Final

Design Concept Report

CAMINO SECO & WRIGHTSTOWN ROAD

Intersection Conceptual Layout

Prepared for

CITY OF TUCSON
DEPARTMENT OF TRANSPORTATION

Prepared by

AECOM

1860 East River Road
Suite 300
Tucson, Arizona 85718

Project No. 60026041

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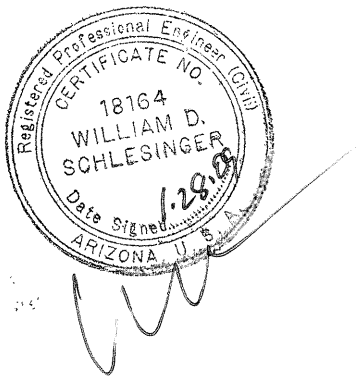

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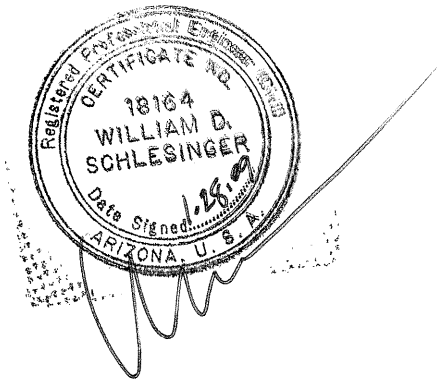

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EXECUTIVE SUMMARY

Camino Seco and Wrightstown Road are classified as major arterial streets according to the City of Tucson Major Streets and Routes Plan. The increase in traffic volumes on Wrightstown Road in recent years and the roadway improvements planned for Camino Seco created a need to evaluate alternatives for the Camino Seco and Wrightstown Road intersection. The purpose of this report was to:

- Develop alternatives for the study intersection
- Conduct a traffic analysis for the alternatives for the year 2030
- Perform a design evaluation based on impacts to adjacent properties, utilities, drainage, traffic safety and provisions for traffic circulation and access
- Recommend a Preferred Alternative for the study intersection

Consequently, three intersection alternative layouts were developed for this study. The first alternative, called the Free Right Alternative, consisted of using the previously designed signalized intersection configuration (Plan No. I-99-43) and included a free-flow right turn lane from Wrightstown Road eastbound to Camino Seco southbound. The second alternative consisted of a single lane modern roundabout. This alternative was called the Roundabout Alternative. Lastly, the Wrightstown Disconnect Alternative involved the reconfiguration of the intersection by connecting the west leg of Wrightstown Road and the south leg of Camino Seco as the through street, with the east leg of Wrightstown Road intersecting as a signalized "T" intersection.

Upon completion of the evaluation, the Free Right Alternative was chosen as the Preferred Alternative. This alternative will provide better traffic operations at the study intersection. By implementing this alternative, the Camino Seco and Wrightstown Road intersection will operate, in 2030, at Level of Service (LOS) B during both the AM and PM peak hours. Moreover, the Preferred Alternative will provide access to Pima Street and maintain residential access and circulation patterns in the area. Additionally, the Preferred Alternative will not require right-of-way acquisition, lessening impacts to adjacent properties.

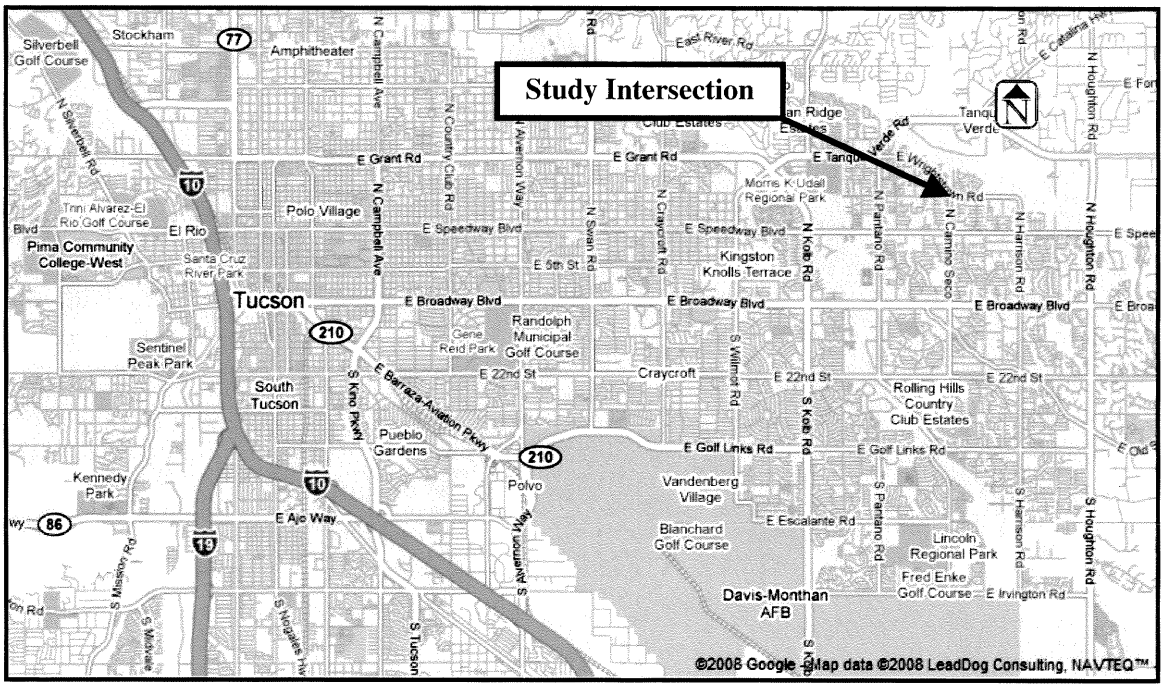
1.0 PROJECT OVERVIEW

1.1 Introduction

The Camino Seco and Wrightstown Road intersection is located on the east side of the Tucson metropolitan area. This intersection straddles the section line between Sections 3 and 4 of Township 14 South, Range 15 East, G& SRM, in Pima County, Arizona. Figure 1 illustrates the location of the study intersection. Within the vicinity of the intersection, both Camino Seco and Wrightstown Road are classified as arterial roads according to the City of Tucson Major Streets and Routes Plan. Camino Seco connects Wrightstown Road to Speedway Boulevard ¾ mile south of the project intersection. Wrightstown Road serves as a connecting arterial between the Pantano Road, Tanque Verde Road and Wrightstown Road intersections, as well as the Harrison Road and Speedway Boulevard intersection. Between Wrightstown Road and Speedway Boulevard, Camino Seco is a two-lane roadway with a posted speed of 25 miles per hour (mph). Wrightstown Road is a three-lane roadway east of the study intersection and a two-lane roadway west of the project site. The speed limit on Wrightstown Road is 35 mph, which was recently lowered from 40 mph by the City of Tucson Department of Transportation (TDOT).

As the eastside of the Tucson Metropolitan Area continues to grow, roadway improvements at the Camino Seco and Wrightstown Road intersection will be necessary. Camino Seco has been planned to be widened from a two-lane roadway to a four-lane roadway between Wrightstown Road and Speedway Boulevard. This improvement project includes sidewalks, concrete curbs, landscaping, bike lanes, street lighting and a new underground storm drain system. To improve safety and traffic operations, a signalized intersection was proposed at the intersection of Camino Seco and Wrightstown Road as part of the Camino Seco widening.

Figure 1 – Vicinity Map



Source of Data: Google Maps[1]

1.2 Project Background and Description

In March 2002, roadway and drainage improvement plans for Camino Seco between Wrightstown Road and Speedway Boulevard were developed by Entranco (Plan No. I-99-43). The roadway was designed to be a four-lane roadway with curb, drainage, and landscape improvements and included a realigned signalized "T" intersection at Wrightstown Road.

The increase in traffic volumes on Wrightstown Road in recent years and the additional capacity proposed for Camino Seco created a need to evaluate alternatives for the Camino Seco and Wrightstown Road intersection. Three intersection alternative layouts were developed and evaluated in this study. The first alternative used the Entranco design and added a free-flow right turn lane from eastbound Wrightstown Road to southbound Camino Seco. This alternative was called the Free Right Alternative. The second alternative was the Roundabout Alternative, which proposed a single lane modern roundabout at the study intersection. Lastly, the Wrightstown Disconnect Alternative involved reconfiguring the west leg of Wrightstown Road. This alternative proposed to align the east leg of Wrightstown Road with the south leg of Camino Seco, creating a north-south through street, with the east leg of Wrightstown Road intersecting as a signalized "T" intersection. The Free Right and Wrightstown Disconnect Alternatives are further described, analyzed, and illustrated in Chapter 3. The Roundabout Alternative was not pursued due to public disapproval.

1.3 Project Objective

The goal of this project was to recommend a Preferred Alternative for the study intersection based on the results of the alternative analysis. The criteria that contributed to the selection of the Preferred Alternative include: Traffic safety, traffic operations, intersection capacity, access management/traffic circulation, construction cost, right-of-way acquisitions, and bicycle and pedestrian accessibility. These factors were compiled into a matrix and each alternative was ranked accordingly. The following chapters of this report document existing conditions, the alternative analysis, and conclusions and recommendations for the study intersection.

2.0 PROJECT AREA CHARACTERISTICS

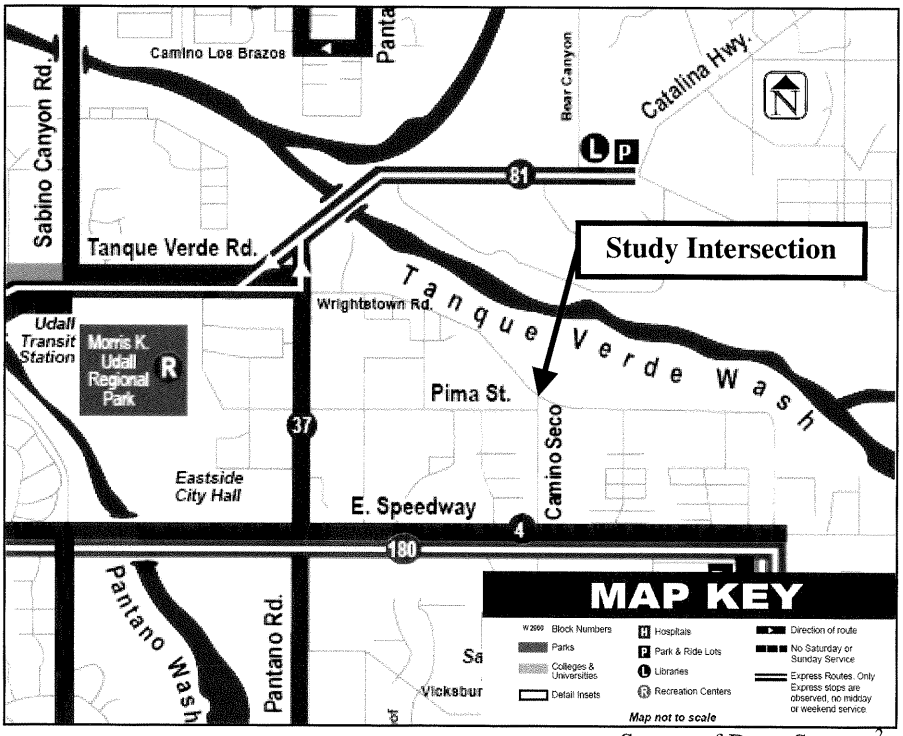
2.1 Existing Transportation Characteristics

- Roadway – Camino Seco is a two-lane roadway with a posted speed limit of 25 mph. Wrightstown Road is also a roadway with a three-lane cross section east of the study intersection and a two-lane cross section west of the intersection. The posted speed limit on Wrightstown Road is 35 mph. The Camino Seco and Wrightstown Road intersection is an unsignalized intersection where the traffic movements from Camino Seco to Wrightstown Road are stop-controlled.

- Bicycle & Pedestrian – No bicycle facilities currently exist on Camino Seco or on Wrightstown Road near the study intersection. However, there are bicycle routes that begin/end on Camino Seco south of Speedway (approximately ¾ mile south of the study intersection). No sidewalks or sidewalk ramps are present on Camino Seco. There is, however, a sidewalk on the north side of Wrightstown Road that begins approximately 250 feet east of the intersection.

- Transit Service – Sun Tran has two main routes in the vicinity of the study intersection. Route 4, which runs along Speedway Boulevard, has a stop at Camino Seco (½ mile south of the Camino Seco/Wrightstown Road intersection). In addition to Route 4, Aero Park Speedway Express Route 180 provides service on Speedway Boulevard. Route 37 primarily runs along Pantano Road and has a stop at Wrightstown Road. Area bus routes are illustrated in Figure 2.

Figure 2 – Existing Sun Tran Bus Service



Source of Data: Suntran[2]

- Street Lighting – Currently, no street lights are located on Camino Seco or Wrightstown Road near the study intersection. Street lights are currently installed on Speedway Boulevard west of Camino Seco. There are also street lights at the intersection of Wrightstown Road and Avenida Ricardo Small, approximately ½ mile east of the study intersection.

