HOUGHTON ROAD IMPROVEMENT PROJECT:

TANQUE VERDE ROAD TO SPEEDWAY BOULEVARD

COT PLAN NO. I-2007-019

COT Job No. SR1C

FINAL
DESIGN CONCEPT REPORT

Prepared for:

CITY OF TUCSON DEPARTMENT OF TRANSPORTATION

Prepared by:

Parsons Brinckerhoff

177 North Church Avenue, Suite 500

Tucson, Arizona 85701

(520) 882-6424

August 9, 2010

EXECUTIVE SUMMARY

The Houghton Road Improvement Project: Tanque Verde Road to Speedway Boulevard, Design Concept Report (DCR) was completed by Parsons Brinckerhoff (PB) to evaluate alternatives for improving Houghton Road in the City of Tucson, Pima County, Arizona. The project limits of this DCR on Houghton Road extend from a point north of Tanque Verde Road to a point south of 5th Street, between Speedway Boulevard and Broadway Boulevard, approximately 2.0-miles.

The Arizona Department of Transportation completed a Houghton Road Corridor Study in October 2004 that identified improvements to Houghton Road from the northern project limit at Tanque Verde, south 13 miles to I-10. The segment of Houghton Road from Tanque Verde Road to Interstate 10 was included as one of the major improvement projects in the Regional Transportation Authority (RTA) funding passed by Pima County voters in May of 2006. Speedway Boulevard to 22nd Street is the northern most of three segments along the Houghton Road segment currently under study by the City. At the request of Pima County, the project was extended to Tanque Verde Road. With that extension, the entire length of the ADOT Corridor Study will be progressing through the Design Concept Report Phase.

The purpose of this project is to improve traffic operations along Houghton Road within the limits of available funding. The proposed project will primarily include the reconstruction of the existing Houghton Road roadway into a four-lane arterial section with a raised median. Project improvements will include bicycle facilities, landscaping and other streetscape amenities, drainage upgrades, and utility relocations. Improvement will be made with regards to pedestrian facilities that vary by roadway segment. The two signalized intersections located at Tanque Verde Road and Speedway Boulevard will also be maintained and improved as necessary. Impacts to businesses, residences, and right-of-way (ROW) are to be minimized.

The design concept study includes a review of existing conditions along Houghton Road, an environmental overview, a presentation of roadway and drainage design plans, criteria development with the Pima County Roadway Design Manual (RDM) and American Association of State Highways and Transportation Officials (AASHTO) design mitigation elements, discussions on traffic, public involvement, and agency coordination. In addition to this DCR, separate project reports were prepared that include the *Preliminary Drainage Concept Report, Traffic Engineering Report, Geotechnical Report, and Public Involvement Plan*.



Figure i. Existing typical section of Houghton Road looking north.

Houghton Road is located on the east side of Tucson and is a section line roadway aligned north and south. Within the project limits from Tanque Verde Road to south of Speedway Boulevard, it has two lanes with an alignment that curves to the east north of Tanque Verde Creek. Houghton Road has been widened at the signalized

intersections with Tanque Verde Road and Speedway Boulevard to provide turn lanes. Houghton Road is also designated as a bike route and contains 8-foot shoulders adjacent to the through lanes that serve as bike lanes. In addition, the roadway is the only regional north-south commuter route between the Rincon Mountains and the Saguaro National Monument to the east and Davis-Monthan Air Force Base to the west. It serves burgeoning residential development areas along and south of this project and provides the only north-south access to Interstate 10 for many eastside Tucson residents.

Design Recommendations

Based on the expectation for future growth, public input, and technical analysis from traffic forecasts, the PB project team recommends the following design for the extension segment of Houghton Road from Tanque Verde Road to Speedway Boulevard:

- Overall, long-term improvements include a 4-lanes north of Speedway Boulevard and 6-lanes south of Speedway Boulevard containing a raised median to handle the forecasted regional growth and increased respective traffic. A design speed of 50 mph with a posted speed limit of 45 mph is recommended.
- An access management plan will be implemented to the roadway section designated as a major divided arterial. The following are recommended to be included in the plan:
    - Median openings should be spaced no closer than 660 feet and ¼ mile is preferred
    - Traffic signals spaced no closer than ½ mile
    - Access of most properties fronting Houghton Road to be right-in/right-out with intermediate U-turn opportunities at approximately every ¼ mile
- There will be no need for additional traffic signals along the project, but relocation/upgrades are necessary at the Tanque Verde Road and Speedway Boulevard intersections.
- There will be no need for arterial street lighting for this project segment.

- Asphalt rubber asphaltic concrete (ARAC) is recommended as the surface layer for the roadway pavement based on its noise reduction qualities and the fact that there are residential homes adjacent to Houghton Road.
- A storm drain system is recommended for Houghton Road, south of the Tanque Verde Creek, along the curbed roadway section.
- The storm drain system south of Speedway Boulevard is recommended to replace the existing concrete lined channels that are on either side of Houghton Road.
- A 10' paved multi-use path is proposed for Houghton Road between Speedway Boulevard and the southern project limit south of 5th Street.
- Construct parallel bridges west of the existing bridges over the Agua Caliente Wash and Tanque Verde Creek and to use a similar prestressed concrete AASHTO girder superstructure and drilled shaft foundations to the existing bridges.
- Remove the east-side parapet of the bridges across the Agua Caliente Wash and Tanque Verde Creek and construct a new railing attached to the outside of the bridge decks in order to obtain a 5' sidewalk width.
- Water harvesting is recommended instead of extensive irrigation due to recent funding issues and dwindling water resources.
- A frontage road is recommended as the solution to consolidating access onto Houghton Road for the five residential parcels on the west side of Houghton Road north of 5th Street.
- Construction of a 20' open median is recommended between the new and existing bridges at the Agua Caliente Wash and Tanque Verde Creek in order to minimize bridge costs.
- 5' sidewalks are recommended for the Pima County segment of Houghton Road between Speedway Boulevard and Tanque Verde Road. Sidewalks north of Tanque Verde Road are not included. A 6' sidewalk is provided on the west side of Houghton Road south of Speedway Boulevard within the Tucson city limits.

- A variable width median is recommended for Houghton Road south of Speedway Boulevard to minimize alignment shifts for northbound Houghton Road traffic.
- The new bridge over the Tanque Verde Creek and the Houghton Road / Speedway Boulevard intersection are proposed to be constructed at the same time due to the close proximity of the bridge to Speedway Boulevard and the lane requirements of the north approach to Speedway Boulevard.
- The Speedway, Camino Seco to Houghton Road project will address some of the issues at Speedway Boulevard and Houghton Road intersection, but the majority of the intersection improvements will be done with the Houghton, Tanque Verde to Speedway Boulevard project.
- A Phase I Environmental Assessment study will be needed done for all parcels with ROW acquisition, prior to the construction, to determine suitable mitigation.

Project Funding and Cost

The overall estimated cost for the recommended improvements is $21,406,000 in 2008 dollars. This project is included in the current Pima Association of Governments (PAG) regional Transportation Improvement Program (TIP) and is to be funded through sales tax revenues collected by the Regional Transportation Authority (RTA).

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY i
TABLE OF CONTENTS vi
1.0 PROJECT OVERVIEW 1
1.1 Project Location 2
2.0 PROJECT DESCRIPTION 4
3.0 PROJECT AREA CHARACTERISTICS 7
3.1 Topography and Terrain 7
3.2 Existing Roadway 7
3.3 Other Roadway Features 10
3.4 Existing Right-of-Way 11
3.5 Existing Drainage 12
3.6 Structures 16
3.7 Signalization and Lighting 16
3.8 Biological Resources 16
3.8.1 Vegetation 17
3.8.2 Wildlife 18
3.8.3 Special Status Species 19
3.8.4 Critical Habitat 23
3.8.5 Wildlife Crossings 24
3.9 Existing Utilities 24
3.10 Land Use, Zoning, and Planned Development 31
3.10.1 Current Zoning 31
3.10.2 Potentially Affected Community Facilities 35
3.11 Future land Use 35
3.12 Archaeological Resources 35
4.0 TRAFFIC AND CRASH DATA 37
4.1 Traffic Volumes from PAG Traffic Volume Maps 37
4.2 Capacity Analysis 37
4.3 Existing Traffic Conditions and Operations 38
4.4 Crash History 40
4.5 Future Traffic Conditions 42
4.6 Future Traffic Projections 42
4.7 Future Traffic Operations 44

4.7.1 Future Intersection Capacity 44
4.7.2 Future Roadway Segment Capacity 47
4.8 Intersection Design 47
4.9 Median Openings and Access Control 49
4.10 Right-Turn Deceleration Lanes 53
4.11 Traffic Signals 53
4.12 Turn-Bay Storage 53
4.13 Transit, Pedestrians and Bicycles 54
4.14 Lighting and ITS 55
4.15 Traffic Engineering Report Conclusions and Recommendations 56
5.0 Design Standards and Criteria 58
5.1 Geometric Standards 58
5.2 Pavement Structure 59
5.3 Other Geotechnical Considerations 60
5.4 Design Speed 62
5.5 Drainage Design 62
5.5.1 Design Criteria for Drainage 63
5.6 Access Control 64
5.7 Roadway Typical Section 64
5.7.1 Pedestrian/Bike Facilities 66
5.8 Roadway Geometrics 66
5.9 Right-of-Way 69
6.0 Major Design Features 70
6.1 Horizontal and Vertical Alignment 70
6.2 Access Control 70
6.3 Right-of-Way 71
6.4 Drainage 76
6.4.1 On-site Drainage 77
6.4.2 Off-site Drainage 77
6.5 Earthwork Considerations 80
6.6 Intersections and Driveways 81
6.7 Utilities 83
6.8 Structures 89
6.9 Landscaping 90
6.10 Construction Sequencing 91
6.11 Jurisdictional Delineation 92

7.0 Social, Economic, and Environmental Considerations 93
7.1 Biological Resources 93
7.1.1 Protected Native Plants 93
7.1.2 Wildlife 93
7.1.3 Special Status Species 93
7.2 Air Quality 94
7.3 Noise 96
7.4 Hazardous Materials 96
7.5 Visual/Aesthetic Resources 97
7.6 Cultural Resources 101
7.7 Neighborhood Impact 101
7.8 Community Resource Impact 102
8.0 Public Involvement 103
8.1 Public Involvement Process 103
8.2 Project Website 103
8.3 Public Open Houses 103
8.4 Small Meetings 105
8.5 Citizen Design Review Committee (CDRC) 106
9.0 Agency Coordination 107
10.0 Alternatives 108
10.1 West side of Houghton Road between 5th Street and Speedway Boulevard 108
10.2 Alignment and Typical Section crossing the Washes 110
10.3 Northbound alignment between Packard Street and Speedway Boulevard 114
11.0 Conclusions and Recommendations 117
12.0 Cost Estimate 122
13.0 Budget Considerations 123

Appendix A Preliminary Engineers' Construction Cost Estimate
Appendix B Utility Contact List
Appendix C Bridge Technical Memorandum
Appendix D Design Recommendations for Wildlife Crossings
Appendix E Alternatives on Houghton Road north of 5th Street

LIST OF TABLES

Table 1 - Existing Vertical Curves 10
Table 2 - Existing Right-of-Way Widths 12
Table 3 - Existing Drainage Crossings 13
Table 4 - TSMS Hydrologic Summary 14
Table 5– Special Status Species Potentially Occurring in the Project Area 20
Table 6 - Existing Utilities within the Project Limits 24
Table 7 - Water Services from Houghton Water Main 28
Table 8 - Zoning Acreage in Vicinity of Project 32
Table 9- Average Daily Traffic 2000, 2005, 2007 37
Table 10 - Level of Service 38
Table 11 - Existing Crash Data Summary 41
Table 12 - Future Traffic Projections 43
Table 13 - Intersection Capacity Analysis Summary 46
Table 14 – Proposed Access Summary 52
Table 15 - Turn-Lane Storage Requirements 54
Table 16 - Required Flexible Pavement Parameters 59
Table 17 - Recommended Pavement Alternatives 60
Table 18 - Roadway Design Criteria 69
Table 19 - Proposed Right-of-Way Acquisition 75
Table 20 - Proposed Slope Easements 75
Table 21 - Proposed Drainage Easements 76
Table 22 - Summary of Proposed Drainage Improvements 80
Table 23 - Existing Project Intersections 82
Table 24 - Utilities Along Houghton Road 83
Table 25 - Possible Hazardous Materials Site 96
Table 26 - Estimated Construction Cost, 2009 Dollars 122

LIST OF FIGURES

Figure 1 - Location Map 3
Figure 2 - Existing Houghton Rd between Tanque Verde Rd and Speedway Blvd 8
Figure 3 - TSMS Node Location from Preliminary Drainage Report 15
Figure 4 - Existing Utilities 30
Figure 5 - Existing Land Uses 33
Figure 6 - Existing Zoning 34
Figure 7 - Existing Traffic Conditions at the Signalized Intersections 39
Figure 8 - Future Traffic Conditions 47
Figure 9 - Proposed Lane Configurations 48
Figure 10 – Existing and Proposed Access Locations 51
Figure 11 - Proposed 4-lane and 6-Lane Typical Section 68
Figure 12 - Proposed ROW Impacts 74
Figure 13 - Proposed Divided Urban Pathway 91
Figure 14 - Proposed Public Art Opportunities 100
Figure 15 - Houghton Road Website 104

1.0 PROJECT OVERVIEW

The Regional Transportation Authority (RTA) plan, approved by voters in May 2006, included the widening of Houghton Road with the addition of pedestrian and bicycle facilities from Tanque Verde Road to Interstate 10 (I-10), a distance of approximately 13 miles. In order to facilitate the improvement evaluation of the roadway, the City of Tucson Department of Transportation (TDOT) divided Houghton Road into three segments and selected different consultants for each segment. Parsons Brinckerhoff (PB) was selected as the consultant for the segment from Speedway Boulevard to 22nd Street. The other two segments (from south of 22nd Street to Valencia Road and from Valencia Road to I-10) are being developed concurrently by two other consultants. Pima County has requested TDOT to extend the project limits of the Houghton Road, Speedway Boulevard to 22nd Street project north approximately one mile to the Tanque Verde Road intersection. With the extension, the project limits begin north of the Tanque Verde Road intersection and end south of the Speedway Boulevard intersection, near 5th Street, for a total segment length of approximately 2 miles.

The Arizona Department of Transportation completed a Houghton Road Corridor Study in October 2004 that identified improvements to Houghton Road from the northern project limit at Tanque Verde, south 13 miles to I-10. The segment of Houghton Road from Tanque Verde Road to Interstate 10 was included as one of the major improvement projects in the Regional Transportation Authority (RTA) funding passed by Pima County voters in May of 2006. The addition of the segment to Tanque Verde Road will have the entire length of the ADOT corridor study progressing through the design concept report phase.

