Avenue and reduce to 330 feet at Rural Road. While the longer queues are apparent due to reduced capacity at Mill Avenue, reduced queues are expected at Rural Road due to metering effect on eastbound traffic volumes at Mill Avenue (three lane traffic reduced to two lanes).

As shown in Figure 6, with 2017 traffic volumes, similar trend is expected with reduced capacity on eastbound Broadway Road.

By maintaining the existing third through lane through the intersection and then merging the third lane downstream of the intersection and retimed traffic signals the queue lengths on Broadway Road and Mill Avenue can be reduced to 1005 feet and 1480 feet with 2012 and 2017 traffic volumes respectively.

The alternative of east-west left turn lanes on Broadway Road at Mill Avenue, with retimed traffic signals will provide similar results.

Figure 6 Approach Queue Lengths at Study Intersections



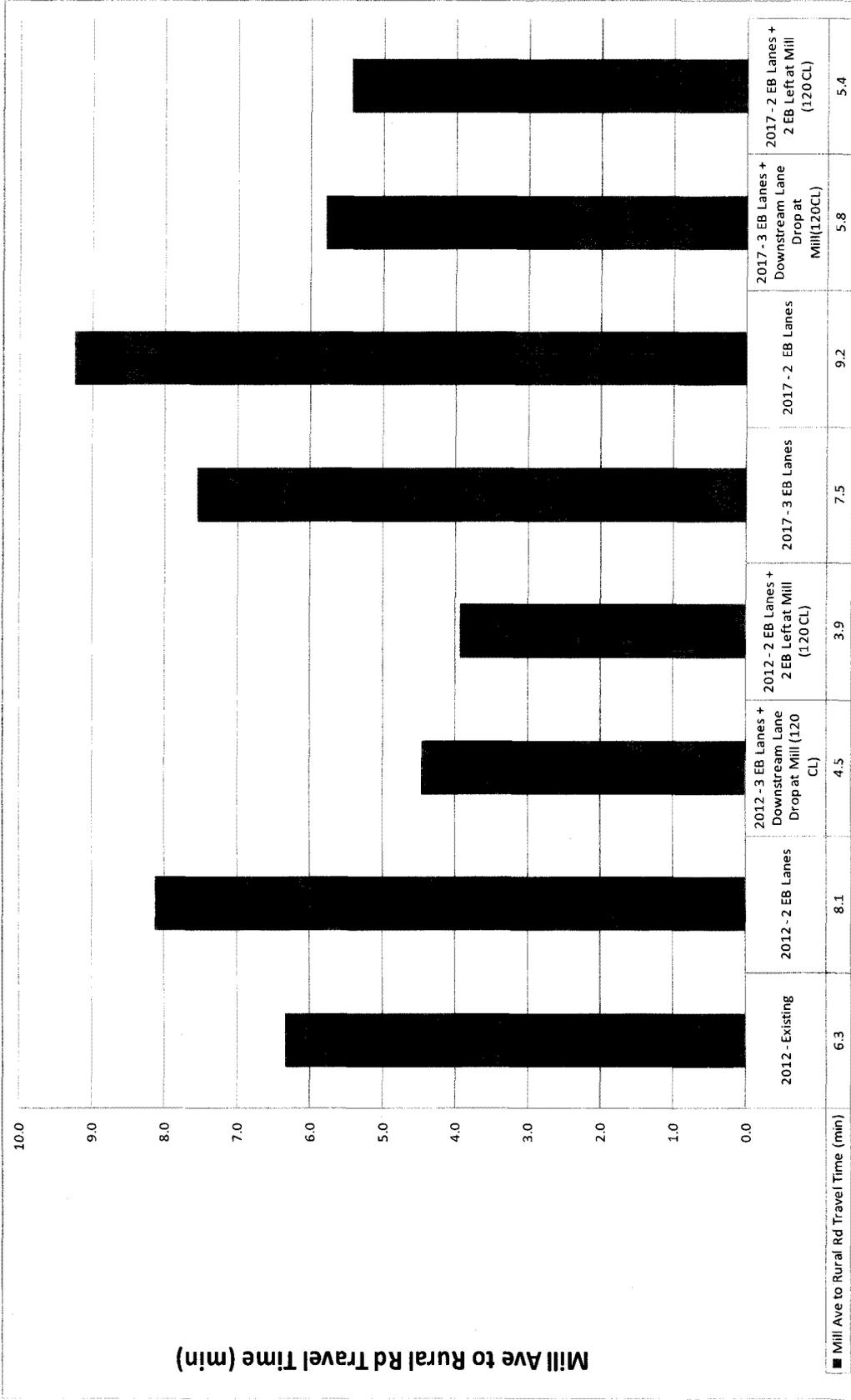
EASTBOUND BROADWAY ROAD TRAVEL TIMES

Eastbound Broadway Road travel times from Mill Avenue to Rural Road were evaluated with and without the project improvements. The travel times were obtained from *Simtraffic 8* microsimulation program. Figure 7 summarizes the travel times on Broadway Road for the improvement alternatives.

The current PM peak hour traffic traveling on eastbound Broadway Road from Mill Avenue to Rural Road takes approximately 6.3 minutes including stops at Mill Avenue, College Avenue and/or Rural Road. With the proposed streetscape improvements the travel time increases to 8.1 minutes. With 2017 traffic volumes, the travel time increases from 7.5 minutes to 9.2 minutes.

With the other proposed intersection improvement alternatives at Mill Avenue, combined with signal timing changes, the travel time on Broadway Road can be maintained at existing or lower levels. Note that the travel times with the improvements are less than the existing condition because the eastbound through volume is reduced in the peak hour and the queues at Rural Road are lower thereby improving the overall travel time.

Figure 7 Eastbound Broadway Road Travel Times



SUMMARY & CONCLUSIONS

A detailed traffic analysis was completed for Broadway Road corridor and study intersections with and without the proposed improvements.

- The historical traffic data shows the average annual daily traffic volumes on Broadway Road are decreasing due to the improvements completed to the regional freeway system surrounding the study area (I-10, US60, SR101L, and SR202L).
- Broadway Road ADT volume forecasts with the proposed streetscape improvements are similar to the existing traffic volumes on four-lane arterials within the City of Tempe.
- Broadway Road major arterial intersections with Mill Avenue and Rural Road are currently operating at LOS E with current afternoon peak hour traffic volumes.
- With the proposed four-lanes on Broadway Road and intersection improvements at Mill Avenue, the study area intersection LOS can be maintained at current LOS E.