- Drainage – There are no existing pavement drainage facilities on Camino Seco. Robb Wash and Camino Seco Wash both run parallel to Camino Seco. They are located approximately 150 feet and 625 feet, respectively, west of the study intersection. Moreover, an unnamed wash runs parallel to Camino Seco 625 feet east of the study intersection. Both Camino Seco and Wrightstown Road lack curb and gutter at the intersection. Pavement runoff drains to a cut ditch along the west side of Camino Seco and to the north along Wrightstown Road.

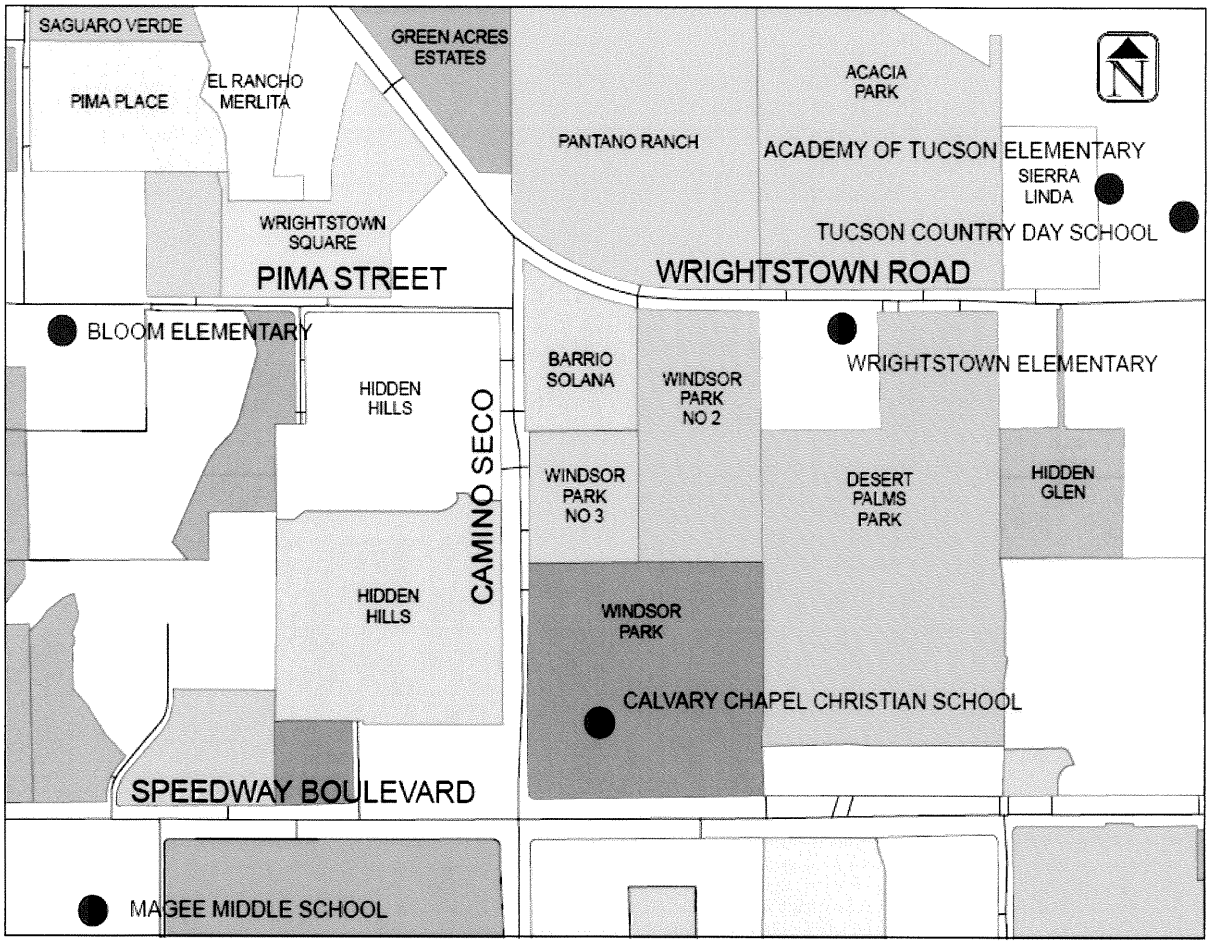
2.2 Existing Right-of-Way

Based on the information collected, the existing right-of-way on Camino Seco varies from approximately 150 feet to 250 feet in width, from Pima Street north to Wrightstown Road. The right-of-way on Wrightstown Road is about 50 feet in width west of the intersection, and 120 feet wide east of the intersection.

2.3 Schools

The schools located in the study area are not adjacent to the Camino Seco and Wrightstown Road intersection. However, Wrightstown Elementary School, Calvary Chapel Christian School, and Bloom Elementary School are all within ½ mile of the intersection. Additionally, Magee Middle School, Academy of Tucson Elementary School, and Tucson Country Day School are in the vicinity of the project. Figure 3 displays the schools within the study area. Note that each school is indicated by a green circle followed by its corresponding name. Additionally, all the residential neighborhoods along Camino Seco and Wrightstown Road are identified in the same figure.

Figure 3 – Neighborhoods and Schools Map



In 2008, a High-intensity Activated crossWalK (HAWK) was installed to serve pedestrians at Wrightstown Elementary School. Figure 4 displays the school crossing.

Figure 4 – Wrightstown Elementary School HAWK

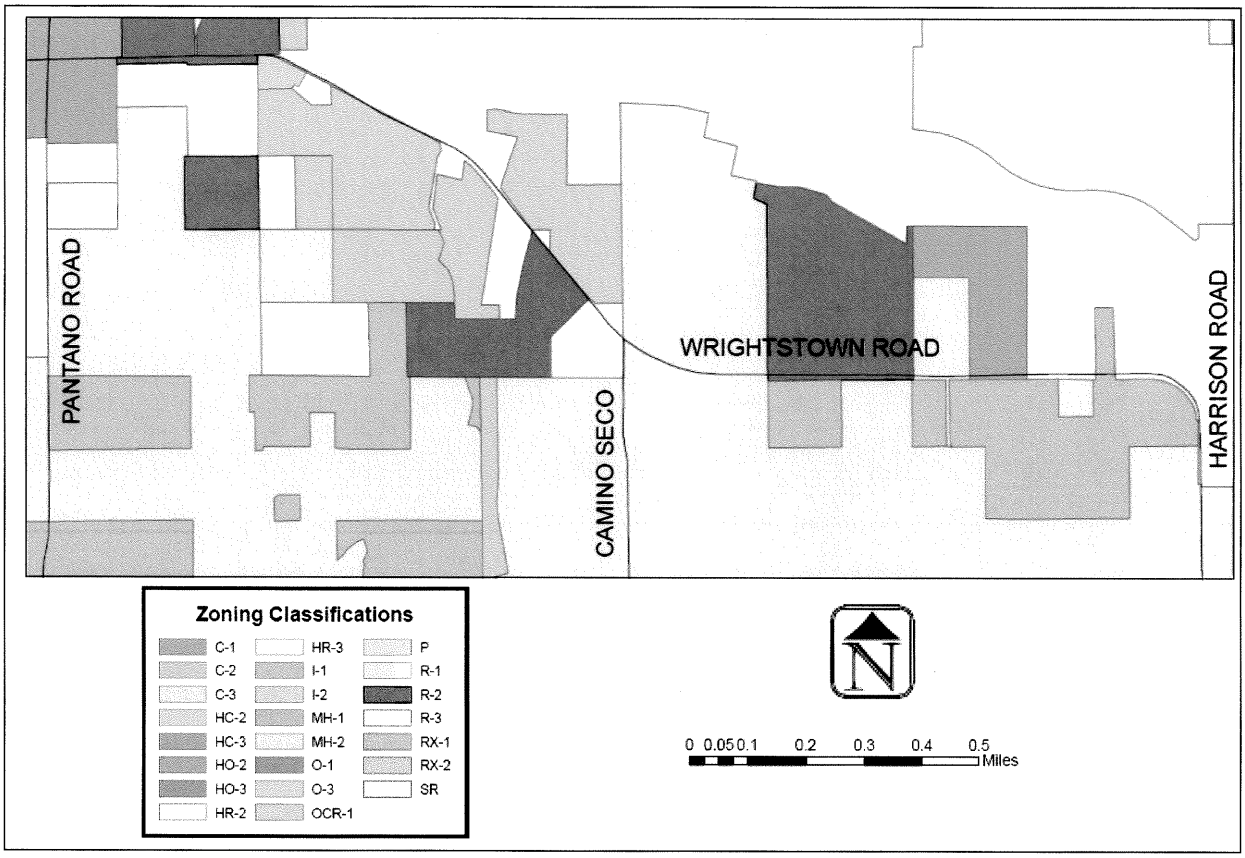
2.4 Neighborhood Associations

Desert Palms Park is the closest neighborhood association in the project area. It is located approximately 1,300 feet east of the Camino Seco and Wrightstown Road intersection. Desert Palms Park is a registered neighborhood association with the City of Tucson. Other non-registered neighborhood associations exist within the individual subdivisions.

2.5 Zoning

Adjacent to the intersection, the zoning is Suburban Ranch (SR) and Residential-1 (R-1). Within one mile of the study intersection, the zoning is R-2, RX-1, and RX-2, as well as C-1. Figure 5 illustrates the zoning in the area.

Figure 5 – Zoning Map



2.6 Current Land Uses

The existing land use adjacent to the Camino Seco and Wrightstown Road intersection is residential. Numerous housing subdivisions are located within the study area, as well as a suburban ranch home (approximately seven acres) at the southwest corner of the intersection. In close proximity to the project area are numerous schools and a church located on Camino Seco just north of Speedway (about ¾ mile south of the Camino Seco/Wrightstown Road intersection).

2.7 Future Land Uses

The area surrounding the Camino Seco and Wrightstown Road intersection is developed. There are no changes in land use anticipated, with the exception of Christian Desert School at the intersection of Wrightstown Road and Harrison Road located approximately 1 mile east of the study intersection.

2.8 Existing Utilities

Utilities in the area are both underground and overhead. Underground utilities include sewer, water, telephone, and gas. Overhead utilities include electricity and cable television. Utility locations will be shown on the plans and identified in the field prior to construction to reduce potential conflicts.

2.9 Traffic Circulation

Pima Street intersects Camino Seco approximately 350 feet south of the existing Camino Seco and Wrightstown Road intersection. Pima Street extends from Camino Seco to Pantano Road, serving as a local street. Pima Street provides residential access for the subdivisions bordered by Pantano Road, Speedway Boulevard, Camino Seco, and Wrightstown Road.

3.0 ALTERNATIVE ANALYSIS

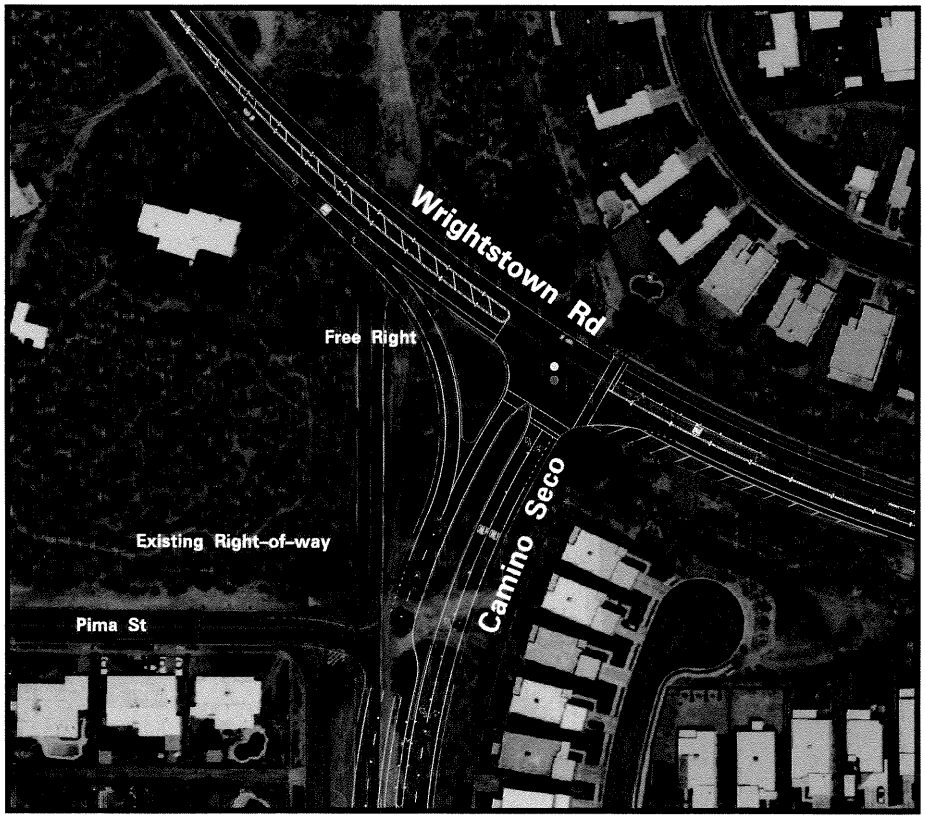
In order to evaluate the alternatives for the study intersection, a traffic analysis and a design evaluation were conducted. The following sections describe in detail the proposed alternatives, the traffic analysis conducted, and design elements utilized to evaluate the alternatives.