This Design Concept Report (DCR) was developed in accordance with the scoping meetings and discussions held with TDOT. The design of the segment of Houghton Road from 5th Street, south of Speedway Boulevard, southward to 22nd Street has been evaluated and summarized in a separate DCR.

The outline of work on Houghton Road from Tanque Verde Road to Speedway Boulevard includes the following main tasks:

1. Design concept for a four-lane divided arterial roadway section with alternatives for incorporating the existing bridges over the Agua Caliente Wash and Tanque Verde Creek.
2. Design recommendations for the existing signalized intersections at Houghton Road/Speedway Boulevard and Houghton Road/Tanque Verde Road.
3. Identify proposed right-of-way needs to accommodate the roadway section.
4. Evaluate existing hydrology at the Agua Caliente Wash and Tanque Verde Creek.
5. Provide hydraulic analysis and drainage design for the Houghton Road roadway improvements including the proposed bridges at the Agua Caliente Wash and Tanque Verde Creek.
6. Identify utility conflicts, and develop mitigation concepts.
7. Prepare a design concept for continuation of pedestrian access along east side of Houghton Road.
8. Provide a phasing plan for final design and construction of the improvements identified in this phase, to better match the funding availability for the corridor.
9. Coordinate with the Tanque Verde Road project, west of Houghton Road, that is under design by Pima County from Catalina Highway to Houghton Road.

1.1 Project Location

The project is located near the eastern Tucson City limits and begins north of Tanque Verde Road and extends south of Speedway Boulevard for an approximate length of 2 miles. Figure 1 shows the project location.

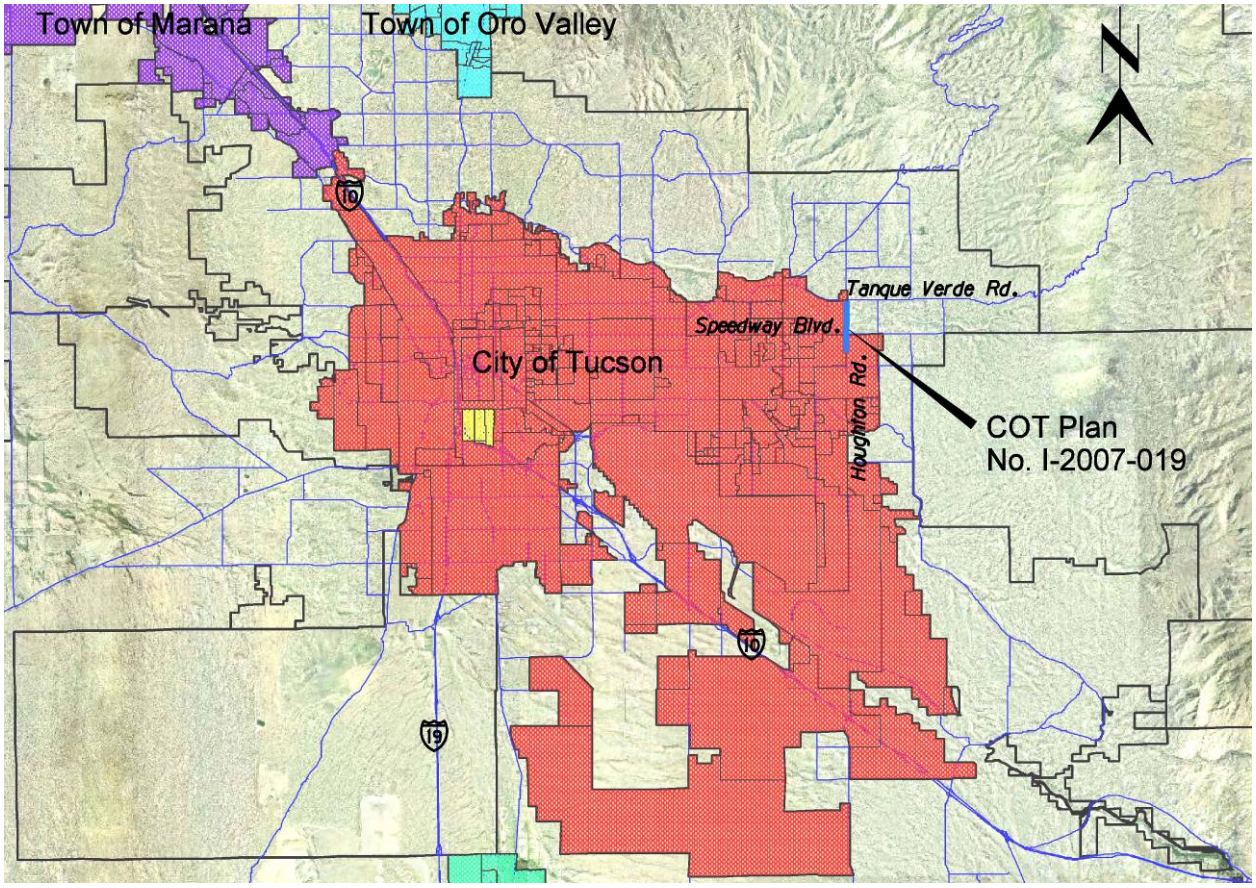


Figure 1 - Location Map

2.0 PROJECT DESCRIPTION

The purpose of this City of Tucson improvement project is to improve traffic operations along Houghton Road between Tanque Verde Road and Speedway Boulevard within the constraints of available funding.

Houghton Road from Tanque Verde Road to Speedway Boulevard had been designed in the late 1980's and constructed in the early 1990's under the Pima County Department of Transportation and Flood Control District project: Houghton Road Speedway Boulevard to Tanque Verde Road, Project No. W.O. 4BHTVC. That project constructed half of an "ultimate" four lane divided arterial roadway by shifting the alignment of Houghton Road to the east and building a new two lane roadway and new bridges over the Tanque Verde Creek and Agua Caliente Wash. The existing Houghton Road roadway with dip section across these two drainages was demolished. Typical sections, roadway plans, and bridge plans from the project all show an ultimate roadway centerline with the intent that the future two additional lanes would be constructed to the west and parallel to the new roadway. Right-of-way was purchased to construct the two lane roadway and the existing right-of-way to the west was retained. The design speed was listed as 55 mph and the design vehicle was selected to be a WB-50.

The City of Tucson Houghton Road project segment from Tanque Verde Road to Speedway Boulevard will use the existing two lane roadway as the northbound lanes of a four lane divided roadway. Two new lanes will be constructed west of the existing roadway alignment. Additional bridges across the Agua Caliente Wash and Tanque Verde Creek will be designed for the new lanes. The alignment and profile of the new southbound lanes will closely match the existing lanes with a median between the existing and new lanes. Houghton Road currently has 8' shoulders between Tanque Verde and Speedway Boulevard that serve as bike lanes. The new roadway will have an outside shoulder that can also serve as a bike lane. Since the existing roadway is uncurbed, the roadway section for the new lanes will also be uncurbed.

A sidewalk will be evaluated for inclusion on the outside of the new lane construction and the existing roadway will be reviewed to determine if sidewalks or a multiuse path can be accommodated outside and east of the existing Houghton Road roadway.

Drainage improvements, besides considerations of additional bridges across the Agua Caliente Wash and Tanque Verde Creek, will consist of improvements to existing culverts such as those in the vicinity of Tanque Verde Road, bank protection along both the existing and new roadways, and evaluation of median drainage. For this report, only the off-site drainage facilities are evaluated. Any closed system that may need to be evaluated will be developed only to the level to provide cost estimates.

At the intersection of Houghton Road and Tanque Verde Road, the roadway approaches will be improved with turn lanes. Pima County currently has a Tanque Verde Road, Catalina Highway to Houghton Road project that will end just to the west of Houghton Road. The intersection of Tanque Verde and Houghton Road will not be included in that project. For the City's Houghton Road, Tanque Verde Road to Speedway Boulevard project, exclusive single lane left turn lanes are planned for the intersection. An eastbound Tanque Verde Road to southbound Houghton Road exclusive right turn lane will also be reviewed. For northbound Houghton Road, a right turn lane drop will be included due to only one lane of thru traffic being carried through the intersection.

At the intersection of Houghton Road and Speedway Boulevard, the improvements will match those currently under design for the City of Tucson Speedway Boulevard: Camino Seco to Houghton Road project. That project ends just west of the Houghton Road/Speedway Boulevard intersection. For northbound Houghton Road, dual left turns will be included as will a right turn lane drop due to only two lanes of thru traffic being carried through the intersection. The east approach or westbound Speedway Boulevard will have minor impacts from this project with the northeast and southeast curb returns tying into the roadway edges proposed by the Speedway Boulevard: Camino Seco to Houghton Road project. Southbound Houghton Road will have only a

single left turn since Speedway Boulevard east of Houghton Road will only have one lane of traffic from the intersection.

The existing access to Houghton Road will be maintained with modifications being required for those impacted on the west side of Houghton Road due to the new travel lanes. Access across the median will be evaluated to determine if median openings and exclusive turn lanes are needed to facilitate left turns and U-turns. Aside from these locations, right-in and right-out will be the primary traffic movement from access points along Houghton Road.

The project will also require utility relocations. There are underground utilities west of the existing bridge over the Tanque Verde Creek that may be impacted by construction of the drilled shafts and piers for the new bridge. There are high-voltage overhead power lines from south of Speedway along the east side of Houghton Road. At the Speedway intersection, a large transmission pole on the southeast corner of the intersection will need to be relocated. South of Speedway Boulevard, a storm drain system may conflict with several utilities that run beneath the existing roadway.

The existing marked crosswalks at both the Tanque Verde Road and Speedway Boulevard intersections will be maintained. Other project improvements include landscaping and identification of art locations.

The currently posted speed of 45 miles per hour (mph) will be maintained throughout the project. The design speed will be 50 miles per hour.

Right of way impacts for the segment of Houghton Road from Tanque Verde Road to Speedway Boulevard will primarily be at both the Tanque Verde Road and Speedway Boulevard intersections as well as along Houghton Road south of Speedway Boulevard. Between Tanque Verde Road and Speedway Boulevard, widening of Houghton Road will be along the west side of Houghton Road where the existing ROW width is anticipated to be sufficient for two more travel lanes.

3.0 PROJECT AREA CHARACTERISTICS

3.1 Topography and Terrain

The project is located in the Tanque Verde Creek and Agua Caliente Wash drainage areas and the existing alignment crosses both washes between Speedway Boulevard and Tanque Verde Road. The roadway generally follows the terrain sloping downward toward each of the washes, but then rises up above the existing terrain as bridges cross over each of the drainages. From the north, the roadway leaves Tanque Verde Road at an elevation of approximately 2598 feet and slopes downward a foot or so then rises up over the Agua Caliente Wash bridge which is at an elevation of approximately 2604 feet. The wash itself is at an elevation of approximately 2585 feet. From the Agua Caliente Wash bridge the roadway continues to rise slightly to a high point of approximately 2605 feet between the two washes, then slopes downward to a low point of approximately 2584 feet after which it rises and crosses the Tanque Verde Creek on a bridge at an elevation of approximately 2588 feet. The creek below the bridge is at an elevation of approximately 2570 feet. South of Tanque Verde Creek the roadway slopes downward off the bridge to a low point of approximately 2580 feet at Speedway Boulevard, which is also the project low point. South of Speedway Boulevard the roadway rises 125 feet to the point where this project ends at approximately elevation 2705 feet.

3.2 Existing Roadway

Houghton Road is classified as a Major-Arterial-Roadway according to the City of Tucson Functional Classification, and is designated as a Scenic Route in the City of Tucson Major Streets and Routes plan. This segment of the Houghton Road Corridor is not part of the 1986 State Route designation and not part of the National Highway System (NHS), as is the case for Houghton Road south of Golf Links Road. The existing Houghton Road typical section south of Speedway Boulevard consists of a three lane roadway with two 12 foot travel lanes, one in each direction, and a center turn lane. Paved shoulders are approximately 8’ wide.

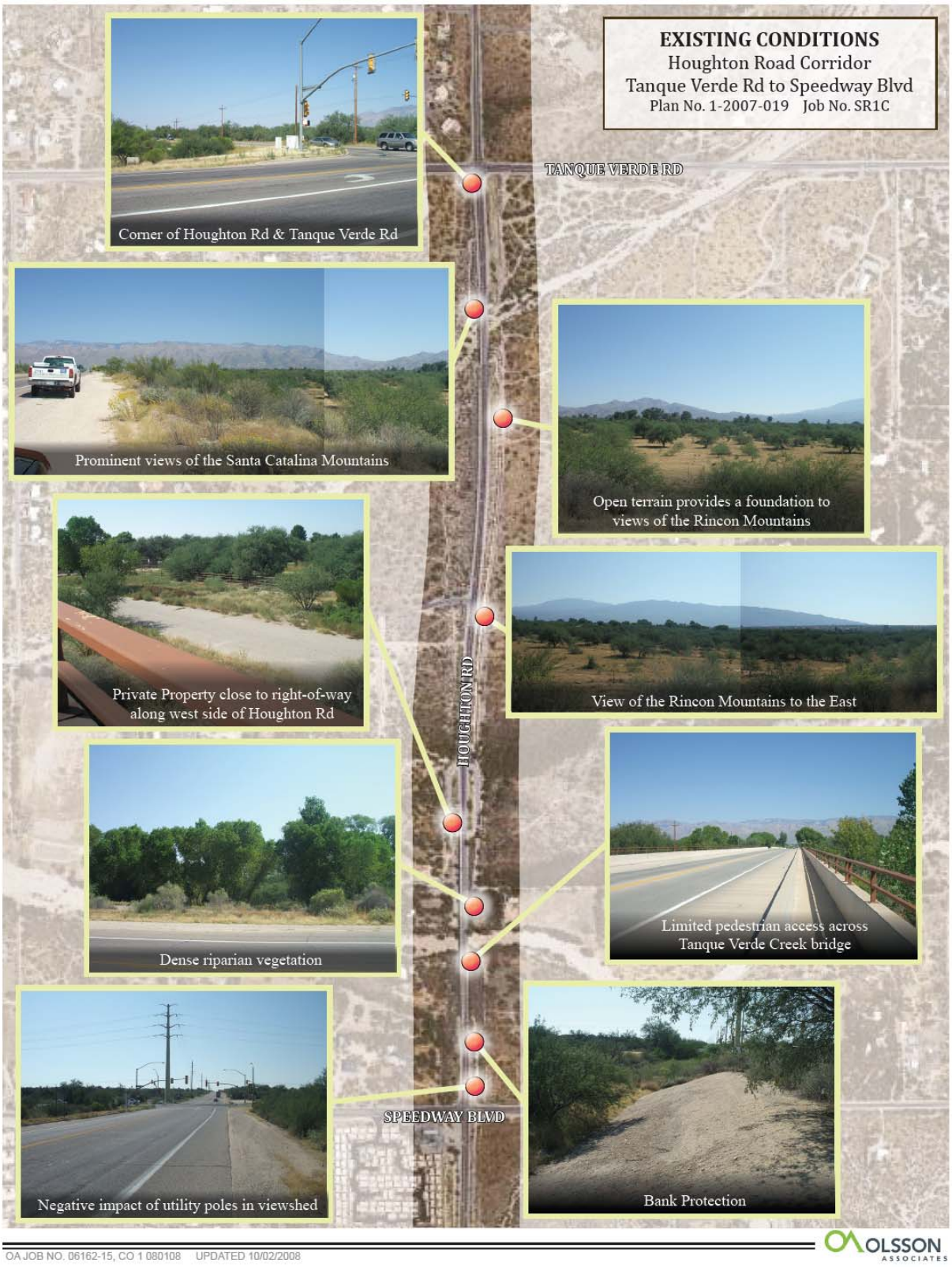


Figure 2 - Existing Houghton Rd between Tanque Verde Rd and Speedway Blvd

Between Tanque Verde Road and Speedway Boulevard, Houghton Road consists of an uncurbed two lane roadway with 12 foot travel lanes and 8' paved shoulders. Figure 2 shows images along Houghton Road between Tanque Verde Road and Speedway Boulevard. Superelevation is 2% down to the east from the west edge of the southbound travel lane. The alignment of Houghton Road is centered on the section line south of Speedway Boulevard. North of Speedway Boulevard the alignment initially follows close to the section line to north of the Tanque Verde Creek crossing. North of Tanque Verde Creek the alignment shifts approximately 150 feet to the east of the section line through a pair of reverse curves with radii greater than 6000'. This shift aligns the roadway with that north of Tanque Verde Road since the section lines north and south of Tanque Verde Road are offset. Additionally, driveways parallel Houghton Road north of the Tanque Verde Creek crossing and tie into Houghton Road at right angles.

The existing Houghton Road vertical profile generally follows the existing terrain within the project limits. Using the digital terrain model (DTM) provided, the existing profile was created by fitting curves and tangent sections along the construction line. A continuous existing profile containing 7 vertical curves was examined. A comparison to the minimum stopping sight distance requirements in the 2004 *Policy on Geometric Design of Highways and Streets* (AASHTO – 'Green Book') was investigated. The design speed used was 50-mph allowing for a posted speed of 45-mph. It was determined from the as-built that none of the existing vertical sag or crest curves were sub-standard. Also, the existing curves were not out of compliance with the Pima County roadway design standards based on minimum stopping sight distance and design speed requirements. In addition, from the fitted existing profile from flown digital terrain model, the tangent grade sections located between Sta 78+50 to Sta 89+00 is 0.4457% and Sta 50+20 to Sta 60+00 is 0.2806%. These are below a minimum 0.5% that is generally considered for longitudinal grades for PC/COT design standards.

The findings indicate some existing roadway alignment deficiencies and it is recommended that new profiles for the Houghton Road project be designed to meet all applicable standards and AASHTO guidelines.

A summary of the existing vertical curves is found in Table 1 as follows with the grades below the minimum 0.5% highlighted.

Table 1 - Existing Vertical Curves

Curve No.	Station VPI	Type	g1(%)	g2(%)	Length (FT)	SSD Avail. (FT)	SSD Min. (FT)	Design Speed Avail. (MPH)	Design Speed Min. (MPH)
1	46+70	Sag	-0.7433	2.1286	350	626	439	62	50
2	50+20	Crest	2.1286	0.2806	350	759	439	70	50
3	60+00	Crest	0.2806	-2.0875	600	756	439	70	50
4	68+00	Sag	-2.0875	-0.5314	400	+9999	439	+100	50
5	78+50	Sag	-0.5314	0.4457	200	+9999	427	+100	50
6	89+00	Crest	0.4457	-0.8230	250	975	429	83	50
7	99+00	Sag	-08230	3.9305	700	612	454	60	50
8	113+00	Crest	3.9305	3.3357	300	1964	454	+100	50
9	127+00	Crest	3.3357	2.5698	300	1559	449	+100	50

Note: SDD = Stopping Sight Distance (AASHTO minimum)

3.3 Other Roadway Features

The existing Houghton Road has limited roadway features within the project limits besides the two bridges located at the Agua Caliente Wash and the Tanque Verde Creek. There are no curbs or sidewalks. Bicyclists use the 8' wide shoulders. There is no street lighting, except that provided above the two signalized intersections. There is also some limited landscaping adjacent to newer development, south of Speedway Boulevard, but no consistent or continuous landscaping along the majority of the project.

There are no facilities for transit along Houghton Road as there are currently no SunTran bus routes serving Houghton Road. However, as part of the RTA Plan and funding approved by the voters in May of 2006, new fixed-route bus service will be provided along Houghton Road from Speedway south to Rita Road.

3.4 Existing Right-of-Way

The existing ROW width along Houghton Road within the project limits varies considerably from 115 feet to nearly 375 feet. The current ROW along Houghton Road between Tanque Verde Road and Speedway Boulevard was established as part of the Pima County Houghton Road project 4BHTVC. The existing western ROW line was retained and new ROW acquired to the east resulting in the current ROW corridor. The present Houghton Road roadway lies on the eastern portion of the available existing ROW width.

South of Speedway Boulevard, the ROW was established under Proceedings No. 829 in December 1954 with an 80-foot ROW, 40 feet each side of the section lines. In intervening years, the ROW has been widened along that section as the adjacent land has been developed. Immediately south of Speedway Boulevard the existing ROW is at least 200', 100' each side of the section line. Further south the ROW changes at various locations and near 5th Street it is approximately 115 feet. See Table 2 for details.

The ultimate ROW called for in the current Major Streets and Routes Plan (MS&R) is 200 feet, 100 feet each side of the section lines, although some of the property along the segment south of Speedway Boulevard was developed when the MS&R called for only 150 feet of ROW, 75 feet on each side of the section line.

Table 2 - Existing Right-of-Way Widths
Houghton Road, Tanque Verde Road to 5th Street

Location (from section line)	Length ft	East Side ft	West Side ft
North of Flintlock Trail (Sta 27+85)	---	75	30
Flintlock Trail to Desert Flower Pl.	235	75	75
Desert Flower Pl. to south Shady Rock Ln.	550	30	75
Shady Rock Ln to Tanque Verde Rd	770	45	75
Tanque Verde Rd to Sta 63+52, (Location from existing roadway centerline)	2015	Varies 147-300	75
Sta 63+52 to 1/2 mile north of Speedway	1565	Varies 155-300	75
1/2 mile north of Speedway to Sta 82+98	385	Varies 171-185	120
Sta 82+98 to Sta 86+69	370	Varies 160-171	100
Sta 86+69 to 500' north of Speedway Blvd.	780	Varies 152-160	Varies 45-100
North of Speedway Blvd. to Speedway Blvd.	500	152	127
Speedway Blvd. to 600' south	600	100	100
600' south Speedway Blvd to Windstorm Dr.	1230	Varies 100-109	100
Windstorm Dr. to 5th Street	705	100	75
From 5th Street southbound	---	40	100

3.5 Existing Drainage

The existing drainage patterns along Houghton Road from Tanque Verde Road to 5th Street typically parallels Houghton Road. Drainage has been identified as either major or minor drainage. The minor drainages are located north of Tanque Verde Road and south of Speedway Blvd. The major drainages are located between the two minor drainage regions and consist of the Agua Caliente Wash located just south of Tanque Verde Road and the Tanque Verde Creek just north of Speedway Blvd. A summary of the existing drainage facilities within the project limits is provided as Table 3.

Table 3 - Existing Drainage Crossings

CP	Location	Structure/New Work
TV-A	Tanque Verde Rd. & Houghton Road Intersection, West Side	2-36"x100' CMP / Extend US & DS
TV-B	Tanque Verde Rd. & Houghton Road Intersection, East Side	3-8'x4'x89' RCBC/Extend US & DS
Agua Caliente Wash	Houghton Road South of Tanque Verde Road	Bridge/New Parallel Bridge West Side
Tanque Verde Creek	Houghton Road North of Speedway Blvd.	Bridge/New Parallel Bridge West Side
B	Speedway Blvd. & Houghton Road Intersection, East Side	2-36"x132' RCP & CB/Reconstruct CB & Remove Exist Channel Lining
C0	Speedway Blvd. & Houghton Road Intersection, West Side	1-10'x4'x172' RCBC & CB/Reconstruct CB
C2	West Side Houghton Road @ OK Driveway	4-36"x57' RCP/Remove & Replace with New 48" Stormdrain
C5	West Side Houghton Road @ Packard Street	3-24"x53' RCP/Remove & Replace with New 36" Stormdrain
A	East Side Houghton Road @ Windstorm Drive	4-24"x83' RCP/Replace with CB and Stormdrain

Minor Drainage

North of Tanque Verde Road, runoff is collected in two cross drainage structures on each side of Houghton Road. These structures direct runoff toward the Agua Caliente Wash, south of Tanque Verde Road. South of Speedway Blvd. Concrete roadside channels carry runoff towards Speedway Blvd where it is conveyed through culverts under Speedway Blvd to the Tanque Verde Creek.

Hydrologic analysis provided design flow rates for the minor drainages. The mapping used in the analysis was the project aerial survey, flown specifically for this project, and 1998 2-foot contour mapping provided through the Pima Association of Governments (PAG). Aerial photographs from both sources were combined along with the project topographic mapping for the analyses. There are Tucson Stormwater Management Study (TSMS) nodes within the project limits; however, these nodes are not impacted

by the proposed improvements. Figure 3 is provided to show the locations of the TSMS nodes. Table 4 provides a summary of flow rates associated with the minor drainages.

Table 4 - TSMS Hydrologic Summary

TSMS NODE	Description	10-YEAR DISCHARGE (ft^3/sec)	100- YEAR DISCHARGE (ft^3/sec)
MC-N0090	Reyes Wash Watershed, Upstream of Speedway Blvd.	192	480
MC-N0100	Reyes Wash Watershed, Upstream of Speedway Blvd.	146	370
MC-N0120	Reyes Wash Watershed, Confluence @ Speedway Blvd.	616	1584
MG-N0170 (Este)	Este Wash Watershed. Coronado Ridge Wash Downstream of Houghton Road	338	892
MG-N0175 (Este)	Este Wash Watershed, Coronado Ridge Wash Downstream of 5th Street	--	951

Major Drainage

The Agua Caliente Wash and Tanque Verde Creek are two major FEMA regulated washes are located in the region between Tanque Verde Road and Speedway Blvd. Both of these major drainages convey runoff under existing bridges on Houghton Road. FEMA 100-Year flow rates just upstream of Houghton Road are 10,500-ft^3/sec and 23,000-ft^3/sec for the Agua Caliente Wash and Tanque Verde Creek, respectively.

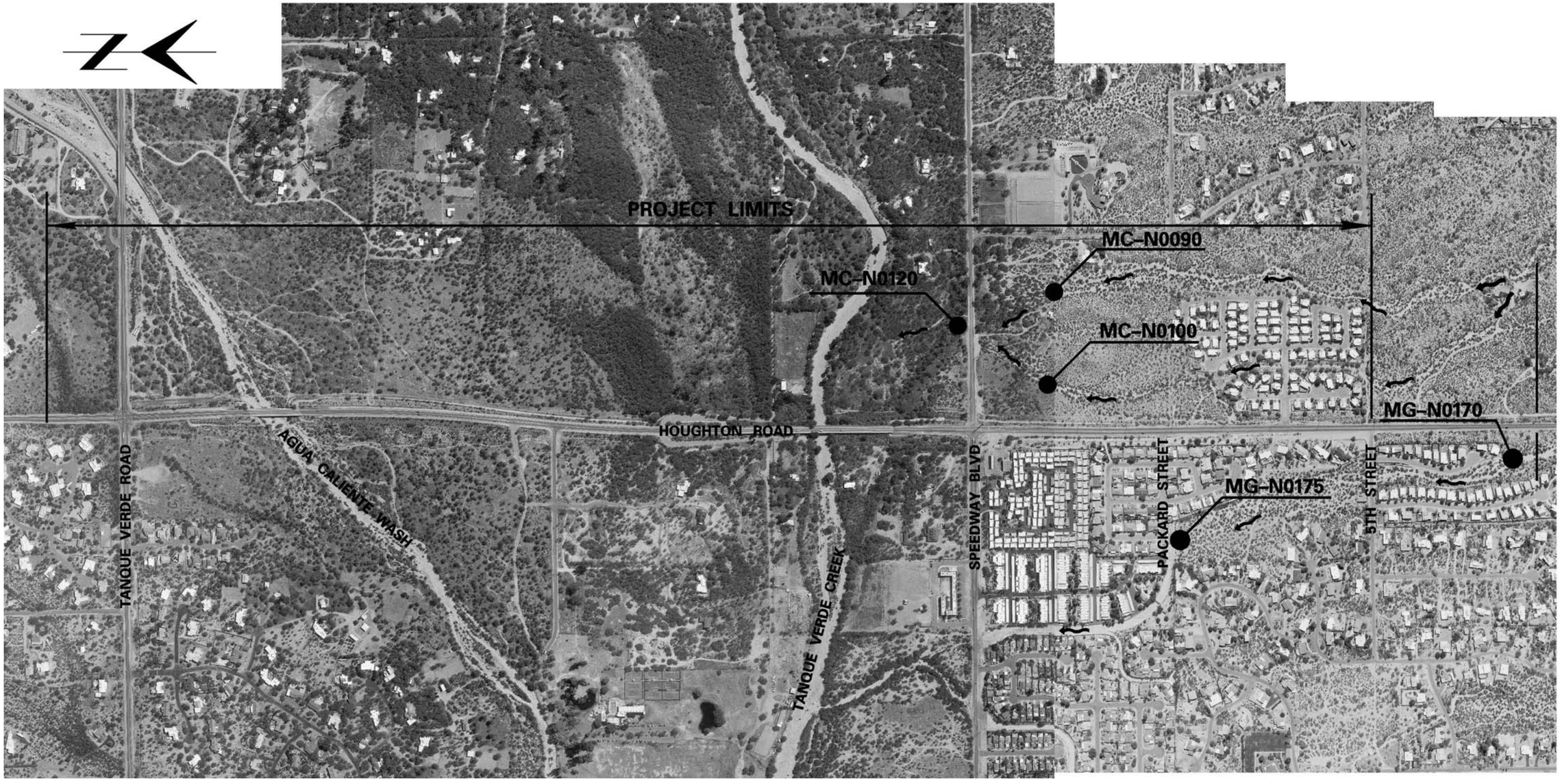


Figure 3 - TSMS Node Location from Preliminary Drainage Report

3.6 Structures

There are currently two bridges located within the limits of this Houghton Road segment. It will be necessary to construct additional bridges to the west for the proposed roadway cross-section. The first existing bridge structure spans Agua Caliente Wash along Houghton Road. This structure is 50 feet wide with a 42 foot clear width on a 31 degree left skew. It consists of three cast-in-place spans for a length of 300 feet over prestressed concrete girders. The second existing bridge structure spans Tanque Verde Creek along Houghton Road. This structure is also 50 feet wide with a 42 foot clear width, but without any skew. It consists of eleven cast-in-place spans for a length of 1,100 feet over prestressed concrete girders. Also, each structure contains a 4 foot wide pedestrian walkway located along the east side of the deck. In addition, reinforced concrete boxes and culvert pipes will be installed at other existing drainage crossings along this roadway segment.