3.1 Alternative Descriptions

3.1.1 Free Right Alternative

This alternative utilized the proposed roadway design originally prepared for the Camino Seco, Wrightstown Road to Speedway Boulevard Improvement Project (Plan I-99-43). This alternative preserved the initial proposed signalized design for the intersection and incorporated a free-flow right turn lane for vehicles traveling southeast on Wrightstown Road that turn south onto Camino Seco. In this alternative, vehicles will be able to bypass the recommended traffic signal when traveling southbound. Hence, traffic operations at the intersection will be improved and travel times will be reduced for vehicles making this movement. Figure 6 illustrates the intersection geometry for the Free Right Alternative.

Figure 6 – Free Right Alternative



3.1.2 Wrightstown Disconnect Alternative

This alternative involved the reconfiguration of the intersection by connecting the west leg of Wrightstown Road and the south leg of Camino Seco, with the east leg of Wrightstown Road intersecting as a signalized "T" intersection. The goal of this alternative was to best utilize the

previously proposed improvements on Camino Seco (widening the roadway from a two-lane section to a four-lane section and increasing the speed limit from 25 mph to 35 mph). Figure 7 illustrates the intersection geometry for the Wrightstown Disconnect Alternative.

Figure 7 – Wrightstown Disconnect Alternative

3.2 Traffic Circulation and Access Management

As mentioned in the previous chapter, Pima Street intersects Camino Seco approximately 350 feet south of the existing Camino Seco and Wrightstown Road intersection. The intersection of Pima Street and Camino Seco is a major access point for neighborhoods bordered by Pantano Road, Speedway Boulevard, Camino Seco, and Wrightstown Road. The Free Right Alternative would provide a northbound left turn lane onto Pima Street, but would restrict eastbound left turns onto Camino Seco. The Wrightstown Disconnect Alternative would not provide access to and from Pima Street for the northbound travel lanes. In other words, the Wrightstown Disconnect Alternative consisted of a right-in, right-out entrance/exit at Pima Street due to the close proximity of the proposed signalized intersection. Based on the City of Tucson Transportation Access Management Guidelines (2003), the minimum spacing for median openings on an arterial is 660 feet. The distance between the proposed locations of the signalized intersection and the unsignalized intersection of Pima Street and Camino Seco does not meet the minimum standard.

If access to Pima Street were restricted at Camino Seco, more vehicles would access Pima Street by way of Sarnoff Drive. Sarnoff Drive intersects Wrightstown Road approximately a half mile northwest of the study intersection. Restricting access to Pima Street would result in changes to circulation patterns in the southwest quadrant of the intersection.

Access to adjacent properties on Wrightstown Road, west of the Camino Seco and Wrightstown Road intersection, will be affected. In particular, the driveway for the residential property located on the south side of Wrightstown Road west of the study intersection would be restricted with either alternative. A preliminary evaluation revealed that both alternatives would have the same effect on access management for the properties surrounding the intersection.

3.3 Traffic Analysis

3.3.1 Network Description and Geometry

The study area consisted of a network with three signalized intersections:

1. Camino Seco and Wrightstown Road
2. Speedway Boulevard and Harrison Road
3. Speedway Boulevard and Camino Seco

These signalized intersections were evaluated to determine the effects of each alternative on traffic operations in the network. The alternatives used to analyze the Camino Seco and Wrightstown Road intersection are described in section 3.1. In order to complete the analysis, information regarding proposed improvements for the adjacent intersections was collected. A traffic study was completed in July 2007 for Speedway Boulevard, from Camino Seco to Houghton Road. The goal of this traffic study was to evaluate the widening of Speedway Boulevard from a two-lane roadway (existing conditions) to a four-lane roadway. The Speedway Boulevard traffic report made recommendations for the lane configurations at the intersection of Speedway Boulevard and Harrison Road. The proposed improvements outlined in the aforementioned traffic study for the intersection of Speedway Boulevard and Harrison Road were utilized for traffic analysis. This proposed lane configuration is shown in Figure 8. Since the west limits of the Speedway Boulevard widening project begin east of the Speedway Boulevard and Camino Seco intersection, the existing geometry, shown in Figure 9, was used for analysis of this intersection.

Figure 8 – Speedway Boulevard and Harrison Road Proposed Improvements

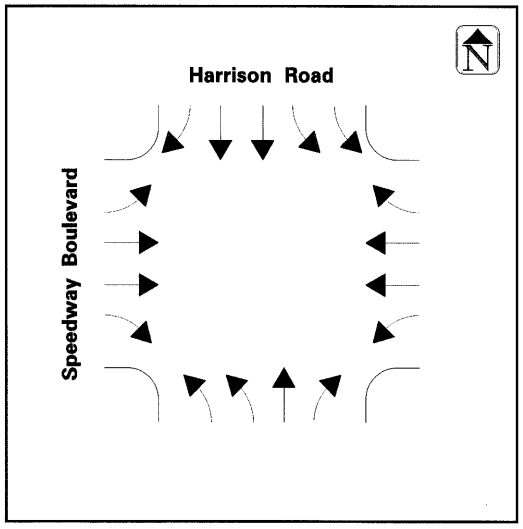
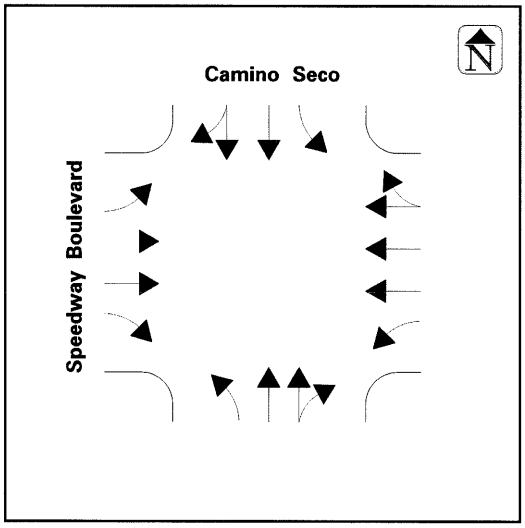


Figure 9 – Speedway Boulevard and Camino Seco Existing Lane Configuration

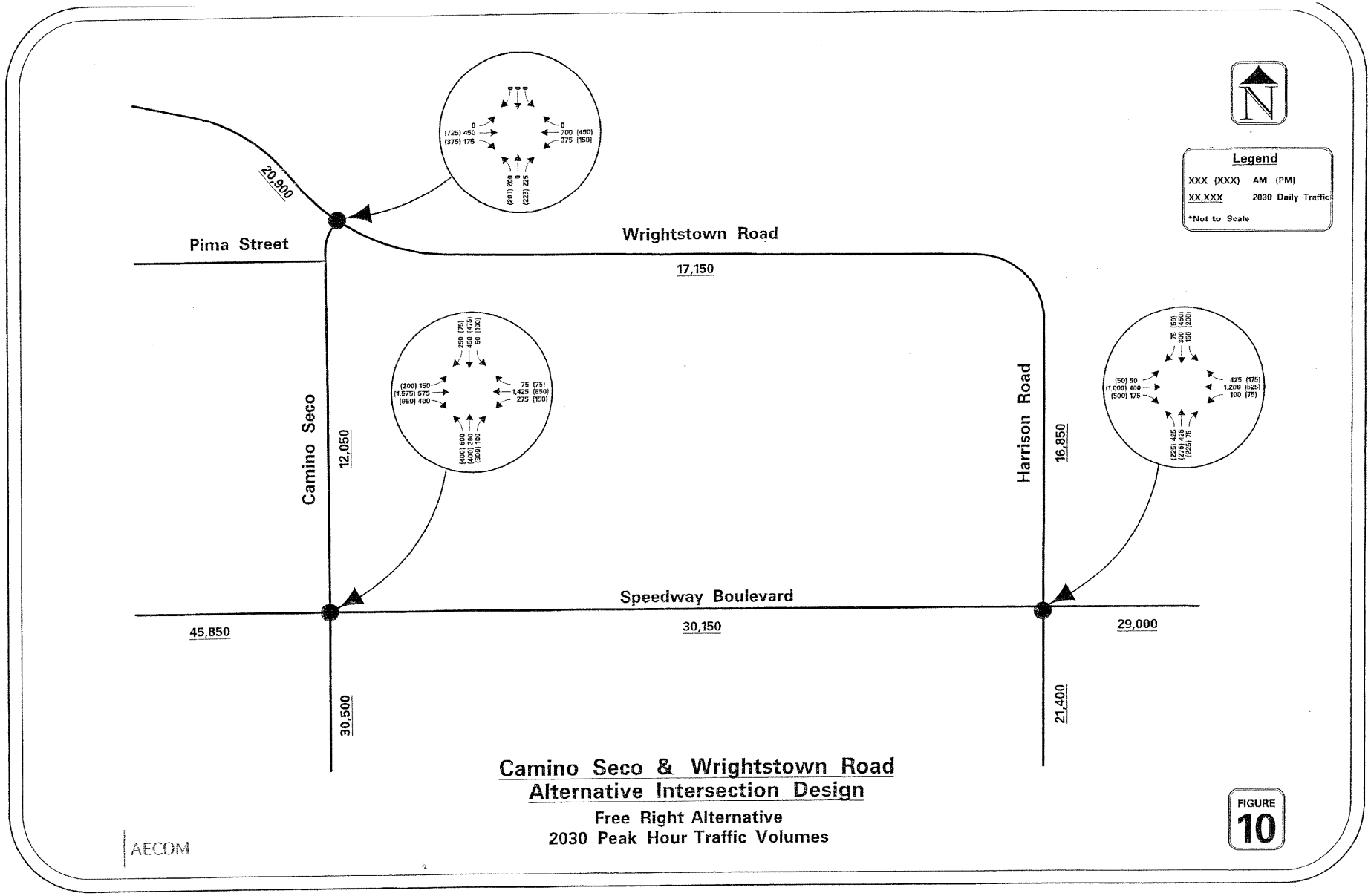


3.3.2 Future Traffic Volumes

The Pima Association of Governments (PAG) travel demand model was used to generate 2030 traffic volume projections. The PAG model incorporated all projects contained in the 2030 Regional Transportation Plan (RTP). The network was modified, for this project, to assume a two-lane roadway on Wrightstown Road between Speedway Boulevard and Pantano Road.

Due to the arterial nature of both Camino Seco and Wrightstown Road, we assumed that existing traffic patterns will not change and traffic volume growth will occur due to population increase. Driver behavior and route choice will not change. The majority of motorists utilize these roadways to travel to and from different areas in the metropolitan region; not to and from locations immediately adjacent to the study intersection. Therefore, the intersection configuration will have minimal effect on traffic volume distribution within the study area. In addition, the traffic projections accounted for the estimated maximum capacity of Wrightstown Road with one lane in each direction and the capacity of the existing intersection of Speedway Boulevard and Camino Seco. As a result, the traffic projections used in the analysis of the two alternatives are similar for both cases. This allowed for a direct comparison of the two alternatives.

K factors and D factors based on existing conditions were applied to the daily volumes and balanced to provide approach and departure volumes for each intersection. Volumes were estimated at the Camino Seco and Wrightstown Road intersection, the Speedway and Camino Seco intersection, and the Speedway and Harrison intersection. The proposed 2030 network peak hour volumes are illustrated in Figures 10 and 11. Figure 10 presents the peak hour volume projections for the Free Right Alternative configuration, and Figure 11 displays the peak hour volume projections for the Wrightstown Disconnect Alternative.