3.7 Signalization and Lighting

Within the project limits, Houghton Road is signalized at its intersection with crossing arterial roadways located at Tanque Verde Road and Speedway Boulevard. These signals all have left turn arrows and there is street lighting at the intersections.

3.8 Biological Resources

The purpose of this section is to identify the range of biological resources within the project area so that these resources can be considered during the process of alternative selection. This biological resource overview documents the ecological setting within the project area and identifies the plant and animal species, including special status species that are likely to occur within the planning area.

The project area encompasses approximately 24 acres over a length of approximately 1 mile and a roadway corridor width of approximately 200 feet, and is located along the

existing Houghton Road alignment between Tanque Verde Road and Speedway Boulevard within the City of Tucson, Pima County, Arizona. The legal description of the project area includes portions of Sections 1 and 2, Township 14 South, Range 15 East (Gila and Salt River Baseline and Meridian).

A biological reconnaissance survey was conducted in January 2009. The reconnaissance survey consisted of an overview assessment of the area to evaluate ecological context and the distribution of wildlife habitats.

3.8.1 Vegetation

The greater project vicinity occurs within the Arizona Upland subdivision of the Sonoran Desertscrub biome (Turner and Brown 1994), which is characterized by high temperatures and generally low precipitation. The project area ranges in elevation from 2,570–2,590 above mean sea level (amsl) and includes two major ephemeral drainages, Tanque Verde Creek and Agua Caliente Wash. Vegetation within the project area is characterized by these two drainages and their floodplains. Historically, the project area was entirely within the floodplains of these drainages; bank protection and road construction projects have ultimately altered the natural flow of water across this section of landscape. This is evident in some areas west of Houghton Road that no longer receive the overland flows associated with a floodplain and the vegetation is trending to include more upland species. Vegetation associations within the project area include Sonoran riparian scrubland and Sonoran riparian deciduous forest and woodlands as described below.

Sonoran riparian scrubland: The Sonoran riparian scrubland community is represented in the project area by a complex of xeroriparian shrub and tree species that occur within the floodplains of major washes and line the banks of smaller washes in the project area. Xeroriparian species are those species supported by intermittent or ephemeral stream flows that increase the amount of water available to the plants beyond that available by direct rainfall. Xeroriparian habitats commonly contain the same plant

communities as the adjacent upland vegetation, but have larger plants and denser growth due to the availability of water. This xeroriparian vegetation provides an element of vertical structure for birds attracted to dense thickets and high perches. Within the project area this community was represented by mesquite (*Prosopis velutina*) trees, acacia (*Acacia constricta* and *A. greggii*) trees, shrubs, desert broom (*Baccharis sarothroides*), burrobrush (*Hymenoclea sarothroides*), desert hackberry (*Celtis pallida*), and triangle-leaf bursage (*Ambrosia deltoidea*).

Sonoran riparian deciduous forest and woodlands: Sonoran riparian deciduous forest and woodlands are streamside associations of sub-tropic species that include cottonwood (*Populus fremontii*), willow (*Salix gooddingii*), and mesquite. Within the project area these plant species are found along the banks of Tanque Verde Creek, north of Speedway Boulevard.

3.8.2 Wildlife

The project area consists of primarily undeveloped lands along an existing transportation corridor. Wildlife that is likely to occur in the project area includes small mammals, reptiles, amphibians, and birds. Medium-sized mammal species such as javelina (*Tayassu tajacu*) or coyote (*Canis latrans*) may forage in the project vicinity and move through the project area. The lack of permanent water sources precludes the presence of many species associated with aquatic or wet riparian habitats; however, water may accumulate in depressions providing temporary aquatic habitat that may provide breeding sites for amphibians. Undeveloped lands within the project area have a higher habitat value for wildlife than lands associated with human development. The undeveloped areas, Aqua Caliente Wash, and Tanque Verde Creek allow for a moderate degree of wildlife movement, as well as connectivity among habitat areas used for foraging, cover, and reproduction.

Some additional wildlife species likely to be present in the study area include: birds such as cactus wren (*Campylorhynchus brunneicapillus*), curve-billed thrasher (*Toxostoma*

curvirostre), phainopepla (*Phainopepla nitens*), canyon towhee (*Pipilo fuscus*), Gila woodpecker (*Melanerpes uropygialis*), Gambel's quail (*Callipepla gambelii*), great-horned owl (*Bubo virginianus*), and red-tailed hawk (*Buteo jamaicensis*); mammals such as cactus mouse (*Peromyscus eremicus*), white-throated woodrat (*Neotoma albigula*), desert cottontail (*Sylvilagus audubonii*), black-tailed jackrabbit (*Lepus californicus*), javelina, and coyote; and reptiles such as side-blotched lizard (*Uta stansburiana*), whiptail lizards (*Aspidoscelis* spp.), zebra-tailed lizard (*Callisaurus draconoides*), and rattlesnakes (*Crotalus* spp.). Caves, abandoned mines, buildings, and bridges located in the greater project vicinity could provide roost sites for bats such as cave myotis (*Myotis velifer*), pallid bat (*Antrozous pallidus*), and Mexican free-tailed bat (*Tadarida brasiliensis mexicana*). If there are active roosts in the project vicinity, these and other bats would likely forage within the study area. The bridges over the Aqua Caliente Wash and Tanque Verde Creek should be surveyed for the presence of bats during the design phase. Food sources for bats in general, such as insects, are available throughout the project area, although limited potential roost sites (e.g., caves, abandoned buildings) are present. Two species of bats that are known to occur in southern Arizona feed primarily on the nectar and pollen of columnar plants such as saguaro cactus and agave; the lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*) and Mexican long-tongued bat (*Choeronycteris mexicana*). Although saguaros are present in the greater project vicinity, none are present within the project area.

3.8.3 Special Status Species

The term special status species in this report refers to species that are listed under the federal Endangered Species Act of 1973 (16 U.S.C. 1531–1544, as amended) with lead management by the US Fish and Wildlife Service, as well as species that are not protected under the Endangered Species Act but have been given special status designations by state or other federal agencies.

A list of threatened, endangered, proposed, candidate, and conservation agreement species for Pima County was obtained from the US Fish and Wildlife Service; the Arizona Game and Fish Department's On-line Environmental Review Tool was used to obtain a list of special status species that have been documented within three miles of the project area. The following table summarizes these species. A general description of the habitat requirements for each of these species is also provided, as well as an evaluation of the potential for each species to be present in the project area. Suitable habitats for one candidate species (Western yellow-billed cuckoo [*Coccyzus americanus*]), and one species listed as sensitive by the US Forest Service, the Bureau of Land Management, and salvage restricted by the Arizona Department of Agriculture (Tumamoc globeberry [*Tumamoca macdougalii*]) are present in the project area and identified by highlighting in the table below.

Table 5– Special Status Species Potentially Occurring in the Project Area

Species Name	Status[a]	Habitat Requirements	Habitat Present?
Plants			
Acuna cactus (*Echinomastus erectocentrus* var. *acunensis*)	ESA C	Restricted to well-drained knolls and gravel ridges between major washes in palo verde-saguaro associations in the Arizona Uplands subdivision of Sonoran desertscrub from 1,300 to 2,000 feet.	No suitable habitat present Outside species' elevation range
Gooddings onion (*Allium gooddingii*)	CA	Forested drainage bottoms and moist north facing slopes of mixed conifer and spruce fir above 7,500 feet.	No suitable habitat present Outside species' elevation range
Huachuca water umbel (*Lilaeopsis schaffneriana* ssp. *recurva*)	ESA LE	Cienegas, perennial low-gradient springs, and other wetlands from 3,500 to 6,500 feet.	No suitable habitat present Outside species' elevation range
Kearney blue star (*Amsonia kearneyana*)	ESA LE	West-facing drainages in the Baboquivari Mountains from 3,600 to 3,800 feet.	No suitable habitat present Outside species' range

Species Name	Status[a]	Habitat Requirements	Habitat Present?
Nichol Turk's head cactus (*Echinocactus horizonthalonius* var. *nicholii*)	ESA LE	Sonoran desertscrub on dissected alluvial fans at the foot of limestone mountains and on inclined terraces and saddles on limestone mountainsides from 2,400 to 4,100 feet.	No suitable habitat present Outside species' range; this species is restricted to the Vekol and Waterman Mountains
Pima pineapple cactus (*Coryphantha scheeri* var. *robustispina*)	ESA LE	Occurs in alluvial valleys or on hillsides in rocky to sandy or silty soils. Sonoran desertscrub or semidesert grassland communities; from 2,300 to 5,000 feet. In the Tucson area, rarely found north of I-10.	Species not known to occur in northeastern Tucson
Tumamoc globeberry (*Tumamoca macdougalii*)	USFS S BLM S SR	Along arroyos and sandy washes below 3,000 feet in desert grasslands, Sinaloan thornscrub, and Sonoran desertscrub.	Suitable habitat is present. Documented within 3 miles of the project area
Invertebrates			
San Xavier talussnail (*Sonorella eremita*)	CA	Deep, limestone rockslides with outcrops of limestone and decomposed granite from 3,850 to 3,920 feet.	No suitable habitat present Outside of elevation range
Fish			
Desert pupfish (*Cyprinodon macularius*)	ESA LE WSCA	Shallow waters of springs, small streams, and marshes below 5,000 feet. Tolerates saline and warm water. Currently known only from reintroduced populations.	No suitable habitat present
Gila chub (*Gila intermedia*)	ESA LE WSCA	Pools, springs, cienegas, and streams of the Gila River Basin from 2,000 to 5,500 feet.	No suitable habitat present
Gila topminnow (*Poeciliopsis occidentalis occidentalis*)	ESA LE WSCA	Small streams, springs, and cienegas in vegetated shallows below 4,500 feet.	No suitable habitat present
Reptiles and Amphibians			
Chiricahua leopard frog (*Lithobates [Rana] chiricahuensis*)	ESA LT WSCA	Streams, rivers, backwaters, ponds, or stock tanks in oak or pine woodlands, chaparral, or grasslands in montane regions of central and southeastern Arizona from 3,281 to 8,890 feet.	No suitable habitat present. Outside of elevation range.

Lowland leopard frog (*Rana yavapaiensis*)	USFS S WSCA	Habitat generalist occurring in aquatic habitats in desertscrub, grassland, and pine-oak woodland in central and extreme northwestern Arizona from 800 to 5,500 feet.	No aquatic habitats present in the project area Documented within 3 miles of the project area
Northern Mexican gartersnake (*Thamnophis eques megalops*)	USFS S WSCA	Densely vegetated habitat surrounding cienegas, stock tanks, permanent streams, marshes, and headwaters from 3,000 to 6,200 feet in central, south central, and southeastern Arizona.	No aquatic habitats present in the project area Documented within 3 miles of the project area
Sonoyta mud turtle (*Kinosternon sonoriense longifemorale*)	ESA C	Ponds and streams near 1,100 feet.	No suitable habitat present Outside species' elevation range

Birds

California brown pelican (*Pelecanus occidentalis californicus*)	ESA LE PDL	Transient to the lower Colorado River and large bodies of water in central Arizona at various elevations.	No suitable habitat present
Masked bobwhite (*Colinus virginianus ridgewayi*)	ESA LE WSCA	Desert grasslands with diversity of dense native grasses, forbs, and brush from 1,000 to 4,000 feet. Currently restricted to the Altar Valley.	No suitable habitat present. Outside of geographic range.
Mexican spotted owl (*Strix occidentalis lucida*)	ESA LT WSCA	Statewide in mature montane forest and woodland, old-growth mixed-conifer, and pine-oak forests on steep slopes and canyons from 4,100 to 9,000 feet.	No suitable habitat present
Southwestern willow flycatcher (*Empidonax traillii extimus*)	ESA LE WSCA	A riparian obligate species; cottonwood-willow and tamarisk vegetation communities along rivers and streams below 8,500 feet.	No suitable habitat present No permanent water present within Tanque Verde Creek
Yellow-billed cuckoo (*Coccyzus americanus*)	ESA C WSCA	Large blocks of riparian woodlands (cottonwood, willow, or tamarisk galleries) ; mainly nests below 5,000 feet in southeastern AZ.	Documented within 3 miles of the project area at Tanque Verde Creek

Mammals

Jaguar (*Panthera onca*)	ESA LE WSCA	A variety of habitats from Sonoran desertscrub up to subalpine fir forests, but are most often sighted in Madrean-Evergreen woodlands, shrub-invaded semidesert grasslands, and along river bottoms.	No suitable habitat present

Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*)	ESA LE WSCA	Desert grassland and scrubland up to oak transition areas when foraging on nectar or pollen of columnar cacti or agave below 6,000 feet. Roosts in caves, mines, tunnels, and occasionally old buildings.	No roosting habitat within the project area. No columnar cacti or agave within the project area. Documented within 3 miles of the project area.
Mexican long-tongued bat (*Choeronycteris mexicana*)	WSCA	Species is migratory; occur in the summer in mesic areas in canyons of mixed oak-conifer forests in mountains as far north as the Santa Catalina Mountains and as far west as the Baboquivari Mountains; most occurrences are between 4,000 and 6,000 feet; feeds on nectar, pollen, probably insects, and occasionally fruit of columnar cacti (these bats are not typically found in low desert situations). Roost in caves, mines, rock shelters, and sink holes.	No roosting habitat within project area. No columnar cacti within project area Documented within 3 miles of the project area.
Ocelot (*Leopardus* (=*Felis*) *pardalis*)	ESA LE WSCA	Humid tropical and subtropical forests, savannahs, and semiarid thornscrub below 8,000 feet.	No suitable habitat present
Sonoran pronghorn (*Antilocapra americana sonoriensis*)	ESA LE WSCA	Arizona Upland and Lower Colorado River Valley Sonoran desertscrub in broad alluvial valleys south of Interstate 8 from the western boundary of the Cabeza Prieta Wildlife Refuge east to State Route 85.	Outside species' range

Sources: US Fish and Wildlife Service list of threatened, endangered, proposed, candidate, and conservation agreement species potentially occurring in Pima County, <http://arizonaes.fws.gov/>, accessed January 2009.
Arizona Game and Fish Department On-line Environmental Review Tool Receipt No. 20090116007904

[a] Status Definitions: ESA=Endangered Species Act, C=Candidate, CA=Conservation Agreement, LE=Listed Endangered, PDL=Proposed Delisted, SR=Salvage Restricted, USFS=US Forest Service, S=Sensitive, BLM=US Bureau of Land Management LT=Listed Threatened, WSCA=Wildlife of Special Concern in Arizona (AGFD Draft 3/16/96)

3.8.4 Critical Habitat

Critical habitat that has been designated or proposed by the US Fish and Wildlife Service for the conservation of threatened and endangered species receives special legal protection under the Endangered Species Act. The project area does not include any designated or proposed critical habitat.

3.8.5 Wildlife Crossings

Logan Simpson Design, Inc. prepared a wildlife crossing design recommendation for the project. A copy of the report is included in the appendix. Two washes in the project area were identified (Tanque Verde Creek and Agua Caliente Wash) as potential wildlife crossings because they are the largest and most heavily vegetated within the project area. They are also protected under the City's environmental regulations, making them more appropriate locations for investment in wildlife crossing structures. Both washes provide highly critical wildlife linkages and function as primary movement corridors between large blocks of undeveloped lands. They both originate in the Coronado National Forest on the east side of the Tucson Basin and continue to the west, ultimately connecting to the Santa Cruz River and Tucson Mountains on the west side of the Basin. It is recommended that the bridge structures at these two washes are maintained so these washes can continue to function in this capacity.

3.9 Existing Utilities

There are numerous utilities along Houghton Road within the project limits as shown in Table 6 below. TBE Group, Inc. provided base utility mapping for PB on the project and had contacted these utilities to confirm the existence of their facilities within the project limits.

Table 6 - Existing Utilities within the Project Limits

Owner	Utility / Facility
Cox Communication	Fiber Optic / Coax Cable TV
Southwest Gas	Natural Gas
Tucson Electric Power	Electric
Tucson Water	Water, Reclaimed Water
Qwest	Underground Telephone
Pima County Regional Wastewater Reclamation Department	Sanitary Sewer
Pima County DOT	Traffic Signals

A discussion on individual utility facilities follows:

Fiber Optic – Cox Communications

Cox Communications has a fiber optic television line on the east side of Houghton Road from Tanque Verde Road to south of Speedway Boulevard. South of Speedway Boulevard, utility locating survey did not pick up a continuation of the line.

Cable – Cox Communication

Cox Communications has limited underground cable TV facilities in the project vicinity. The utility services many of the side streets and residences along the Houghton Road project segment. North of Tanque Verde Road, there is a crossing at Houghton Road from the west which joins a fiber optic television (FOTV) line on the east side.

Natural Gas – Southwest Gas

There are gas lines along the east and west sides of Houghton Road. A detailed location discussion follows:

North of Tanque Verde Road: A 2" polyethylene (PE) gas line crosses Houghton Road near Shady Rock Lane and runs south along the east side to Rancho del Este Drive.

Tanque Verde Road: A 4" and an 8" high pressure steel gas line runs approximately 33' north of Tanque Verde Road. The 4" steel gas line crosses Houghton Road and continues eastward. The 8" steel gas line crosses Tanque Verde Road approximately 90' west of Houghton Road where it continues to the south.

Between Tanque Verde Road and Speedway Blvd: North of the west frontage road at the Tanque Verde Creek, the 8" steel gas line crosses Houghton Road and continues southward along the east side. The 8" steel gas line runs southward east of the Tanque Verde Wash bridge to Speedway Boulevard. A 2" PE gas line parallels the west side of

the existing west frontage road and crosses Houghton Road beneath the Tanque Verde bridge to the east side where it turns south and parallels the 8" steel gas line.

Speedway Boulevard: The 8" steel and 2" PE gas line cross Speedway Boulevard from the north at approximately 150' east of Houghton Road where an 8" steel and a 4" PE continue southward. At the northeast corner of Speedway Boulevard, a 4" PE splits from the 8" steel gas line and runs to the east. Just south of the intersection, an 8" steel and a 4" PE gas line cross Houghton Road from the west where they both join the 8" steel and 4" PE on the east side and continue to the south on the east side.

Between Speedway Blvd and 5th Street: Utility locating survey was only able to document the 8" steel gas line along the east side of Houghton Road to 5th Street. The 4" PE was identified to approximately 700' south of Speedway Boulevard.

Electric – Tucson Electric Power (TEP)

All electric lines within the project limits are owned by Tucson Electric Power (TEP). For most of the project length, poles are located within the existing ROW. Between Speedway Boulevard and Broadway Boulevard, there are (9) poles outside the existing ROW with one being a very large metal pole on the southeast corner of the Speedway Boulevard intersection.

North of Tanque Verde Road: Overhead power lines run along the east side of Houghton Road from Flintlock Trail to Tanque Verde Road.

Tanque Verde Road: The overhead power lines run east and west along the north side of Tanque Verde Road. There is an overhead crossing located about 100' west of Houghton Road at Tanque Verde Road. Just south of Tanque Verde Road, the utility survey was not able to locate this line on the west side of Houghton Road.

Between Tanque Verde Road and Speedway Boulevard: There is an underground electric line beginning north of Speedway Boulevard to the west of Houghton Road at

the frontage road which continues south to the Tanque Verde Wash where it crosses Houghton Road to the east via overhead lines. Also, an overhead line begins 75' west of Houghton Road at the existing frontage road and continues to Speedway Boulevard.

Speedway Boulevard: At Speedway Boulevard, an overhead power line crosses Speedway Boulevard west of Houghton Road and joins with a line running east and west along the south side of Speedway Boulevard. The east-west overhead power lines connect to a tall, metal, transmission pole located on the southeast corner of the intersection, outside the existing ROW. There is an underground electric line beginning at the southwest corner of Speedway Boulevard which runs to the east of Houghton Road along the overhead line location.

Between Speedway Boulevard and 5th Street: At the transmission pole on the southeast corner of the Speedway Boulevard intersection, the overhead power lines run south along the east side of Houghton Road to 5th Street. There are overhead power line crossings at Houghton Road located just north and south of 5th Street. Four poles are outside the existing ROW, and five are within the existing ROW

Water – Tucson Water

A Tucson Water waterline travels along the west side of Houghton Road along the entire project length from Tanque Verde Road to 5th Street. From north of Flintlock Trail, a 12" asbestos cement pipe (ACP), heads south along the west side of Houghton Road and a 24" ductile iron (DI) water line runs east and west near the middle of Tanque Verde Road. The 12" (ACP) water main then runs south to Speedway Boulevard along the west side of Houghton Road. At Speedway Boulevard, a 24" concrete cylinder (CC) line and a 12"/16" (DI) reclaimed water (RW) line runs to the east, crossing Houghton Road. From Speedway Boulevard, the 12" (ACP) continues south at the west side of Houghton Road to 5th Street. Along its length, there are service connections to this line to service areas to both the east and west sides of Houghton Road. With regard to the existing water main lines, Table 7 lists the side service location (laterals) and the size of the lines.

Table 7 - Water Services from Houghton Water Main

Location	Size
Flintlock Trail	6" PVC
Desert Flower Place	6" PVC
Shady Rock Lane	6" PVC
Rancho del Este Dr.	6" PVC
North of Frontage Road	8" PVC
Frontage Road	8" PVC
Speedway Boulevard (to east)	6" PVC
South of Speedway Boulevard	8" PVC
Packard St.	8" PVC
East of Packard St.	8" CA
Windstorm Dr.	8" PVC
5th Street	8" PVC

West of the existing Tanque Verde Bridge and just west of the existing W. Drachman Street frontage road there is an existing Tucson Water well site.

Telephone - Qwest

North of Tanque Verde Road: Qwest has an underground telephone line on the west side of Houghton Road north of Rancho del Este Drive. At Rancho del Este Drive, lines cross Houghton Road and there are lines on each side of Houghton Road to Tanque Verde Road.

Tanque Verde Road: There are underground telephone lines along the south side of Tanque Verde Road and they cross Houghton Road just south of the intersection.

Between Tanque Verde Road and Speedway Boulevard: South of Tanque Verde Road, underground telephone lines parallel Houghton Road on the east side to Speedway Boulevard. At the Agua Caliente Wash and Tanque Verde Creek, some lines cross these washes in conduits under the existing bridges. Other lines cross the washes.

There are underground telephone lines west of the frontage road on the west side of Houghton Road and these lines cross Houghton Road beneath the Tanque Verde bridge, just north of the main Tanque Verde Wash channel. South of the main Tanque Verde Creek channel, an underground telephone line was picked up on the west side of Houghton Road. From this area, underground telephone lines are on the east side and west side of Houghton Road to Speedway Boulevard.

Speedway Boulevard: Underground telephone lines cross Speedway Boulevard east of Houghton Road. No lines were found crossing on the west side. Underground telephone lines are on the north side of Speedway Boulevard, east of Houghton Road.

South of Speedway Boulevard: Underground telephone lines are on the east side and west side of Houghton Road to 5th Street. One Houghton Road crossing was found approximately 700' south of Speedway.

Sanitary Sewer – Pima County Regional Wastewater Reclamation Department

Pima County Regional Wastewater Reclamation Department has underground sanitary sewer facilities within segments of the Houghton Road alignment. North of Tanque Verde Road, there is an 8" PVC sewer lateral located west of Houghton Road at Shady Rock Lane. Also, there is a 18" VCP sewer line crossing Houghton Road just north of the Tanque Verde Wash. At Packard Street, south of Speedway Boulevard, there is an 8" PVC sewer line that crosses Houghton Road connecting to residences in the vicinity. Like the water main facilities, these underground sewer lines will also be examined for conflicts occurring near proposed drainage structures crossing Houghton Road.

Traffic Signals – Pima County

There are two traffic signals within the project limits: one at the Tanque Verde Road intersection and one at the Speedway Boulevard intersection. Both these traffic signals were designed by Pima County and are currently maintained by Pima County.

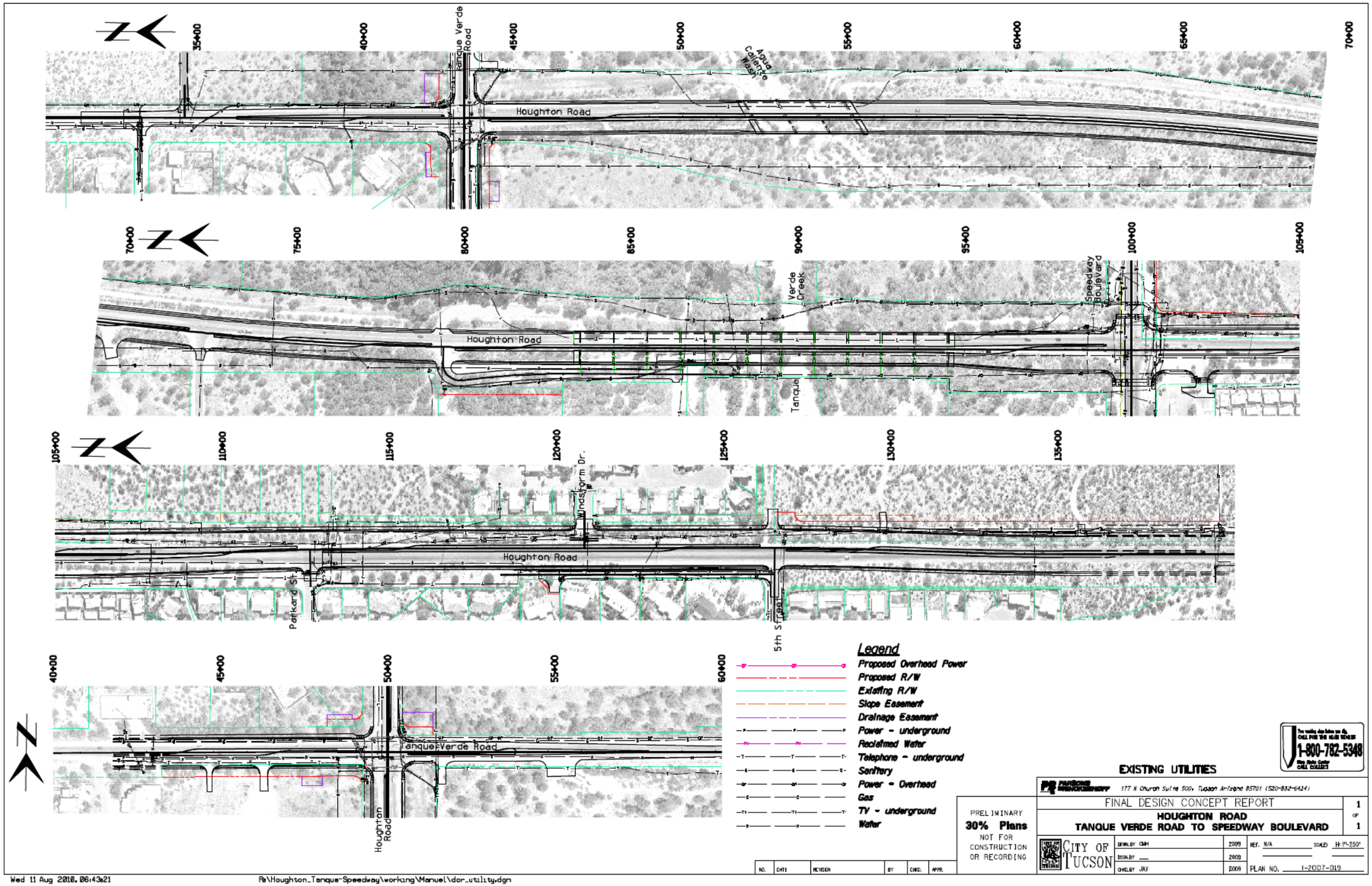


Figure 4 - Existing Utilities

3.10 Land Use, Zoning, and Planned Development

The existing land uses along Houghton Road between Tanque Verde Road and Speedway Boulevard are primarily undeveloped land zoned for low density residential development. Two relatively large watercourses cross Houghton Road in this project area (Agua Caliente Wash and Tanque Verde Creek), less than a mile east of their confluence. This contributes to a high degree of scenic riparian vegetation in the area, and as a result the development that has occurred has been primarily high-end custom homes on very large lots. Limited commercial development has occurred at the major intersections, though the majority of the commercially zoned land is still undeveloped. Figure 4 illustrates the existing land uses.