Camino Seco & Wrightstown Road
Alternative Intersection Design

Free Right Alternative
2030 Peak Hour Traffic Volumes

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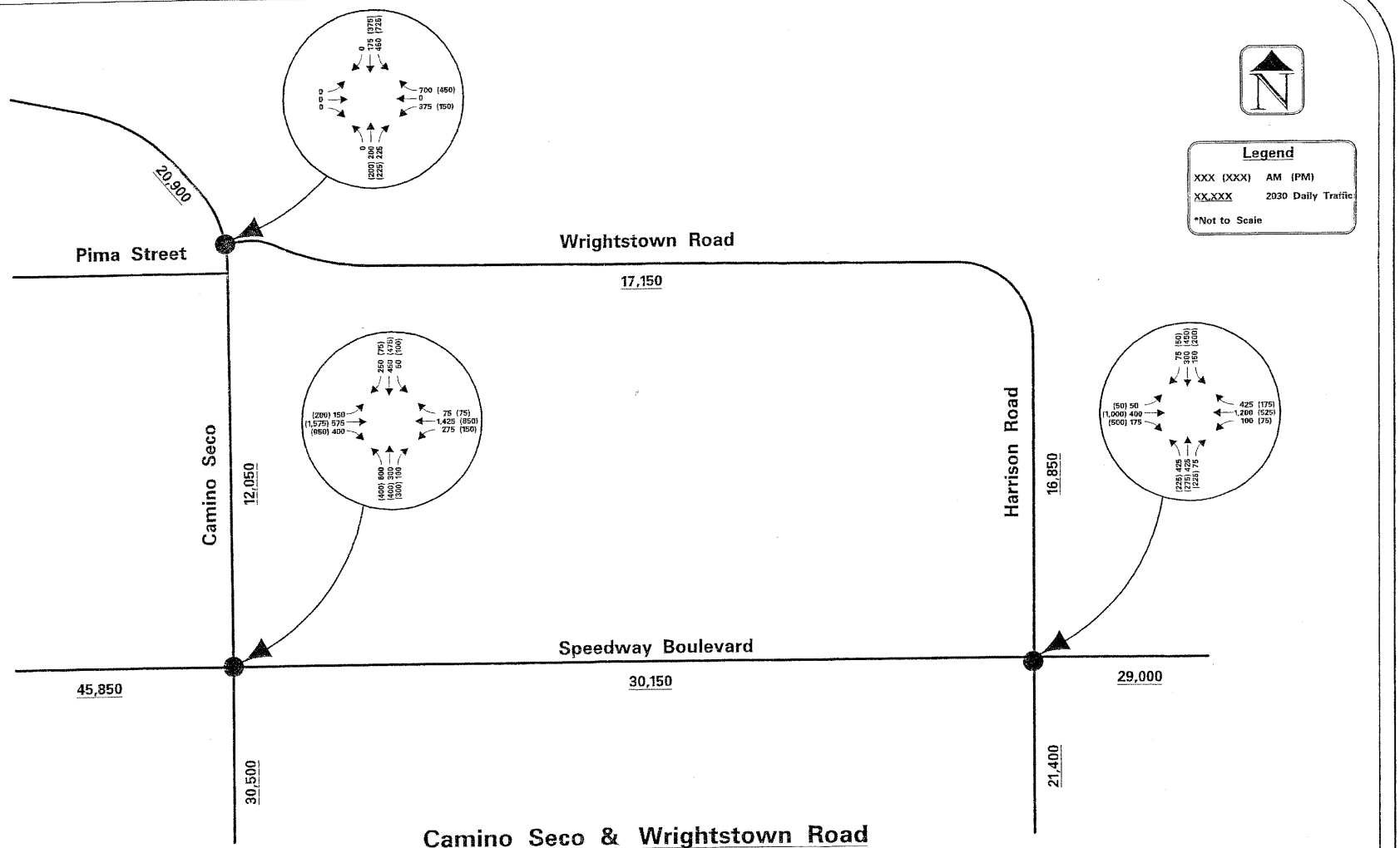
FIGURE 10



Camino Seco & Wrightstown Road
Alternative Intersection Design

Wrightstown Disconnect Alternative
2030 Peak Hour Traffic Volumes

FIGURE 11

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3.3.3 Level of Service Analysis

To perform the alternative analysis, the traffic program Synchro was used. Synchro implements the methods of the Highway Capacity Manual (HCM). Table 1 presents the LOS criteria for signalized intersections.

Table 1 – LOS and Control Delay for Signalized Intersections

Level of Service	Signalized Intersection Control Delay (s/veh)
A	0-10.0
B	>10.0-20.0
C	>20.0-35.0
D	>35.0-55.0
E	>55.0-80.0
F	>80.0

Source: HCM 2000[3]

A Synchro network was created for both the Free Right and Wrightstown Disconnect Alternatives to evaluate the 2030 AM and PM peak hour periods. This network included the Camino Seco and Wrightstown Road intersection, the Speedway Boulevard and Camino Seco intersection, and the Speedway Boulevard and Harrison Road intersection. A 90-second cycle length was assumed for each signalized intersection. The phasing, at the intersection of Speedway Boulevard and Harrison Road, was altered from 2 phases to 4 phases to include a permissive/protected left turn movement for the northbound and southbound movements. Other assumptions used in the analysis included a Peak Hour Factor (PHF) of 0.95, percentage of heavy vehicles equal to 2% and right turns permitted on red.

Based on the results of the Synchro analysis for the Camino Seco and Wrightstown Road Intersection, the Free Right and Wrightstown Disconnect Alternatives are expected to operate at an acceptable LOS in 2030. The intersection is expected to experience LOS B in the AM peak hour with the Free Right Alternative. The Wrightstown Disconnect Alternative is expected to provide LOS C during the same time period. During the PM peak hour, it is anticipated that the Free Right Alternative will operate at LOS B in 2030, while the Wrightstown Disconnect Alternative will provide LOS C at the intersection.

The Speedway Boulevard and Harrison Road intersection is expected to operate at an acceptable LOS in 2030. However, the Speedway Boulevard and Camino Seco intersection is expected to operate at LOS E during the peak hour periods. The results of the analyses for both alternatives can be seen in Figures 12 and 13. Moreover, the individual LOS for each movement is included in Appendix A together with the Synchro output sheets.

Figure 12 – AM Peak Period Average Delay

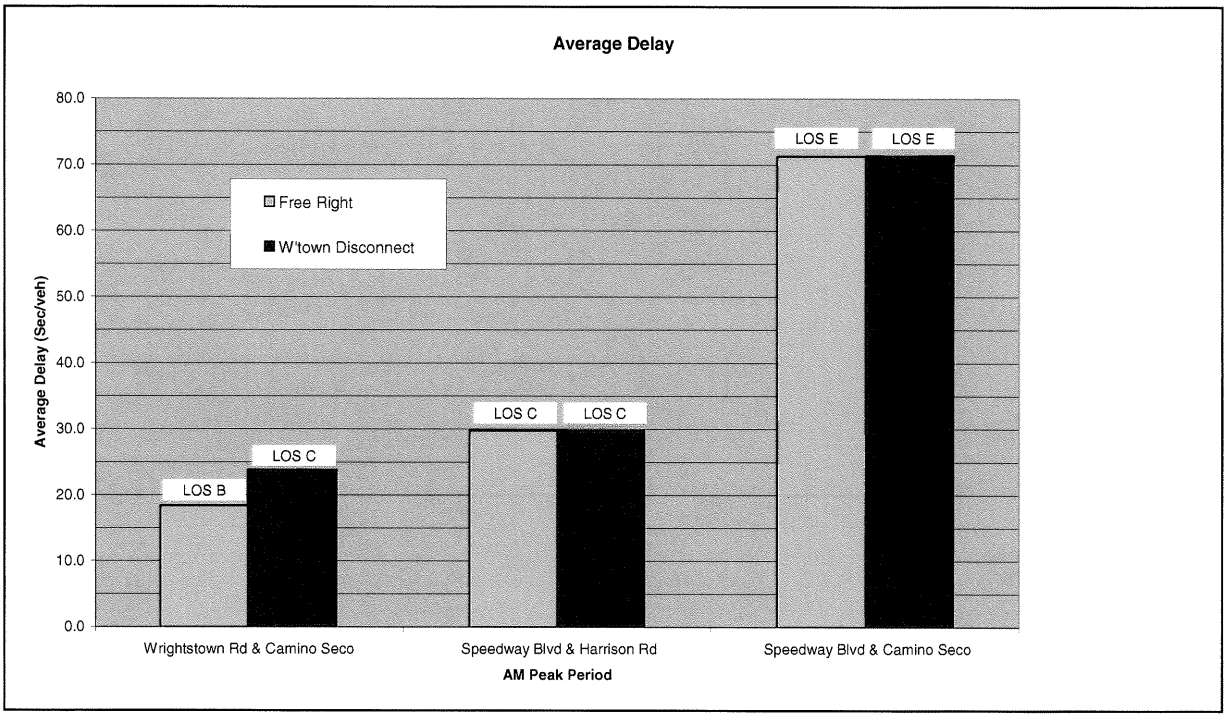
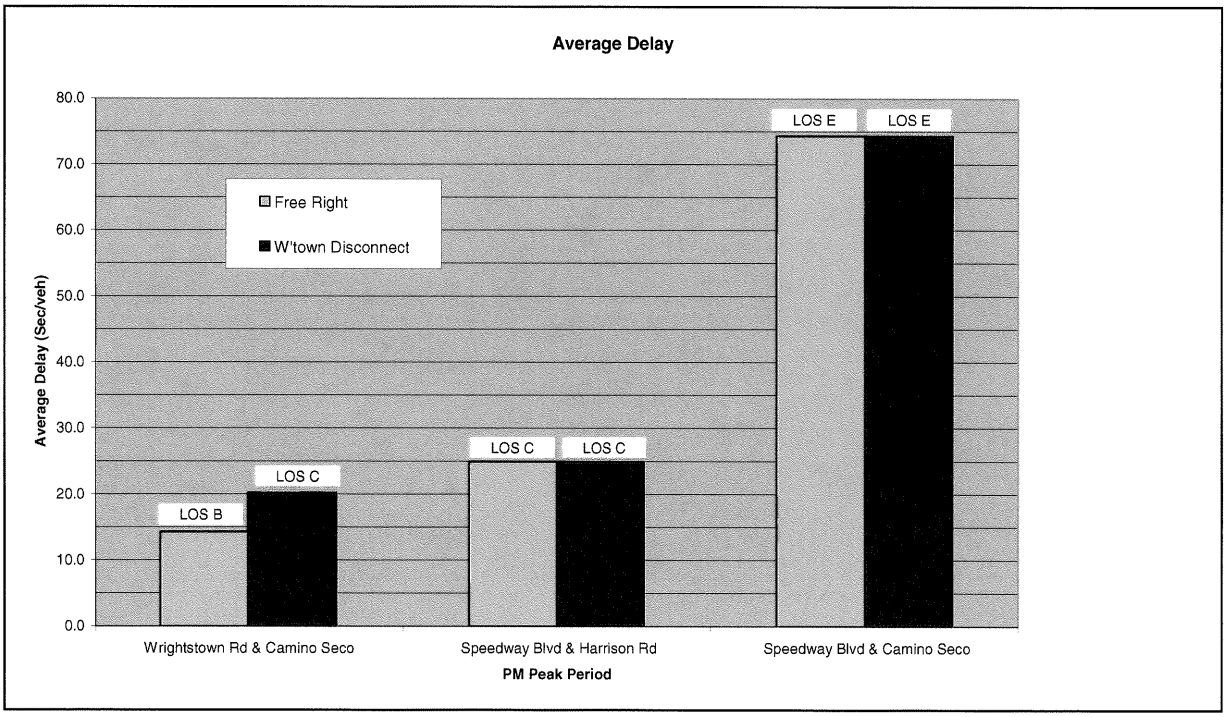
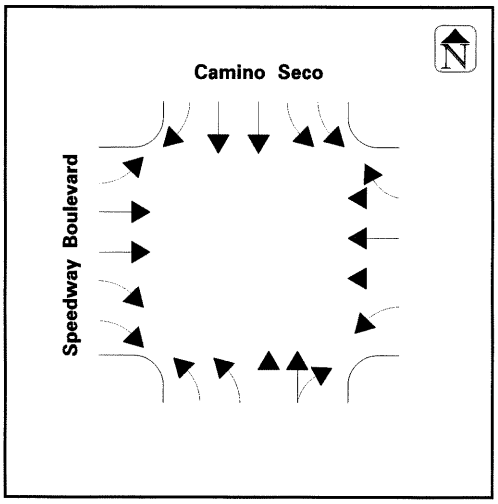


Figure 13 – PM Peak Period Average Delay



Since the intersection at Speedway Boulevard and Camino Seco is not expected to operate at an acceptable LOS during the AM or PM peak periods, this intersection was evaluated with additional capacity. This additional capacity consisted of adding left turn lanes on Camino Seco, creating dual left turn lanes for both northbound and southbound; a second right turn lane on eastbound Speedway Boulevard; and an exclusive right turn lane on southbound Camino Seco. The additional capacity evaluated resulted in the lane configuration illustrated in Figure 14.

Figure 14 – Speedway Boulevard and Camino Seco Intersection Lane Configuration



Synchro was also used to analyze the traffic operations of this intersection. With the lane configuration shown in Figure 14, this intersection is expected to operate at an acceptable LOS for both the AM and PM peak hours.

Note that if improvements are implemented to the Speedway Boulevard and Camino Seco intersection, the study intersection is expected to operate in 2030 at an acceptable LOS with either the Free Right Alternative or the Wrightstown Disconnect Alternative.

3.4 Design Standards and Criteria

Design criteria were developed for this project. The design criteria were created based on standards from the City of Tucson and the American Association of State Highway and Transportation Officials (AASHTO). The design criteria used to lay out the alternatives were as follows:

- *Geometrics*: COT Development Guidelines; AASHTO "A Policy on Geometric Design of Highways and Streets", 2004 Edition; FHWA Guidelines for Roundabouts.
- *Standards*: City of Tucson Development Standards, 2000.
- *Side slopes*:
  - Standard cut slope in clear zone 6:1, Minimum cut slope 3:1
  - Standard fill slope in clear zone 6:1, Minimum fill slope 3:1
- *Clear Zone*: 14-16 feet should be provided based on the AASHTO Roadside Design Guide, Table 3.1, pg 3-6
- *Design Speed*: 40 mph

- *Bike Lane Width:* 5 feet
- *Through Lane Width*: 12 feet
- *Turn Lane Width*: 12 feet
- *Median Width*: 20 feet; 8 feet at bullnose
- *Shoulder*: N/A
- *Bike Lanes*: One bike lane in each direction
- *Travel Lanes*: Two lanes in each direction on Camino Seco; One lane in each direction on Wrightstown Road
- *Bus Pullouts*: N/A
- *Structures*: N/A
- *Handicap Ramps*: ADA Compliant

3.5 Horizontal & Vertical Alignment

The horizontal alignment of the existing roadway will be modified to accommodate the additional travel lanes and raised median. The horizontal alignment at the north end of the project varies with the alternatives proposed for this project. The vertical alignment of the roadway will follow the existing grade, as closely as possible, to minimize cut and fill areas.

3.6 Typical Section

The proposed typical section for Camino Seco consists of a four-lane divided arterial roadway with a 20-foot wide raised median. The section includes two 12-foot travel lanes and one 5-foot bike lane in each direction, and a 12-foot left turn lane at median openings.

For the Free Right Alternative, the Wrightstown Road typical section will include widening to accommodate a free-flow right turn lane for eastbound Wrightstown Road, and a taper for dropping the left turn lane provided for westbound traffic. The section east of Camino Seco will have two through lanes and a continuous left turn lane, and the section west of Camino Seco will have two through lanes, a free-flow right turn lane for eastbound traffic, and a taper section to drop the continuous left turn lane. This alternative will also utilize a taper section to add the free-flow right turn lane.

For the Wrightstown Disconnect Alternative, a median will be provided on the west leg of Wrightstown Road to accommodate the transition into Camino Seco. This results in three 12-foot travel lanes and a 20-foot median. The east leg of Wrightstown Road will have a three lane cross section that includes 12-foot travel lanes and one 5-foot bike lane in each direction

3.7 Right-of-Way

The previous project on Camino Seco (Plan No. I-99-43) proposed modifications to the intersecting angle between Camino Seco and Wrightstown Road. The project proposed joining Camino Seco with Wrightstown Road at a perpendicular angle, which would shift the alignment of Camino Seco to the east, affecting the private land located on the southeast corner of the study intersection. As a result, right-of-way was dedicated on the southeast corner of the study intersection to accommodate the proposed design. The Free Right Alternative will maintain this alignment and therefore, no additional right-of-way will be needed. Slope easements might be needed on the southwest corner to accommodate the free-flow right-turn lane.

However, there are potential right-of-way issues with the Wrightstown Disconnect Alternative. As seen in Figure 7, this alternative will impact the parcel of land located at the southwest corner of the intersection. This is a large parcel zoned suburban ranch. A portion of this land will need to be acquired to accommodate the alignment of the Wrightstown Disconnect Alternative. Similarly, the southeast corner will be slightly affected by this alternative.

3.8 Drainage

Both the Free Right and Wrightstown Disconnect Alternatives will include curb and gutter as part of the improvements. This will allow for the construction of curb inlets and an underground storm drain system. Pavement runoff collected into the storm drain system will outlet into the existing drainage channel on the north side of Wrightstown Road.

3.9 Utilities

It is anticipated that water line modifications will be needed for this project. Both the existing 6-inch and 12-inch lines were constructed prior to 1985. Roadway construction will encroach into the allowable cover over the pipe. Reconstruction of the waterline will increase construction costs, increase the duration of the construction schedule, and impact accessibility in the areas of construction. The contractor will need to provide access to local streets and driveways during construction.

3.10 Traffic Signals

To accommodate future traffic volumes from all three approaches, a traffic signal was recommended at the Camino Seco and Wrightstown Road intersection in the Camino Seco, Speedway Boulevard to Wrightstown Road DCR completed in 2000. This signal should operate with permissive/protected phasing for left turns for both alternatives.

3.11 Street Lighting

Street lighting will be an element of this project. Luminaries will be located along Camino Seco, adjacent to the study intersection.

3.12 Landscaping

Landscaping will be included in this project for the medians and the area between the road and right-of-way. Low water usage plants and water harvesting will be incorporated into the design.

3.13 Public Involvement Process

The public involvement portion of the design concept process consisted primarily of an open house meeting. The open house took place on May 28, 2008 at Magee Middle School. Over 120 people attended this event. A questionnaire/comment form was made available at the meeting for documenting comments and concerns specific to the project. The main design priorities from the public perspective are listed as follows:

- Traffic safety
- Traffic operations
- Intersection capacity
- Access management/traffic circulation
- Construction cost

During the public involvement process conducted in 2000 for the Camino Seco roadway widening project, access to Pima Street was a major concern of area residents. Pima Street provides local access to the surrounding neighborhood and to an elementary school located one half mile east of the study intersection. The residents, as well as the Tucson Unified School District (TUSD), indicated that access to Pima Street from Camino Seco needs to be maintained to preserve good circulation in the area.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The average delay for the Camino Seco and Wrightstown Road intersection under the Free Right Alternative is expected to be 18.9 seconds per vehicle in the AM peak hour, and 14.3 seconds per vehicle in the PM peak hour. Under the Wrightstown Disconnect Alternative, the intersection average delay is anticipated to be 23.8 seconds per vehicle in the AM peak hour, and 20.2 seconds per vehicle in the PM peak hour. The lower intersection delays estimated with the lane configuration proposed with the Free Right Alternative will result in better traffic operations at the study intersection.

The Speedway Boulevard and Harrison Road intersection will not be impacted by any of the alternatives evaluated in this study, and is expected to operate at an acceptable LOS in 2030 with the improvements proposed as part of the Speedway Boulevard widening. With the expected traffic growth, the Speedway Boulevard and Camino Seco intersection will operate at an unacceptable LOS in the AM and PM peak periods under both alternatives.

Access to Pima Street is an important factor for the traffic circulation in the area. With the Free Right Alternative, access to Pima Street from Camino Seco will not be restricted. Only left-turn movements from Pima Street onto Camino Seco will be restricted. The Wrightstown Disconnect Alternative requires that the study intersection be shifted to the south. As a result, access to Pima Street from northbound Camino Seco will be restricted, as well as left turn access from Pima Street onto Camino Seco. Blocking Pima Street access from Camino Seco will have a negative impact on the overall traffic circulation of the area, since it will reduce the number of access points to the elementary school and residential properties.

Right-of-way acquisitions will not be necessary for implementation of the Free Right Alternative. However, to implement the Wrightstown Disconnect Alternative, significant right-of-way would need to be acquired at the southwest corner of the Camino Seco and Wrightstown Road intersection.

In order to select a Preferred Alternative, an evaluation matrix was composed to compare the Free Right and Wrightstown Disconnect Alternatives. The design criteria used to evaluate the alternatives were the seven highest ranked design aspects selected as a result of the open house held for this project in May 2008. The evaluation matrix is presented in Table 2.

Table 2 – Evaluation Matrix

Design Criteria	Intersection Alternatives		
	1 - Free Right	2 - Modern Roundabout	3 - Wrightstown Disconnect
Traffic Safety	24 conflict points.		24 conflict points.
Alternative Ranking	●		●
Traffic Operations	18.9 seconds/vehicle of delay in AM Peak Hour (LOS B) 14.3 seconds/vehicle of delay in PM Peak Hour (LOS B)		23.8 seconds/vehicle of delay in AM Peak Hour (LOS C) 20.2 seconds/vehicle of delay in PM Peak Hour. (LOS C)
Alternative Ranking	●		◐
Intersection Capacity	Free right will allow for a higher number of EB right-turns at intersection. AM volume/capacity ratio: 0.68 PM volume/capacity ratio: 0.80 EB app. 95%-ile queue: 450 ft WB app. 95%-ile queue: 350 ft NB app. 95%-ile queue: 200 ft		AM volume/capacity ratio: 0.71 PM volume/capacity ratio: 0.67 EB app. 95%-ile queue: 400 ft WB app. 95%-ile queue: 400 ft NB app. 95%-ile queue: 200 ft
Alternative Ranking	●		●
Access Management	Will allow left turns from Camino Seco onto westbound Pima Street. Left turns out of Pima Street will be restricted.		The proximity of the intersection improvements to Pima Street will not allow left turns from Camino Seco to westbound Pima Street. Left turns out of Pima Street will also restricted.
Alternative Ranking	◐		⊕
Construction Cost	Traffic signal improvements are costly elements.		Traffic signal improvements are costly elements. The Camino Seco widening will have to be constructed together with the improvements at the study
Alternative Ranking	◐		⊕
Right-of-Way Acquisitions	No right-of-way acquisitions will be necessary for this alternative.		Approximately 8,700 SF of additional right-of-way will need to be purchased at the southwest and southeast corners of the intersection. Based on a provided cost of $25 PSF, the total cost to purchase the needed right-of-way will be roughly $220,000.
Alternative Ranking	●		⊕
Bicycle and Pedestrian Accessibility	Will require additional mitigation measures (such as a speed table or pedestrian signal) at free right turn lane location.		Will allow for standard signalized intersection phasing, including pedestrian phase.
Alternative Ranking	◐		●
Overall Ranking	●		◐

Legend
Criteria ranked from most desirable ● to least desirable ⊕

4.2 Recommendations

4.2.1 Preferred Alternative

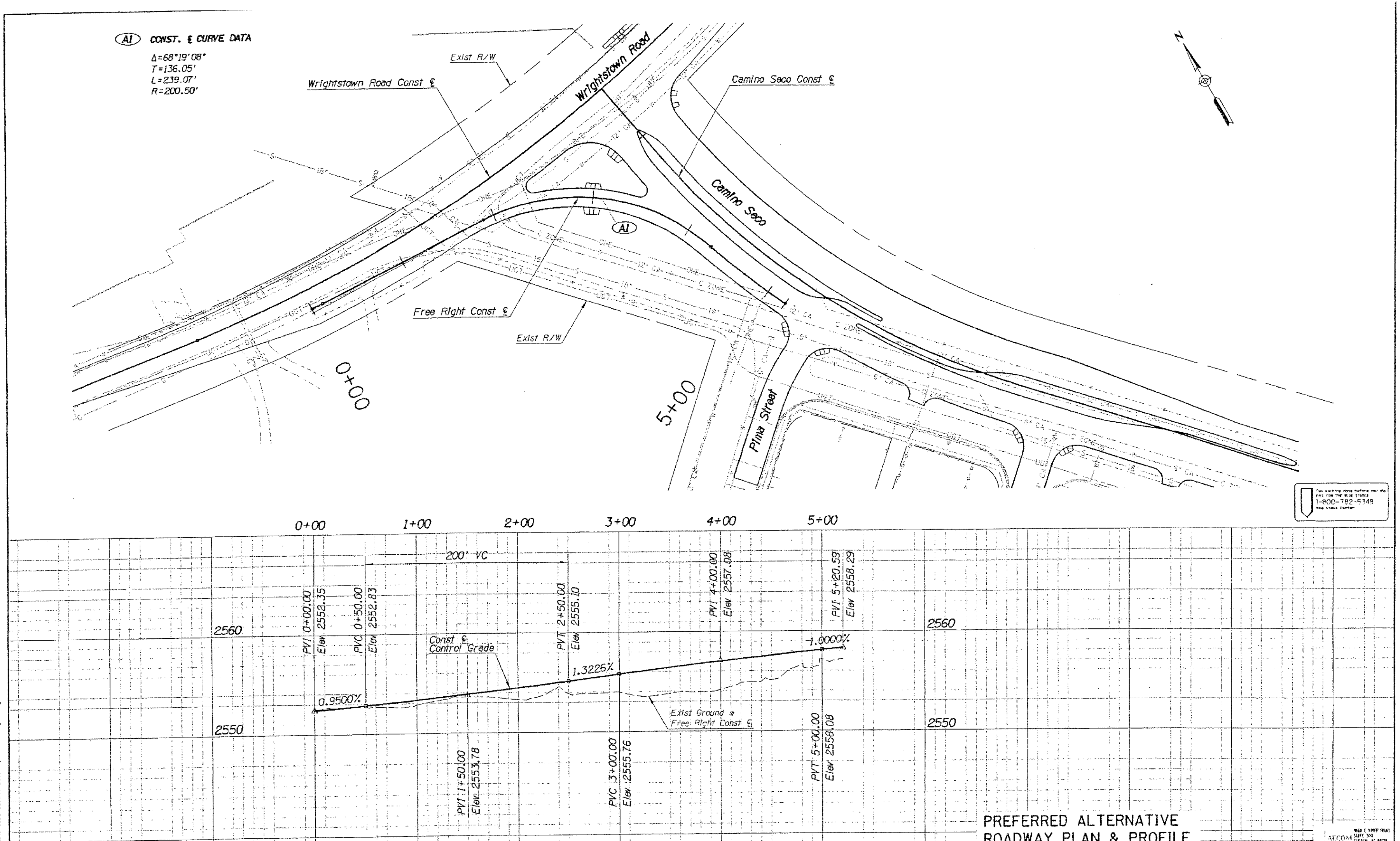
After evaluating both alternatives, we recommend that the Free Right Alternative be the Preferred Alternative. The implementation of the Free Right Alternative will provide a cost effective design that will improve traffic operations and safety at the Camino Seco and Wrightstown Road intersection. The free-flow right-turn lane will utilize the additional capacity on Camino Seco that the roadway is expected to have in the future. A preliminary cost estimate was elaborated for the Preferred Alternative and is shown in Table 3.