Major Residential Subdivisions:

- There are no major residential subdivisions within the project area.

Institutional Uses:

- 1 Charter School: TAG Elementary
- The Club at Mariposa

3.10.1 Current Zoning

Figure 5 shows the current zoning for the area, while Table 8 lists the approximate acreage of the major zoning classification found in the area bounded by Tanque Verde Loop Road to the East, Harrison Road to the west, Speedway Boulevard to the south and Tanque Verde Road to the north.

Table 8 - Zoning Acreage in Vicinity of Project

Zoning	Description	Approx. Acres
City of Tucson		
C-1 and C-2	Commercial	36
O-3	Office	32
R1	Urban residential lots >7,000 sq ft.	2015
R3	Urban residential 36 units/ac	34
RX-1	Rural residential lots >36,000 sq ft.	132
SR	Suburban Ranch lots >144,000 sq ft.	799
	Total Acres	3084
Pima County		
CB-1 and CB-2	Commercial	3
CR-1	Residential lots >36,000 sq, ft.	2707
RVC	Rural Village Center	5
SR	Suburban Ranch	1894
	Total Acres	4609

The table illustrates that the approximately 98% of land in this area is zoned for medium to low-density residential use. There are no PADs in the area, which is instead characterized by large lot sizes and custom built homes.

A small amount of the area is zoned for local and general commercial (C-1 and C-2), with the commercial zoning located primarily at the arterial road intersections, with the exception of the piece zoned commercial for the Club at La Mariposa.

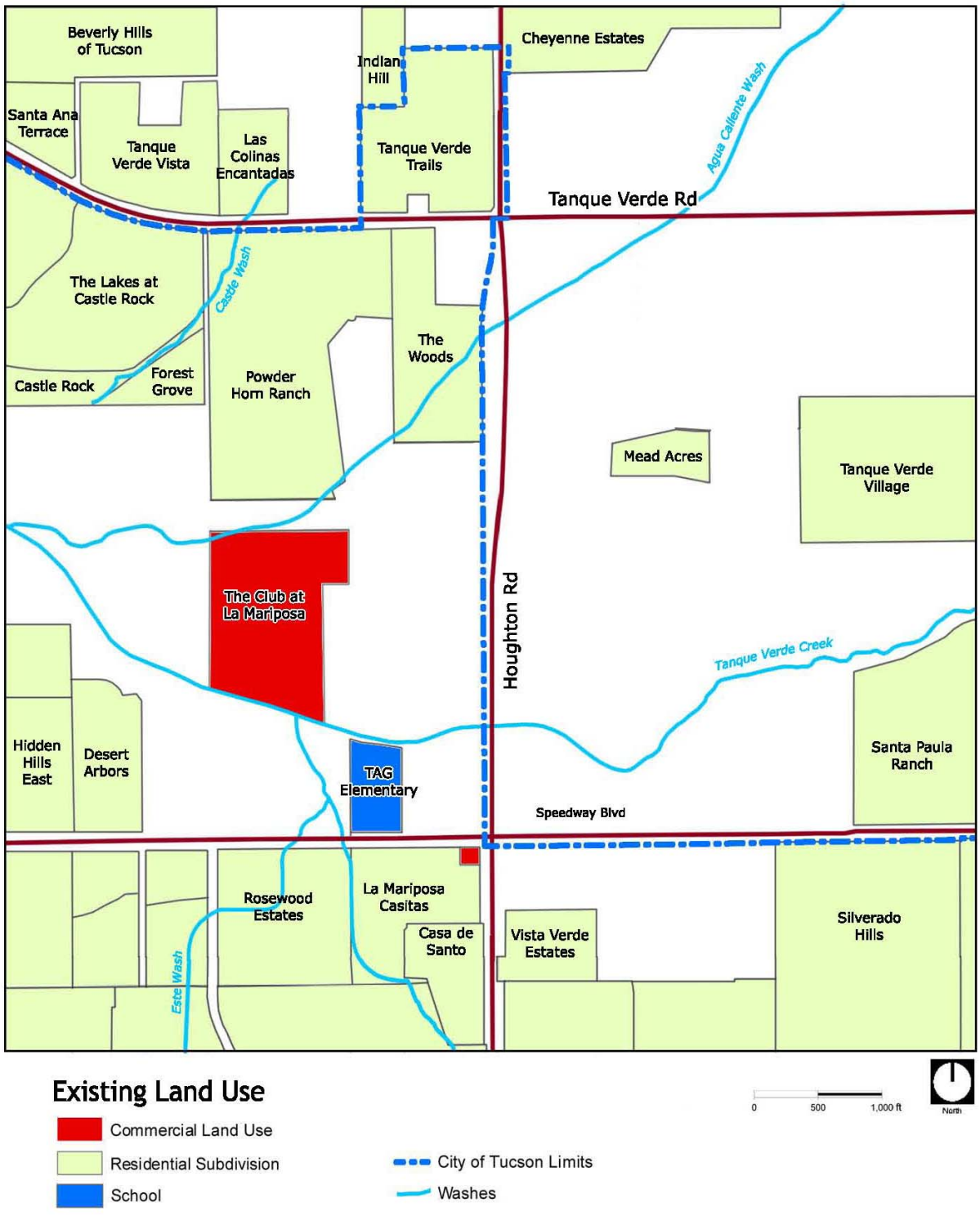


Figure 5 - Existing Land Uses

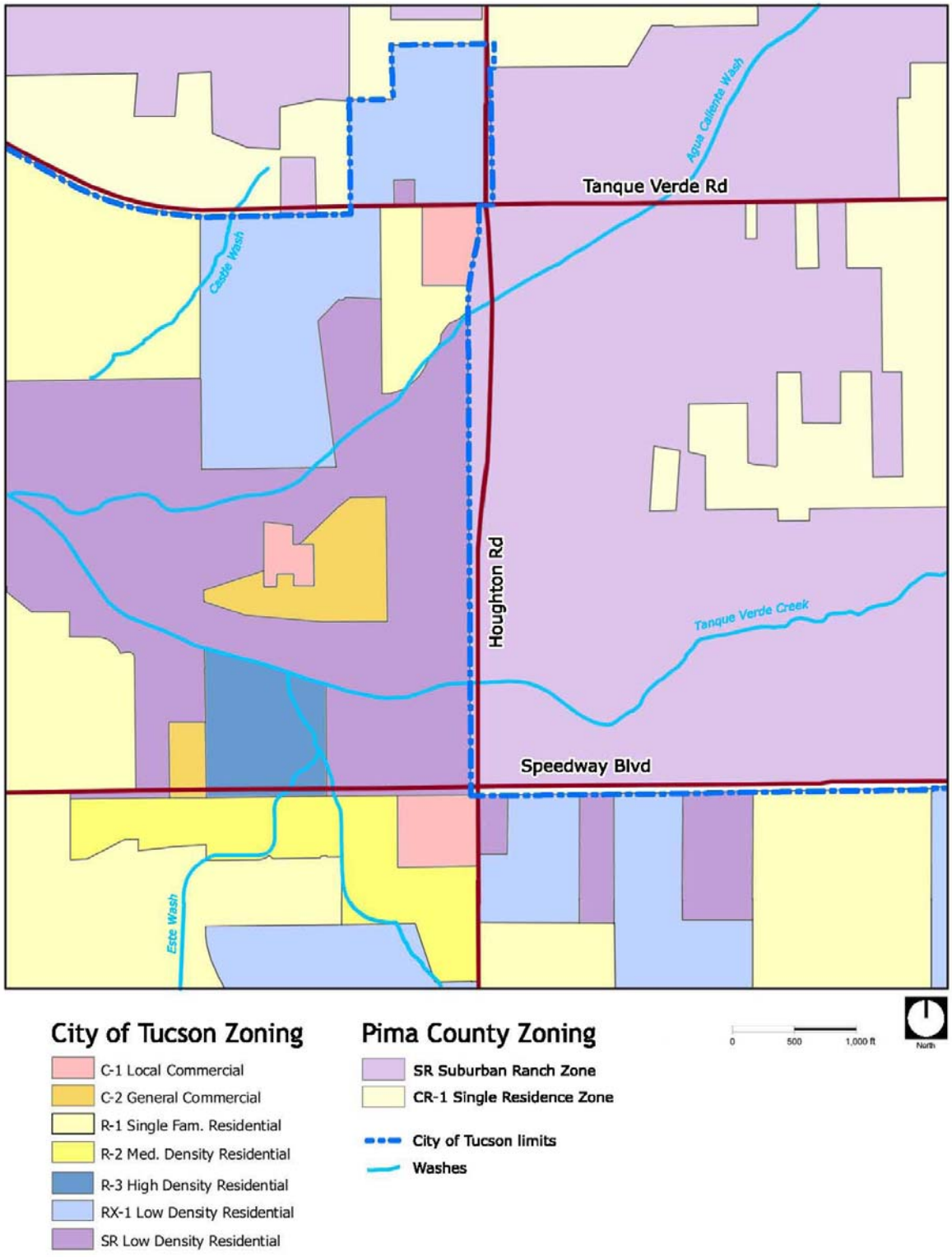


Figure 6 - Existing Zoning

3.10.2 Potentially Affected Community Facilities

The TAG Elementary charter school is the only school located within the study area. It is located on the north side of Speedway Boulevard about 1000 feet west of Houghton Road.

The Club at Mariposa is a private club west of Houghton Road between Tanque Verde Creek and Agua Caliente Wash. Primary all-weather access is off Houghton Road at the north end of the Tanque Verde Creek bridge.

There are no churches located within the study area, although the Rincon Church of God is located just across Tanque Verde Road from the study area, and Saint John on the Desert Presbyterian Church is located ¼ of a mile further north on Houghton Road.

There are no fire station facilities in the project area to be impacted by construction, the closest being Tucson Fire Department Station 12 on Harrison south of Broadway Boulevard.

3.11 Future land Use

Future residential and commercial growth is anticipated along the Houghton Road corridor. The major intersections for this segment on Houghton Road are located at Tanque Verde Road and Speedway Boulevard and are of interest for commercial land development.

3.12 Archaeological Resources

Tierra Right of Way Services, Ltd. Conducted a Class III cultural resource survey along the Houghton Road corridor right-of-way from Speedway Boulevard to Old Spanish Trail. The survey revealed that the project crosses portions of three previously recorded prehistoric sites:

- The Tanque Verde Wash site (AZ BB:13.68[ASM])
- The Houghton Road site (AZ BB:13.398[ASM])
- An unnamed artifact scatter (AZ BB:13.654[ASM]) – since destroyed.

The Tanque Verde Wash site and the Houghton Road site are multi-component prehistoric villages that have been recommended eligible for inclusion in the National Register of Historic Places (NRHP). Previous investigations at both sites have demonstrated that each contains significant buried cultural resources including human burials. Therefore, it is recommended that an archaeological testing plan be developed and implemented at the portions of these two sites likely to be affected by the proposed widening of Houghton Road.

For areas outside the recorded boundaries of the Tanque Verde Wash site and the Houghton Road site, it is recommended that the project be allowed to proceed with no further need for archaeological work. Additional surveys for cultural resources will be required if the right-of-way is extended beyond the study corridor. In addition, all work shall cease immediately when incidentally encountering cultural deposits more than 50-years old. The Director of the Arizona State Museum and the Pima County Archaeological and Historic Preservation Office shall be notified so a consultation process can begin and a course of treatment decided upon.

4.0 TRAFFIC AND CRASH DATA

A *Traffic Engineering Report* was prepared for the segment of Houghton Road from Tanque Verde to 22nd Street. This report included the segment from Tanque Verde Road to Speedway Boulevard which is the section under study in this DCR. Its purpose was to evaluate existing and future (2030) traffic conditions and provide specific recommendations to be used for the design of improvements on Houghton Road. These recommendations include the lane configuration at signalized intersections; turn lane storage requirements, traffic control requirements, location and configuration of median openings, pedestrian, bicycle and transit features, and the need for roadway lighting.

4.1 Traffic Volumes from PAG Traffic Volume Maps

The average daily traffic along Houghton Road has increased over the past few years. Between 2000 and 2007 volumes increased approximately by 9% along the roadway segment between Tanque Verde Road and Speedway Boulevard. Comparison numbers are shown in Table 9.

Table 9- Average Daily Traffic 2000, 2005, 2007

Roadway Segment	2000	2005	2007
Tanque Verde Road to Speedway Boulevard	12,400	17,000	13,500

4.2 Capacity Analysis

Capacity analysis was performed on both existing and proposed traffic. The analysis results are expressed in Level of Service (LOS) which classifies the average delay of vehicles in seconds and is used to describe how a roadway facility (an intersection or roadway section), operates under a given set of conditions. These conditions include, but are not limited to vehicle and pedestrian volumes, number and width of lanes,

grade, available shoulder and median widths, and the type of traffic control (traffic signal, stop sign, etc.) that is present. There are 6-levels of service (LOS A through F) which are defined by traffic flow measure that is considered a primary indicator of how each facility type is operating. For signalized and unsignalized intersections, this measure is the average time (seconds) that vehicles are delayed (not running at normal operating speed) at the intersection. On arterial roadways, the measure is the average travel speed of vehicles. Level of Service criteria for signalized intersections is described in Table 10.

Table 10 - Level of Service

LOS	Average Delay per Vehicle (sec)
A	≤ 10
B	>10-20
C	>20-35
D	>35-55
E	>55-80
F	>80

Roadway Segment Capacity requirements for Houghton Road can be estimated using planning level roadway capacity thresholds adopted by PAG. PAG sets the capacities for 4 and 6 lane roadways at 43,000 and 64,000 vehicles per day (vpd) respectively. At a planning level, roadway lane requirements are typically determined based on 80% of the roadway capacity, which essentially reflects Level of Service D traffic operations. Applied to the PAG capacities, 4 and 6-lane roadways will carry approximately 34,400 and 51,200 vpd, respectively.

4.3 Existing Traffic Conditions and Operations

The turning movement counts at the Tanque Verde Road intersection were collected as part of the traffic study for Tanque Verde Road, Catalina Highway to Houghton Road project on February 26, 2008, that PCDOT currently has under design under a separate

contract. Turning counts at the Speedway Boulevard intersection were collected as part of the traffic study for Speedway Boulevard, Camino Seco to Houghton Road project that the COT has under design under a separate contract. Daily directional traffic counts were collected on Houghton Road and on each side street by Kittelson as for their Houghton Road: Tanque Verde Road to 22nd Street traffic engineering report on October 1, 2008. Recent daily counts were also obtained from PAG. The hourly and daily traffic volume data are summarized in Figure 7 below. The 2008 ADT for the segment of Houghton Road from Tanque Verde Road to Speedway Boulevard is 16,825.