Table 3 – Preliminary Cost Estimate

Item Description	Estimated Cost
Removals	**$50,000**
Asphaltic Paving/Base	**$500,000**
Roadway Drainage	**$250,000**
Curb and Sidewalk	**$150,000**
Traffic Signal Improvements	**$250,000**
Street Lighting	**$150,000**
Landscape	**$200,000**
Water Modifications	**$125,000**
Traffic Control/Mobilization	**$100,000**
Contingency (20%)	**$450,000**
TOTAL	**$2,200,000**

4.2.2 Plan and Profile

The following figure provides a 15% plan and profile view of the Preferred Alternative at the Camino Seco and Wrightstown Road intersection. Additional plan and profile drawings of the design completed in 2002 for the Camino Seco widening project can be found in Appendix B.



PREFERRED ALTERNATIVE ROADWAY PLAN & PROFILE

AECOM

Preliminary Design

Not for Construction or Recording

November 2008

DEPARTMENT OF TRANSPORTATION/ENGINEERING DIVISION

CAMINO SECO / WRIGHTSTOWN ROAD

ALTERNATIVE INTERSECTION DESIGN

CITY OF TUCSON

NO.	DATE	REVISION	BY	CHKD.	APPR.

DRAWN BY SC 11-08

DSGN. BY SC 11-08

CHKD. BY FLD 11-08

REF.

SCALE: 1"=40'

PLAN NO.

1 of 1

PLOTTED BY: OrangG
Date Plotted: 11/12/2008
Time Plotted: 5:53:43 PM
Filename: T:\26041 Camino Seco\C_Seco\Docs\report\FreeRightPP.dgn

5.0 REFERENCES

1. Google Maps: http://maps.google.com

2. Sun Tran. System Wide Routes Map. 6 February 2008.http://www.suntran.com/routes.php

3. Transportation Research Board. *Highway Capacity Manual.* National Research Council. Washington, D.C. 2000.

4. Trafficware. *Synchro 7.* 2006.

5. City of Tucson. *Transportation Access Management Guidelines for the City of Tucson, Arizona* 17 March 2003

APPENDIX A
SYNCHRO OUPUT

Movement	WBL	WBR	SEL	SER	NEL	NER
Lane Configurations						
Volume (vph)	375	700	450	175	200	225
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	4.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1770	1583	1770	1583
Flt Permitted	0.21	1.00	0.95	1.00	0.95	1.00
Satd. Flow (perm)	388	1583	1770	1583	1770	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	395	737	474	184	211	237
RTOR Reduction (vph)	0	0	0	0	0	175
Lane Group Flow (vph)	395	737	474	184	211	62
Turn Type		custom		Free		Perm
Protected Phases	3	8	4		2	
Permitted Phases	8			Free		2
Actuated Green, G (s)	42.4	42.4	24.0	70.8	18.4	18.4
Effective Green, g (s)	42.4	42.4	24.0	70.8	18.4	18.4
Actuated g/C Ratio	0.60	0.60	0.34	1.00	0.26	0.26
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	494	948	600	1583	460	411
v/s Ratio Prot	0.15	c0.47	0.27		c0.12	
v/s Ratio Perm	c0.33			0.12		0.04
v/c Ratio	0.80	0.78	0.79	0.12	0.46	0.15
Uniform Delay, d1	11.1	10.7	21.1	0.0	22.0	20.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	8.8	4.1	7.0	0.1	3.3	0.8
Delay (s)	19.9	14.7	28.1	0.1	25.3	20.9
Level of Service	B	B	C	A	C	C
Approach Delay (s)	16.5		20.3		23.0	
Approach LOS	B		C		C	

Intersection Summary			
HCM Average Control Delay	18.9	HCM Level of Service	B
HCM Volume to Capacity ratio	0.69		
Actuated Cycle Length (s)	70.8	Sum of lost time (s)	10.0
Intersection Capacity Utilization	69.3%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	375	700	200	225	450	175
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.58	1.00
Satd. Flow (perm)	1770	1583	1863	1583	1086	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	395	737	211	237	474	184
RTOR Reduction (vph)	0	278	0	149	0	0
Lane Group Flow (vph)	395	459	211	88	474	184
Turn Type		pm+ov		Perm	pm+pt	
Protected Phases	3	1	2		1	1 2
Permitted Phases		3		2	1 2	
Actuated Green, G (s)	20.8	39.2	32.1	32.1	50.5	55.5
Effective Green, g (s)	20.8	39.2	32.1	32.1	50.5	55.5
Actuated g/C Ratio	0.24	0.45	0.37	0.37	0.59	0.64
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	427	811	693	589	781	1198
v/s Ratio Prot	c0.22	c0.12	0.11		0.13	0.10
v/s Ratio Perm		0.17		0.06	c0.23	
v/c Ratio	0.93	0.57	0.30	0.15	0.61	0.15
Uniform Delay, d1	32.0	17.3	19.2	18.0	14.1	6.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	25.7	0.9	1.1	0.5	1.3	0.1
Delay (s)	57.7	18.2	20.3	18.6	15.4	6.2
Level of Service	E	B	C	B	B	A
Approach Delay (s)	32.0		19.4			12.8
Approach LOS	C		B			B

Intersection Summary			
HCM Average Control Delay	23.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	86.3	Sum of lost time (s)	15.0
Intersection Capacity Utilization	68.7%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	SEL	SER	NEL	NER
Lane Configurations						
Volume (vph)	150	450	725	375	200	225
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	4.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	0.85
Flt Protected	0.95	1.00	0.95	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1770	1583	1770	1583
Flt Permitted	0.15	1.00	0.95	1.00	0.95	1.00
Satd. Flow (perm)	287	1583	1770	1583	1770	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	474	763	395	211	237
RTOR Reduction (vph)	0	0	0	0	0	199
Lane Group Flow (vph)	158	474	763	395	211	38
Turn Type		custom		Free		Perm
Protected Phases	3	8	4		2	
Permitted Phases	8	3		Free		2
Actuated Green, G (s)	39.1	39.1	30.3	58.6	9.5	9.5
Effective Green, g (s)	39.1	39.1	30.3	58.6	9.5	9.5
Actuated g/C Ratio	0.67	0.67	0.52	1.00	0.16	0.16
Clearance Time (s)	5.0	5.0	5.0		5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0		3.0	3.0
Lane Grp Cap (vph)	288	1056	915	1583	287	257
v/s Ratio Prot	0.04	c0.30	c0.43		c0.12	
v/s Ratio Perm	0.33			0.25		0.02
v/c Ratio	0.55	0.45	0.83	0.25	0.74	0.15
Uniform Delay, d1	8.3	4.6	12.0	0.0	23.4	21.1
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.1	0.3	8.8	0.4	9.4	0.3
Delay (s)	10.5	4.9	20.8	0.4	32.7	21.4
Level of Service	B	A	C	A	C	C
Approach Delay (s)	6.3		13.9		26.7	
Approach LOS	A		B		C	

Intersection Summary			
HCM Average Control Delay	14.3	HCM Level of Service	B
HCM Volume to Capacity ratio	0.80		
Actuated Cycle Length (s)	58.6	Sum of lost time (s)	15.0
Intersection Capacity Utilization	72.1%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (vph)	150	450	200	225	725	375
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00
Frt	1.00	0.85	1.00	0.85	1.00	1.00
Flt Protected	0.95	1.00	1.00	1.00	0.95	1.00
Satd. Flow (prot)	1770	1583	1863	1583	1770	1863
Flt Permitted	0.95	1.00	1.00	1.00	0.50	1.00
Satd. Flow (perm)	1770	1583	1863	1583	937	1863
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	474	211	237	763	395
RTOR Reduction (vph)	0	398	0	195	0	0
Lane Group Flow (vph)	158	76	211	42	763	395
Turn Type		Perm		Perm	pm+pt	
Protected Phases	3		2		1	10
Permitted Phases		3		2	10	
Actuated Green, G (s)	12.9	12.9	14.1	14.1	57.1	57.1
Effective Green, g (s)	12.9	12.9	14.1	14.1	57.1	57.1
Actuated g/C Ratio	0.16	0.16	0.18	0.18	0.71	0.71
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	285	255	328	279	1064	1330
v/s Ratio Prot	c0.09		0.11		c0.34	0.21
v/s Ratio Perm		0.05		0.03	c0.17	
v/c Ratio	0.55	0.30	0.64	0.15	0.72	0.30
Uniform Delay, d1	30.9	29.6	30.6	27.9	8.7	4.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	2.3	0.7	4.3	0.2	4.2	0.6
Delay (s)	33.2	30.2	34.9	28.1	12.9	4.7
Level of Service	C	C	C	C	B	A
Approach Delay (s)	31.0		31.3			10.1
Approach LOS	C		C			B

Intersection Summary			
HCM Average Control Delay	20.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	80.0	Sum of lost time (s)	10.0
Intersection Capacity Utilization	71.5%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	400	175	100	1200	425	425	425	75	150	300	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.97	1.00	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	3433	1863	1583	3433	3539	1583
Flt Permitted	0.11	1.00	1.00	0.48	1.00	1.00	0.52	1.00	1.00	0.17	1.00	1.00
Satd. Flow (perm)	200	3539	1583	885	3539	1583	1872	1863	1583	628	3539	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	421	184	105	1263	447	447	447	79	158	316	79
RTOR Reduction (vph)	0	0	107	0	0	187	0	0	49	0	0	59
Lane Group Flow (vph)	53	421	77	105	1263	260	447	447	30	158	316	20
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	1	2		1	2		3	4		3	4	
Permitted Phases	2		2	2		2	4		4	4		4
Actuated Green, G (s)	41.1	37.3	37.3	41.1	37.3	37.3	28.0	23.0	23.0	28.0	23.0	23.0
Effective Green, g (s)	41.1	37.3	37.3	41.1	37.3	37.3	28.0	23.0	23.0	28.0	23.0	23.0
Actuated g/C Ratio	0.46	0.42	0.42	0.46	0.42	0.42	0.31	0.26	0.26	0.31	0.26	0.26
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	159	1482	663	446	1482	663	676	481	409	355	914	409
v/s Ratio Prot	c0.01	0.12		0.01	c0.36		c0.04	c0.24		0.02	0.09	
v/s Ratio Perm	0.14		0.05	0.10		0.16	0.17		0.02	0.11		0.01
v/c Ratio	0.33	0.28	0.12	0.24	0.85	0.39	0.66	0.93	0.07	0.45	0.35	0.05
Uniform Delay, d1	33.0	17.1	15.8	16.0	23.4	18.0	28.4	32.3	25.0	36.5	26.9	24.8
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	1.2	0.5	0.4	0.3	6.4	1.7	2.4	26.7	0.3	0.9	1.0	0.2
Delay (s)	34.2	17.6	16.2	16.2	29.8	19.8	30.9	59.0	25.3	37.4	28.0	25.1
Level of Service	C	B	B	B	C	B	C	E	C	D	C	C
Approach Delay (s)		18.5			26.5			43.3			30.3	
Approach LOS		B			C			D			C	

Intersection Summary			
HCM Average Control Delay	29.8	HCM Level of Service	C
HCM Volume to Capacity ratio	0.84		
Actuated Cycle Length (s)	89.1	Sum of lost time (s)	20.0
Intersection Capacity Utilization	79.8%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	50	1000	500	75	525	175	225	275	225	200	450	50
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	1.00	1.00	0.95	1.00	0.97	1.00	1.00	0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85	1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00	0.95	1.00	1.00
Satd. Flow (prot)	1770	3539	1583	1770	3539	1583	3433	1863	1583	3433	3539	1583
Flt Permitted	0.38	1.00	1.00	0.17	1.00	1.00	0.38	1.00	1.00	0.40	1.00	1.00
Satd. Flow (perm)	702	3539	1583	309	3539	1583	1372	1863	1583	1460	3539	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	53	1053	526	79	553	184	237	289	237	211	474	53
RTOR Reduction (vph)	0	0	221	0	0	120	0	0	151	0	0	40
Lane Group Flow (vph)	53	1053	305	79	553	64	237	289	86	211	474	13
Turn Type	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm	pm+pt		Perm
Protected Phases	1	2		1	2		3	4		3	4	
Permitted Phases	2		2	2		2	4		4	4		4
Actuated Green, G (s)	27.8	24.1	24.1	27.8	24.1	24.1	21.3	16.5	16.5	21.3	16.5	16.5
Effective Green, g (s)	27.8	24.1	24.1	27.8	24.1	24.1	21.3	16.5	16.5	21.3	16.5	16.5
Actuated g/C Ratio	0.40	0.35	0.35	0.40	0.35	0.35	0.31	0.24	0.24	0.31	0.24	0.24
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Lane Grp Cap (vph)	340	1234	552	203	1234	552	566	445	378	587	845	378
v/s Ratio Prot	0.01	c0.30		c0.02	0.16		c0.03	c0.16		0.02	0.13	
v/s Ratio Perm	0.05		0.19	0.14		0.04	0.10		0.05	0.09		0.01
v/c Ratio	0.16	0.85	0.55	0.39	0.45	0.12	0.42	0.65	0.23	0.36	0.56	0.03
Uniform Delay, d1	15.6	20.9	18.2	25.4	17.4	15.3	22.0	23.7	21.2	22.5	23.1	20.2
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Incremental Delay, d2	0.2	7.6	4.0	1.2	1.2	0.4	0.5	7.2	1.4	0.4	2.7	0.2
Delay (s)	15.9	28.5	22.1	26.6	18.5	15.7	22.5	30.9	22.6	22.8	25.8	20.3
Level of Service	B	C	C	C	B	B	C	C	C	C	C	C
Approach Delay (s)		26.0			18.7			25.7			24.6	
Approach LOS		C			B			C			C	

Intersection Summary			
HCM Average Control Delay	24.2	HCM Level of Service	C
HCM Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	69.1	Sum of lost time (s)	20.0
Intersection Capacity Utilization	68.6%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

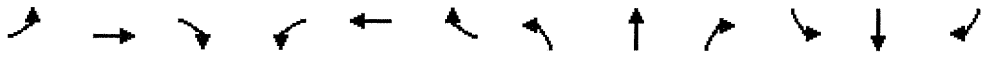
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	575	400	275	1425	75	600	300	100	50	450	250
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.99		1.00	0.96		1.00	0.95	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1805	5047		1805	3407		1770	3350	
Flt Permitted	0.12	1.00	1.00	0.30	1.00		0.24	1.00		0.31	1.00	
Satd. Flow (perm)	226	3539	1583	575	5047		447	3407		574	3350	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	605	421	289	1500	79	632	316	105	53	474	263
RTOR Reduction (vph)	0	0	282	0	6	0	0	32	0	0	76	0
Lane Group Flow (vph)	158	605	139	289	1573	0	632	389	0	53	661	0
Heavy Vehicles (%)	2%	2%	2%	0%	2%	2%	0%	2%	2%	2%	2%	2%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		
Protected Phases	1	2		1	2		3	4		3	4	
Permitted Phases	2		2	2			4			4		
Actuated Green, G (s)	38.0	33.0	33.0	38.0	33.0		42.0	17.0		42.0	17.0	
Effective Green, g (s)	38.0	33.0	33.0	38.0	33.0		42.0	17.0		42.0	17.0	
Actuated g/C Ratio	0.38	0.33	0.33	0.38	0.33		0.42	0.17		0.42	0.17	
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	163	1168	522	280	1666		527	579		540	570	
v/s Ratio Prot	0.05	0.17		c0.05	0.31		c0.30	0.11		0.02	0.20	
v/s Ratio Perm	0.32		0.09	c0.34			c0.20			0.02		
v/c Ratio	0.97	0.52	0.27	1.03	0.94		1.20	0.67		0.10	1.16	
Uniform Delay, d1	43.3	27.1	24.6	34.7	32.6		34.2	38.9		22.1	41.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	60.6	1.6	1.2	62.4	12.3		106.9	3.1		0.1	90.4	
Delay (s)	103.9	28.7	25.9	97.1	44.9		141.1	41.9		22.2	131.9	
Level of Service	F	C	C	F	D		F	D		C	F	
Approach Delay (s)		37.7			53.0			101.5			124.6	
Approach LOS		D			D			F			F	

Intersection Summary			
HCM Average Control Delay	71.3	HCM Level of Service	E
HCM Volume to Capacity ratio	1.12		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	107.9%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	200	1575	950	150	850	75	400	400	300	100	475	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	
Lane Util. Factor	1.00	0.95	1.00	1.00	0.91		1.00	0.95		1.00	0.95	
Frt	1.00	1.00	0.85	1.00	0.99		1.00	0.94		1.00	0.98	
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1770	3539	1583	1770	5023		1770	3312		1770	3467	
Flt Permitted	0.23	1.00	1.00	0.08	1.00		0.22	1.00		0.22	1.00	
Satd. Flow (perm)	427	3539	1583	146	5023		419	3312		419	3467	
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	211	1658	1000	158	895	79	421	421	316	105	500	79
RTOR Reduction (vph)	0	0	263	0	9	0	0	123	0	0	12	0
Lane Group Flow (vph)	211	1658	737	158	965	0	421	614	0	105	567	0
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		
Protected Phases	1	2		1	2		3	4		3	4	
Permitted Phases	2		2	2			4			4		
Actuated Green, G (s)	55.2	51.2	51.2	55.2	51.2		34.8	17.8		34.8	17.8	
Effective Green, g (s)	55.2	51.2	51.2	55.2	51.2		34.8	17.8		34.8	17.8	
Actuated g/C Ratio	0.50	0.47	0.47	0.50	0.47		0.32	0.16		0.32	0.16	
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	
Lane Grp Cap (vph)	263	1647	737	132	2338		341	536		341	561	
v/s Ratio Prot	0.03	0.47		c0.04	0.19		c0.19	0.19		0.05	0.16	
v/s Ratio Perm	0.37		0.47	c0.56			c0.20			0.05		
v/c Ratio	0.80	1.01	1.00	1.20	0.41		1.23	1.15		0.31	1.01	
Uniform Delay, d1	31.2	29.4	29.4	50.1	19.5		43.1	46.1		37.8	46.1	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	
Incremental Delay, d2	16.0	23.8	33.2	140.8	0.5		128.4	85.5		0.5	40.8	
Delay (s)	47.2	53.2	62.6	190.9	20.0		171.5	131.6		38.3	86.9	
Level of Service	D	D	E	F	B		F	F		D	F	
Approach Delay (s)		56.0			43.8			146.1			79.4	
Approach LOS		E			D			F			E	

Intersection Summary			
HCM Average Control Delay	74.3	HCM Level of Service	E
HCM Volume to Capacity ratio	1.21		
Actuated Cycle Length (s)	110.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	106.2%	ICU Level of Service	G
Analysis Period (min)	15		
c Critical Lane Group			



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	575	400	275	1425	75	600	300	100	50	450	250
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	0.88	1.00	0.91		0.97	0.95		0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.99		1.00	0.96		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	3539	2787	1805	5047		3502	3407		3433	3539	1583
Flt Permitted	0.15	1.00	1.00	0.33	1.00		0.33	1.00		0.38	1.00	1.00
Satd. Flow (perm)	276	3539	2787	621	5047		1201	3407		1388	3539	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	158	605	421	289	1500	79	632	316	105	53	474	263
RTOR Reduction (vph)	0	0	277	0	7	0	0	41	0	0	0	144
Lane Group Flow (vph)	158	605	144	289	1572	0	632	380	0	53	474	119
Heavy Vehicles (%)	2%	2%	2%	0%	2%	2%	0%	2%	2%	2%	2%	2%
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	1	2		1	2		3	4		3	4	
Permitted Phases	2		2	2			4			4		4
Actuated Green, G (s)	33.9	27.0	27.0	33.9	27.0		24.9	15.9		24.9	15.9	15.9
Effective Green, g (s)	33.9	27.0	27.0	33.9	27.0		24.9	15.9		24.9	15.9	15.9
Actuated g/C Ratio	0.43	0.34	0.34	0.43	0.34		0.32	0.20		0.32	0.20	0.20
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	250	1213	955	371	1729		642	687		672	714	319
v/s Ratio Prot	0.06	0.17		c0.07	c0.31		c0.11	0.11		0.01	0.13	
v/s Ratio Perm	0.22		0.05	0.27			c0.20			0.02		0.07
v/c Ratio	0.63	0.50	0.15	0.78	0.91		0.98	0.55		0.08	0.66	0.37
Uniform Delay, d1	29.8	20.5	18.0	23.6	24.7		28.4	28.3		21.8	29.0	27.1
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	5.1	1.5	0.3	9.9	8.6		31.3	1.0		0.1	2.3	0.7
Delay (s)	35.0	22.0	18.3	33.6	33.3		59.7	29.2		21.8	31.3	27.9
Level of Service	C	C	B	C	C		E	C		C	C	C
Approach Delay (s)		22.4			33.4			47.5			29.5	
Approach LOS		C			C			D			C	

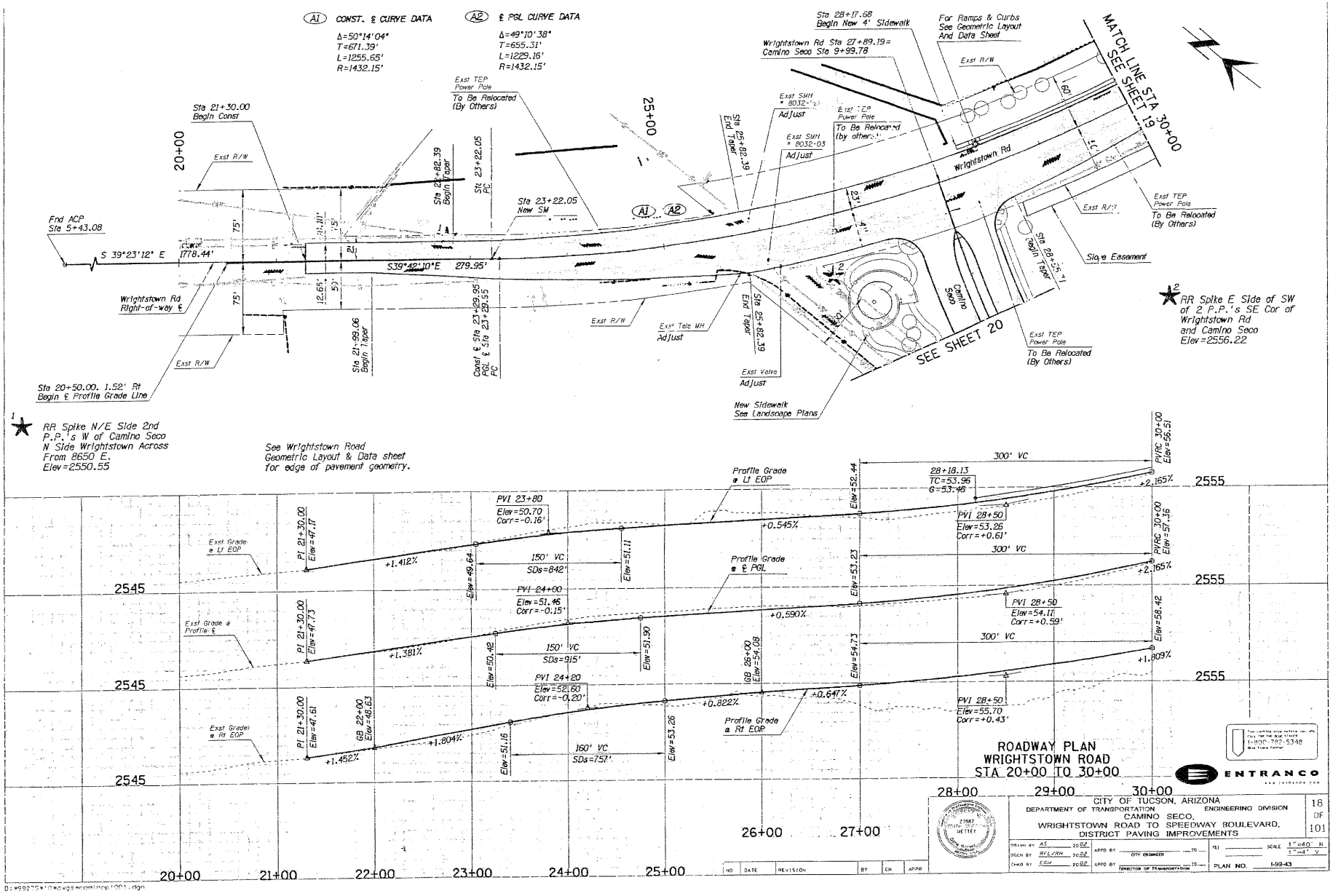
Intersection Summary			
HCM Average Control Delay	33.1	HCM Level of Service	C
HCM Volume to Capacity ratio	0.93		
Actuated Cycle Length (s)	78.8	Sum of lost time (s)	20.0
Intersection Capacity Utilization	83.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	200	1575	950	150	850	75	400	400	300	100	475	75
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Lane Util. Factor	1.00	0.95	0.88	1.00	0.91		0.97	0.95		0.97	0.95	1.00
Frt	1.00	1.00	0.85	1.00	0.99		1.00	0.94		1.00	1.00	0.85
Flt Protected	0.95	1.00	1.00	0.95	1.00		0.95	1.00		0.95	1.00	1.00
Satd. Flow (prot)	1770	3539	2787	1770	5023		3433	3312		3433	3539	1583
Flt Permitted	0.24	1.00	1.00	0.08	1.00		0.24	1.00		0.22	1.00	1.00
Satd. Flow (perm)	441	3539	2787	154	5023		874	3312		781	3539	1583
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	211	1658	1000	158	895	79	421	421	316	105	500	79
RTOR Reduction (vph)	0	0	259	0	10	0	0	123	0	0	0	64
Lane Group Flow (vph)	211	1658	741	158	964	0	421	614	0	105	500	15
Turn Type	pm+pt		Perm	pm+pt			pm+pt			pm+pt		Perm
Protected Phases	1	2		1	2		3	4		3	4	
Permitted Phases	2		2	2			4			4		4
Actuated Green, G (s)	54.5	48.5	48.5	54.5	48.5		25.5	18.5		25.5	18.5	18.5
Effective Green, g (s)	54.5	48.5	48.5	54.5	48.5		25.5	18.5		25.5	18.5	18.5
Actuated g/C Ratio	0.54	0.48	0.48	0.54	0.48		0.26	0.18		0.26	0.18	0.18
Clearance Time (s)	5.0	5.0	5.0	5.0	5.0		5.0	5.0		5.0	5.0	5.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	3.0		3.0	3.0	3.0
Lane Grp Cap (vph)	320	1716	1352	181	2436		402	613		385	655	293
v/s Ratio Prot	0.04	c0.47		c0.05	0.19		c0.07	0.19		0.02	0.14	
v/s Ratio Perm	0.32		0.27	0.42			c0.19			0.05		0.01
v/c Ratio	0.66	0.97	0.55	0.87	0.40		1.05	1.00		0.27	0.76	0.05
Uniform Delay, d1	23.7	25.0	18.1	42.9	16.4		40.7	40.8		40.8	38.7	33.5
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.00	1.00		1.00	1.00	1.00
Incremental Delay, d2	4.9	15.1	1.6	33.9	0.5		57.8	36.7		0.4	5.3	0.1
Delay (s)	28.5	40.0	19.7	76.9	16.9		98.5	77.5		41.2	43.9	33.6
Level of Service	C	D	B	E	B		F	E		D	D	C
Approach Delay (s)		32.1			25.3			85.1			42.3	
Approach LOS		C			C			F			D	