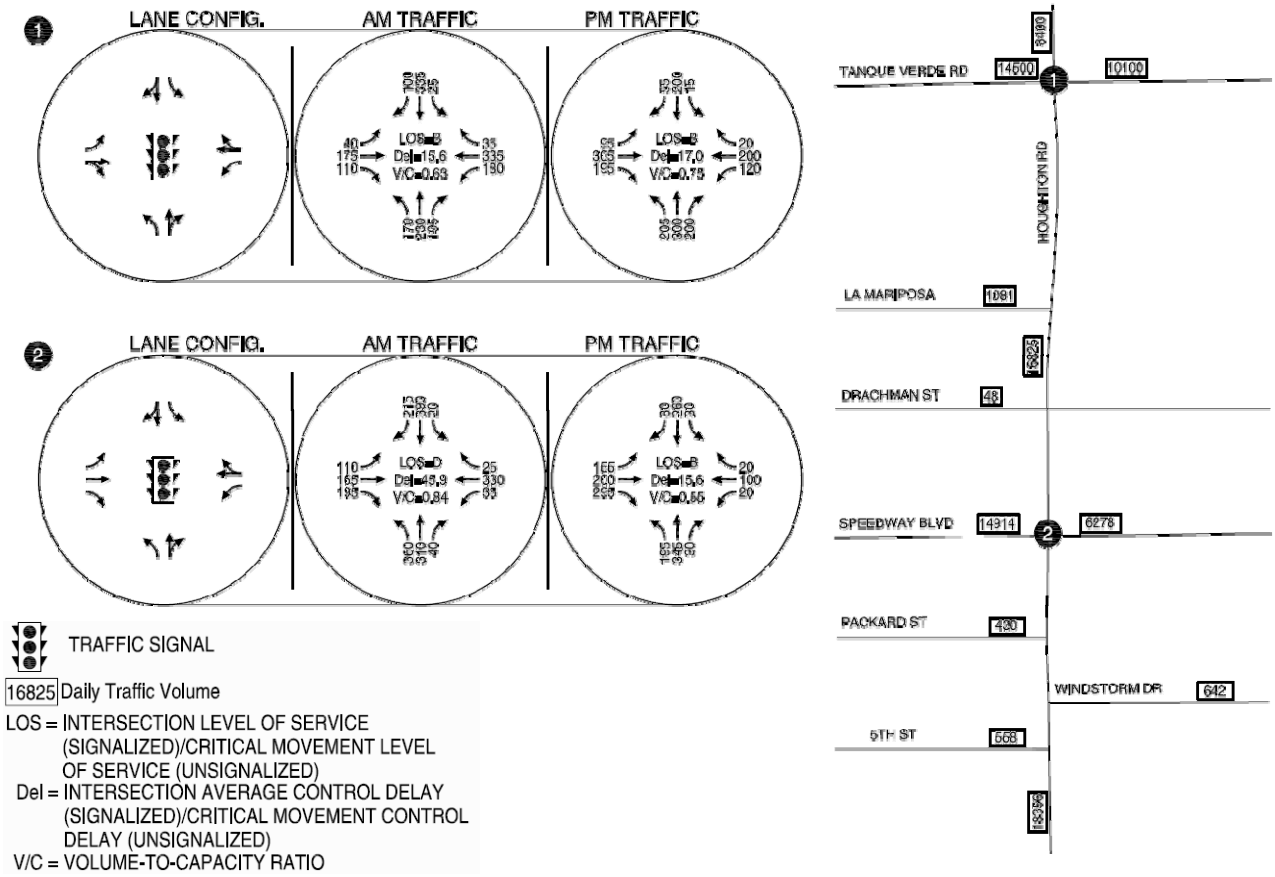


Figure 7 - Existing Traffic Conditions at the Signalized Intersections

Traffic factors were calculated from the 24-hour roadway counts. The K-factor (K), which represents the percentage of daily traffic that occurs during the peak hour and directional split (D) are based on traffic flow during both morning and evening peak hours.

The K-traffic factors indicate that the peak traffic periods are relatively short (i.e. one hour or so). Data collected on Houghton Road between Tanque Verde Road and Speedway Boulevard indicated 2% heavy vehicles which is slightly lower than other major arterials in the metropolitan area where 3-5% is typical. Classification data collected on Speedway Boulevard, west of Houghton Road indicated 4% heavy vehicles. Based on traffic counts, peak hours occur from 7 AM to 8 AM and from 5 PM and 6 PM.

Intersection capacity analysis was performed using the Synchro 6 traffic analysis software which utilizes the current Highway Capacity Manual procedures. The Synchro model for this section of Houghton Road was provided by the City. The analysis results of existing traffic conditions at the signalized intersections are included in Figure 7. The results show that overall traffic operations at the Tanque Verde Road and Speedway Boulevard intersections are LOS D or better during the morning and evening peak periods. Several movements at each intersection operate at LOS E during one of the peak periods.

Based on a review of existing hourly traffic volumes at each side street, it is clear that no additional signals are currently warranted.

4.4 Crash History

The Tucson Police Department and Pima County Department of Transportation provided crash data of Houghton Road, from Tanque Verde Road to Speedway Boulevard Segment for the 3-year period from October 1, 2005 to September 30, 2008.

At the two signalized intersections, the accident rates are low relative to the average crash rate of 0.99 for signalized intersections within Pima County between January 2005 to December 2007. At the Tanque Verde Road, Speedway Boulevard and Broadway Boulevard intersections, the crash data does not indicate any unusual conditions that require immediate mitigation.

During the analysis period, no fatalities occurred along Houghton Road from Tanque Verde Road to Speedway Boulevard. Table 11 shows the existing crash data summary.

Table 11 - Existing Crash Data Summary

	Tanque Verde Intersection		Tanque Verde Road to Speedway Boulevard Segment		Speedway Boulevard Intersection	
Crash Type	Number	%	Number	%	Number	%
Angle	1	4%	0	0%	1	8%
Rear-end	9	39%	2	50%	7	54%
Turning	7	30%	0	0%	5	38%
Sideswipe	2	9%	0	0%	0	0%
Single Vehicle	2	9%	1	25%	0	0%
Pedestrian	0	0%	0	0%	0	0%
Backing	1	4%	0	0%	0	0%
U-turn	1	4%	0	0%	0	0%
Motorcycle	0	0%	0	0%	0	0%
Head-on	0	0%	0	0%	0	0%
Unknown	0	0%	1	25%	0	0%
Total Accidents	23		4		13	
Daily ADT	25,000				26,799	
Length (mi)	N/A		1.0		N/A	
Accident Rate[1,2]	0.84		0.24		0.44	
Severity						
Fatal	0	0%	0	0%	0	0%
Injury	9	39%	3	67%	5	38%
PDO	14	61%	1	33%	8	62%

1. Intersection accident rates refer to number of accidents per million vehicles entering intersection.
   Rate = (number of 3-year accidents x 10^6)/(3 years x weekday entering volume x 365 days).
2. Segment accident rates refer to the number of accidents per million vehicles-miles of travel.
   Rate = (number of 3-year accidents x 10^6)/(3 years x weekday volume x segment length x 365 days).

4.5 Future Traffic Conditions

Houghton Road is a key component in the regional transportation system, particularly as the metropolitan area expands to the southeast along the I-10 corridor. As mentioned earlier in this report, the PAG 2030 RTP calls for upgrading the existing 2-lane roadway to a 4/6-lane limited access parkway that will serve as a north-south truck route. Other planned improvements in the vicinity of Houghton Road include widening Tanque Verde Road and Speedway Boulevard.

A summary of the on-going and planned Houghton Road improvements, and other crossing roadway improvements within the limits of this project, according to the 2030 RTP adopted on June 29, 2006, are shown on the following list:

- Ultimately, widen Houghton Road, creating a limited access parkway from I-10 to Tanque Verde Road; 4/6 lanes; beginning in 2010. RTA funded.
- Widen Tanque Verde Road from Catalina Highway to Houghton Road to four lanes. Scheduled to occur between 2010 and 2020. RTA funded.
- Widen Speedway Boulevard from Camino Seco to Houghton Road to four lanes. Scheduled to occur prior to 2010. RTA funded.
- Widen Broadway Boulevard from Camino Seco to Houghton Road to four lanes. Scheduled to occur between 2010 and 2020. RTA funded.
- Widen 22nd Street from Camino Seco to Houghton Road to four lanes. Scheduled to occur between 2010 and 2020. RTA funded.

4.6 Future Traffic Projections

The *Traffic Engineering Report* analyses the future 20-year traffic demands for Houghton Road and a study was developed utilizing 2030 projections produced by the current PAG (Pima Association of Governments) regional traffic forecasting model. The PAG projections predict low growth on both sides of Houghton Road because zoning along Tanque Verde Road only allows low density residential developments and it is

anticipated that few trips generated by new developments along Houghton Road corridor, primarily located on the south part of the corridor, will use Tanque Verde Road to go west. On Speedway Boulevard, PAG predicts moderate growth west of Houghton Road and low growth to the east of Houghton Road. The low traffic growth east of Houghton Road is reasonable considering that zoning along Speedway Boulevard only allows low density residential.

For comparative purposes, the future 2030 traffic projections used in the Houghton Road Corridor Study (HRCS) are included in Table 12 below. These projections, which were based on several development scenarios for the corridor, indicate traffic will grow on Houghton Road at approximately half the rate predicted by PAG.

Table 12 - Future Traffic Projections

Roadway	Segment	Existing Daily Volume (Year)	PAG		HRCS		Assumed For This Study	
			2030	Annual Growth	2030	Annual Growth	2030	Annual Growth
Tanque Verde Road	West	14500	12900	-0.5%	N/A	N/A	16240	0.5%
	East	10300	10500	0.1%	N/A	N/A	11600	0.5%
Speedway Boulevard	West	14914 (2006)	27000	3.4%	18300	0.9%	27000	3.4%
	East	6278 (2007)	6500	0.2%	5900	-0.3%	7000	0.5%
Houghton Rd.	North of Tanque Verde	8400(2005)	16800	4.0%	N/A	N/A	16800	4.0%
	Tanque Verde to Speedway	16825 (2005)	25600	2.1%	22200	1.3%	25600	2.1%
	Speedway to Broadway	18356 (2007)	40100	5.2%	26800	2.0%	40100	5.2%

While it is not the intent of this study to compare previous and current traffic projections, it is clear that the actual traffic growth that will occur over the next 20 years can vary greatly. Since the Houghton Road corridor improvement projects, which are currently in

the preliminary planning/engineering stages, are intended to serve growth beyond 2030, the PAG projections were selected for this traffic study.

4.7 Future Traffic Operations

The *Traffic Engineering Report*, evaluated future intersection and roadway lane requirements based on the results of capacity and level of service analysis of 2030 traffic forecasts. A 4-lane alternative on Houghton Road was evaluated from the segment from Tanque Verde Road to Speedway Boulevard. The following criteria were assumed for the intersection capacity and level of service analysis.

- Percentage of heavy vehicles is conservatively assumed to be 4%.
- Peak-hour factor – 0.90, for changes in traffic demand during the peak hour.
- 4-phase signal operation with permitted/protected left-turn phasing.
- Cycle lengths at either 90 or 120 seconds and optimized timing.
- Right-turns on red are permitted**.**
- Clearance interval (yellow plus all red) of 5 seconds.
- Arrival Type 3, random arrivals, considering the 1-mile signal spacing.

The report also studies the roadway segment LOS for Houghton Road in this project. Considering that this section of Houghton Road will have limited access with a relatively low frequency of driveways and side streets compared to a more commercialized arterial, such as Speedway Boulevard, the overall roadway level of service will be controlled by the operation of the signalized intersections.

4.7.1 Future Intersection Capacity

Based on the intersection capacity analysis results, a 4-lane cross section will provide satisfactory (LOS D or better) traffic operations for the segment from Tanque Verde Road to Speedway Boulevard. Average delays for each intersection approach and for

the entire intersection, fall within the middle of the range of delay used to define LOS D. These results, shown in Table 13 and Figure 8, indicate that the intersection configuration for the 4-lane option will provide a significant amount of excess capacity to serve additional traffic demand beyond that predicted for 2030. At Speedway Boulevard, dual eastbound left-turn lanes and northbound left-turn lanes will be required.