Intersection Summary			
HCM Average Control Delay	42.5	HCM Level of Service	D
HCM Volume to Capacity ratio	0.98		
Actuated Cycle Length (s)	100.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	93.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

APPENDIX B
CAMINO SECO ROADWAY
PLAN & PROFILE


A1 CONST. & CURVE DATA
Δ=50°14'04"
T=671.39'
L=1255.65'
R=1432.15'
A2 & PGL CURVE DATA
Δ=49°10'38"
T=655.31'
L=1229.16'
R=1432.15'
Sta 21+30.00 Begin Const
Exst R/W
Fnd ACP Sta 5+43.08
S 39°23'12" E 1778.44'
Wrightstown Rd Right-of-way ℄
Sta 20+50.00, 1.52' Rt Begin ℄ Profile Grade Line
Exst TEP Power Pole To Be Relocated (By Others)
Sta 21+99.06 Begin Taper
Sta 23+22.05 PC
Sta 23+82.39 Begin Taper
Sta 23+22.05 New SW
S39°42'10"E 279.95'
Const ℄ Sta 23+29.95 PGL ℄ Sta 23+29.95 PC
Exst Tele MH Adjust
Sta 25+82.39 End Taper
Exst Valve Adjust
New Sidewalk See Landscape Plans
Sta 28+17.68 Begin New 4' Sidewalk
Wrightstown Rd Sta 27+89.19 = Camino Seco Sta 9+99.78
For Ramps & Curbs See Geometric Layout And Data Sheet
Exst SMH # 8032-03 Adjust
Exst TEP Power Pole To Be Relocated (by others)
Wrightstown Rd
Sta 28+55.41 Begin Taper
Slope Easement
Exst TEP Power Pole To Be Relocated (By Others)
MATCH LINE STA 30+00 SEE SHEET 19
SEE SHEET 20
RR Spike N/E Side 2nd P.P.'s W of Camino Seco N Side Wrightstown Across From 8650 E. Elev=2550.55
RR Spike E Side of SW of 2 P.P.'s SE Cor of Wrightstown Rd and Camino Seco Elev=2556.22
See Wrightstown Road Geometric Layout & Data sheet for edge of pavement geometry.
Profile Grade @ Lt EOP
Exst Grade @ Lt EOP
PI 21+30.00 Elev=47.17
PVI 23+80 Elev=50.70 Corr=-0.16'
+1.412%
150' VC SDs=842'
Elev=49.64
Elev=51.11
+0.545%
Elev=52.44
28+18.13 TC=53.96 G=53.46
PVI 28+50 Elev=53.26 Corr=+0.61'
300' VC
PVRC 30+00 Elev=56.51
+2.165%
Profile Grade @ ℄ PGL
Exst Grade @ Profile ℄
PI 21+30.00 Elev=47.73
PVI 24+00 Elev=51.46 Corr=-0.15'
+1.381%
150' VC SDs=915'
Elev=50.42
Elev=51.90
+0.590%
Elev=53.23
PVI 28+50 Elev=54.11 Corr=+0.59'
300' VC
PVRC 30+00 Elev=57.36
+2.165%
Exst Grade @ Rt EOP
PI 21+30.00 Elev=47.61
GB 22+00 Elev=48.63
+1.452%
+1.804%
PVI 24+20 Elev=52.60 Corr=-0.20'
160' VC SDs=757'
Elev=51.16
Elev=53.26
+0.822%
GB 26+00 Elev=54.09
Elev=54.73
+0.641%
Profile Grade @ Rt EOP
PVI 28+50 Elev=55.70 Corr=+0.43'
+1.809%
PVRC 30+00 Elev=58.42
2545
2555
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
29+00
30+00
ROADWAY PLAN
WRIGHTSTOWN ROAD
STA 20+00 TO 30+00
ENTRANCO
CITY OF TUCSON, ARIZONA
DEPARTMENT OF TRANSPORTATION ENGINEERING DIVISION
CAMINO SECO,
WRIGHTSTOWN ROAD TO SPEEDWAY BOULEVARD,
DISTRICT PAVING IMPROVEMENTS
18 OF 101
PLAN NO. I-99-43
NO DATE REVISION BY CH APPR
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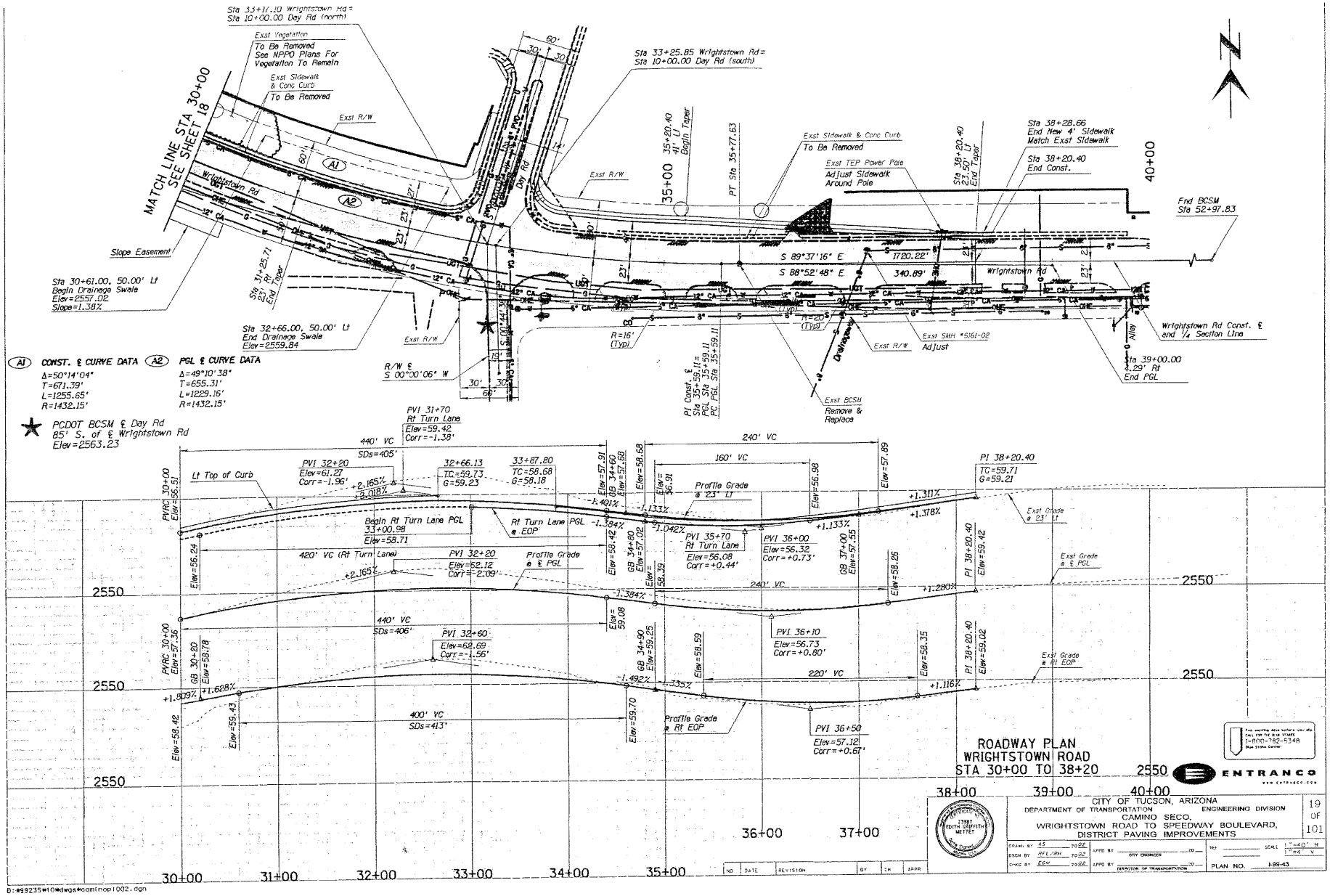

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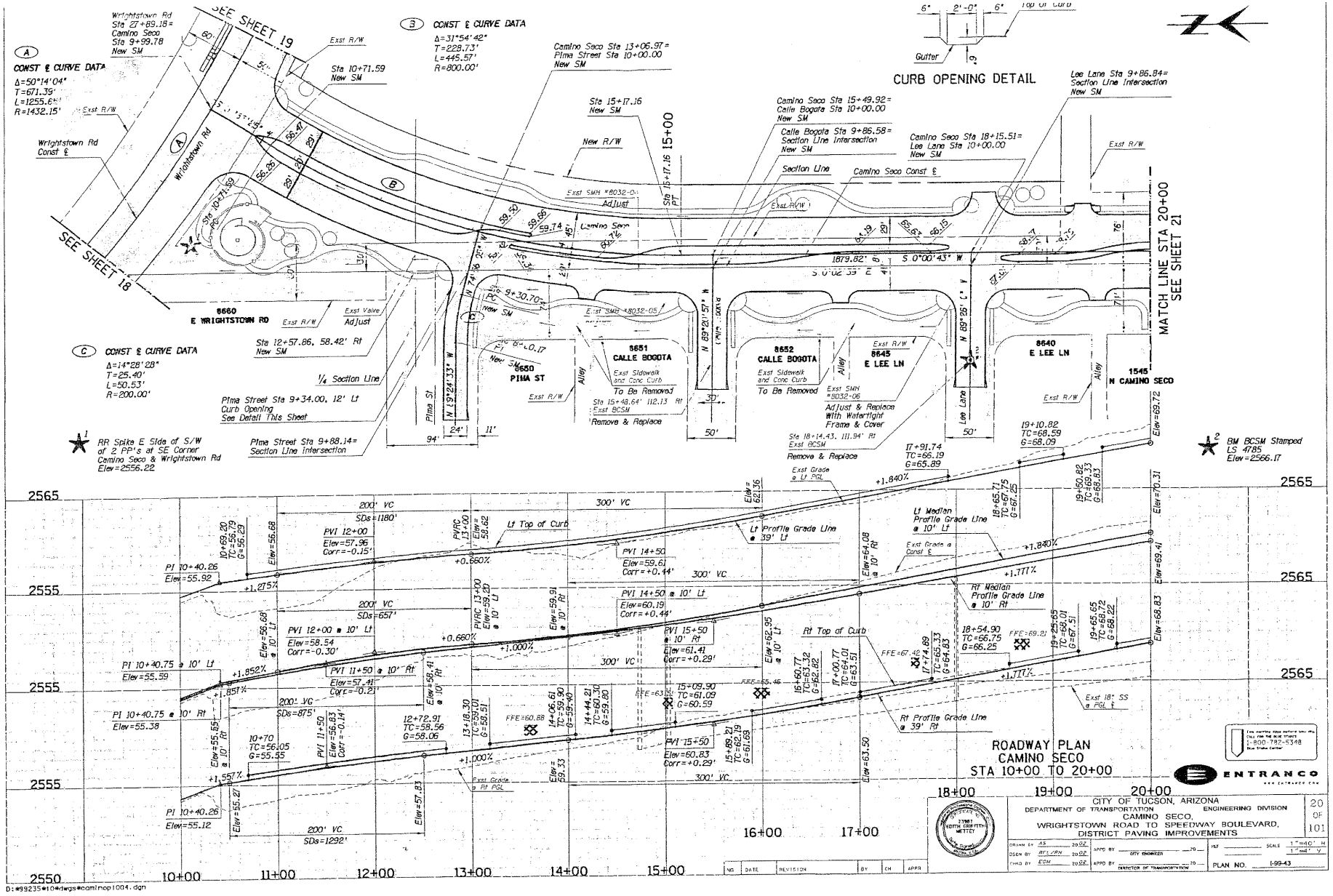

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