Table 13 - Intersection Capacity Analysis Summary

Intersection	Approach	Movement/ Approach	Level of Service and Average Delay (sec/veh) 4-lane AM	4-lane PM
Speedway Boulevard /Houghton Rd.	EB	LT	D	C
		TH	C	C
		RT	A	A
		Approach	B(19)	B (14)
	WB	LT	C	D
		TH	E	D
		RT	C	C
		Approach	C (57)	D (37)
	NB	LT	D	B
		TH	B	B
		RT	B	B
		Approach	C (34)	B (15)
	SB	LT	C	C
		TH	D	B
		RT	D	B
		Approach	D (40)	B (19)
	Intersection		D (36)	B (17)
Tanque Verde Road /Houghton Rd.	EB	LT	C	C
		TH	D	D
		RT	A	A
		Approach	C(28)	C(24)
	WB	LT	C	C
		TH	D	C
		RT	C	C
		Approach	D(42)	C(29)
	NB	LT	D	C
		TH	B	C
		RT	B	B
		Approach	C(24)	C(24)
	SB	LT	B	B
		TH	C	C
		RT	A	A
		Approach	C(29)	C(24)
	Intersection		D (30)	C(25)

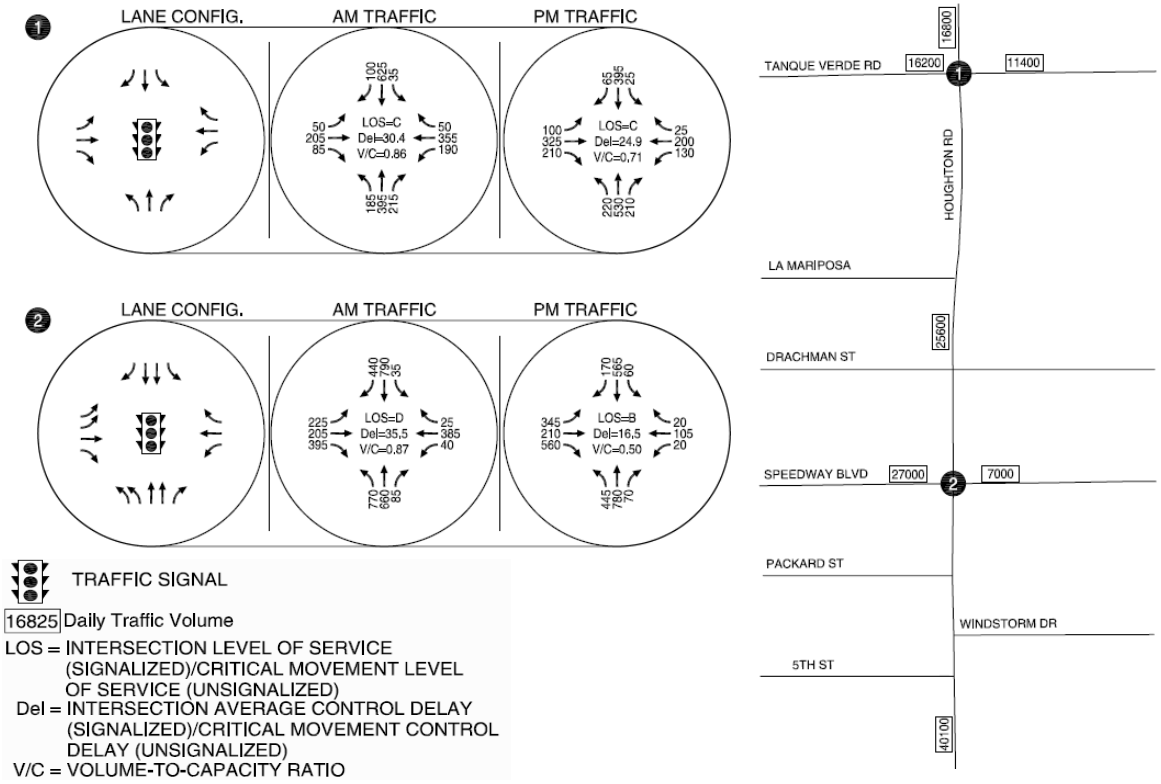


Figure 8 - Future Traffic Conditions

4.7.2 Future Roadway Segment Capacity

The PAG criteria for a roadway capacity of a 4 lane roadway at a LOS of D is 80% of 43,000 vpd, which is 34,000. This was compared to the projected traffic along Houghton Road between Tanque Verde Road and Speedway Boulevard for 2030. For 2030, the projected traffic is expected to be 25,600 vpd (Table 9, Section 4.1) which is below the PAG criteria meaning that four lanes of through traffic north of Speedway Boulevard will be sufficient to serve traffic demands projected for 2030.

4.8 Intersection Design

Based on the capacity analysis results and the following design concept discussion, the intersection lane configurations are recommended as viewed in Figure 9.

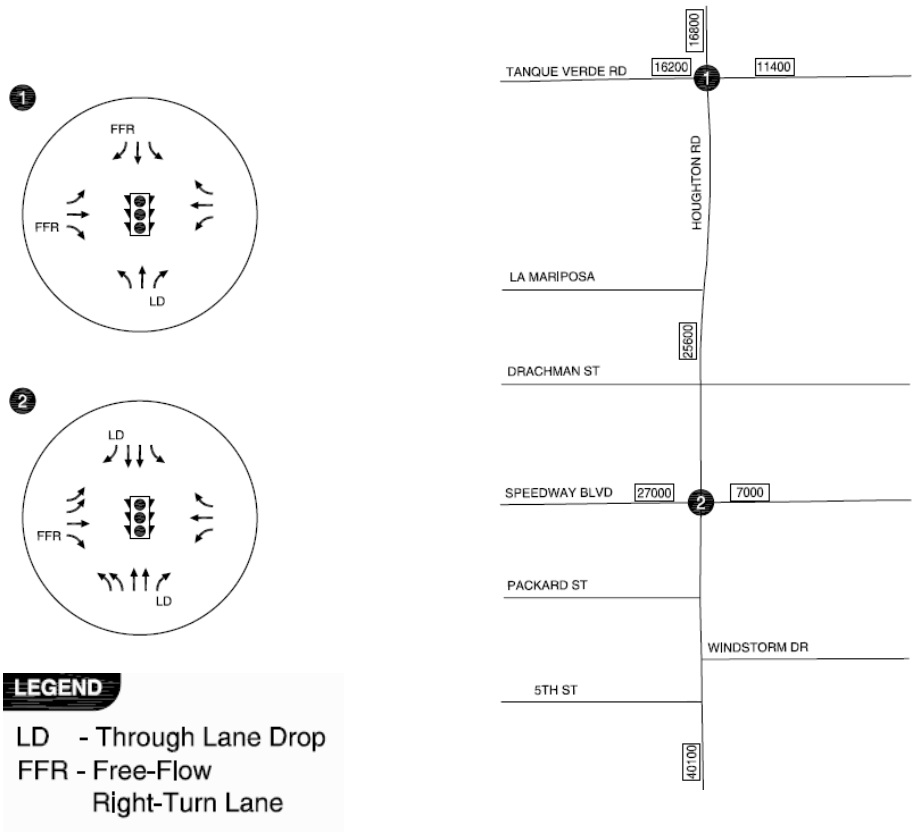


Figure 9 - Proposed Lane Configurations

Tanque Verde Road: The project to widen Tanque Verde Road from Catalina Highway to Houghton Road is funded and scheduled by the RTA. Full build out of the Tanque Verde Road intersection will be included with the Houghton Road project. The west leg of the intersection should include four through lanes, bike lanes and sidewalks. Bike lanes and sidewalks should be provided on the east leg of the intersection. Southbound traffic can have a channelized free-flow right-turn.

Speedway Boulevard: The project to widen Speedway Boulevard from Camino Seco to Houghton Road is funded and currently undergoing design, Since the Speedway Boulevard project does not include full build out of the Speedway Boulevard intersection; it should be included with the Houghton Road project. The west leg of the

intersection should include four through lanes, bike lanes and sidewalks, and dual eastbound left-turn lanes. The outside eastbound through lane can be dropped as a free-flow right-turn lane. On the northbound approach, the outside through lane can be dropped as a right-turn lane to eastbound Speedway Boulevard. Bike lanes and sidewalks should be provided on the east leg of the intersection.

4.9 Median Openings and Access Control

AASHTO considers a divided roadway with a raised median the preferred cross section for arterials with a design speed of 45 mph or greater, particularly with high volumes of through traffic. Several of the more important advantages and disadvantages of a raised median on an arterial include:

- Discourages strip development and encourages large planned development.
- Encourages parallel street development.
- Reduces mid-block accidents.
- Reduces vehicle conflicts at driveways.
- Reduces accident severity.
- Increases U-turn volume at median openings and intersections.
- Can reduce left-turn capacity at a signalized intersection.
- Restricts direct access to adjoining properties.

Considering that Houghton Road will function as a principal urban arterial and, as such, the roadway design must provide a high level of traffic safety and operations, a raised median is appropriate.

Figure 10 shows the existing and proposed access points on Houghton Road between Tanque Verde Road and Speedway Boulevard. Currently, there are 2 signalized intersections and minor existing commercial driveways. Additional access points will

also be required to serve future residential and commercial development within the corridor.

The Transportation Access Management Guidelines for the City of Tucson recommends median openings should be spaced no closer than 660 feet on a suburban arterial and ¼ mile is preferred. The spacing of traffic signals is dependent upon signal timing requirements; however ½ mile is generally the accepted minimum. Based on these guidelines and considering that Houghton Road is to be designed as a high capacity arterial, the recommended access plan as seen in Table 14 minimizes the number and spacing of median openings, while providing access to adjacent properties. The proposed plan limits access of most properties fronting Houghton Road to right-in/right-out only and provides intermediate U-turn opportunities at approximately every ¼ mile. Limiting the number of median openings may result in fairly heavy turning activity at each opening. As such, the storage provided for the left-turn bays should be increased from the standard of 150 feet to 200 feet.

On the west side of Houghton Road, north of 5th Street, access to the five existing residential driveways will need to be maintained. There are safety concerns of direct access to Houghton Road for the closely spaced drives. Stopping sight distance deficiencies to those drives would exist if those drives were allowed to have direct access to the widened Houghton Road roadway. An alternatives analysis was performed and summarized is Section 10 of this report with a frontage road as the recommended alternative to provide the 5 residences access via 5th Street.

On the southwest corner of the Houghton Road/Speedway Boulevard intersection, the commercial driveway closest to the intersection should be closed since it will be closer than 100 feet once the intersection is reconstructed. The second driveway serving the gas station/convenience store will provide Houghton Road access.

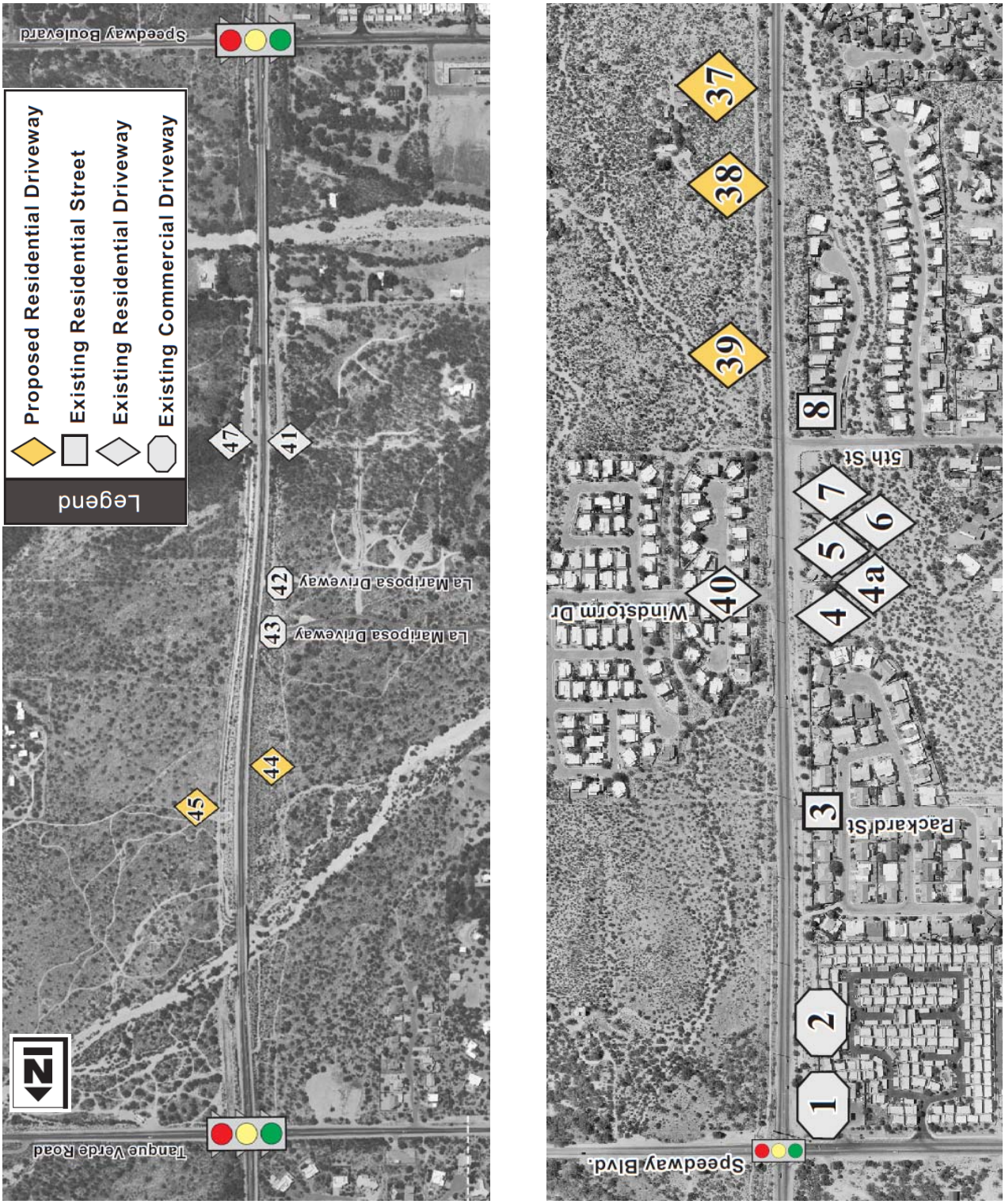


Figure 10 – Existing and Proposed Access Locations

Table 14 – Proposed Access Summary

Number	Driveway Type or Street Name	Existing	Recommended	Comment
31	Camino Quince	Full	Full access	1860 feet south of Broadway Blvd. Provides access to a large residential area and to the Tom Soleng Elementary School.
32	Cowhead Saddle Ln.	Full	Full access	800 feet south of Broadway Blvd
33	Commercial	Full	Right-in right out	
34	Commercial	Right-in right out	Right-in right out	
35	Commercial	Right-in right out	Right-in right out	
36	Commercial	Full	Right-in right out	
37	Residential Street (Future)	Full	Full access	Approximately ¼ mile (1350 ft) north of Broadway Blvd. Will provide access to future residential development on the east side of Houghton Road.
38	Residential	Full	Right-in right out	
39	Residential	Full	Right-in right out	
40	Windstorm Drive	Full	Right-in right out	
41	Residential	Full	Right-in right out	
42	La Mariposa Driveway 1	Full	Full	Approximately ½mile (2790 ft) north of Speedway Blvd. Will provide access to La Mariposa Resort on the west side of Houghton Road.
43	La Mariposa Driveway 2	Full	Right-in right out	
44	Residential(Future)	Full	Full	Approximately 1850 ft south Tanque Verde Road. Will provide access to future residential development on the west side of Houghton Road.
45	Residential (Future)	Full	Right-in right out	
46	Residential (Future)	Full	Full	Approximately ½mile (2790 ft) north of Speedway Blvd. Will provide access to future residential development on the east side of Houghton Road.
47	Residential	Full	Right-in right out	

4.10 Right-Turn Deceleration Lanes

The right-turn lane warrants provided in the *Transportation Access Management Guidelines*, indicate that a right-turn deceleration lane would be warranted at each side street and commercial driveway. South of Speedway Boulevard, Houghton Road is proposed to be a 6-lane divided roadway. Due to ROW constraints, the outside lane would serve as a deceleration lane for right turns.

North of Speedway Boulevard, in the 4-lane section within Pima County, peak hour volume warrants for right turn lanes from the Pima County Subdivision and Development Street Standards were reviewed. Neither the side streets of Drachman Street nor the drive to La Mariposa met the minimum requirements of a max. peak hour right turn volume of 40 vph against a Houghton Road ADT greater than 10,000.

4.11 Traffic Signals

Existing traffic volumes and potential future development within the Houghton Road Corridor, suggest that a future traffic signal may need to be considered at 5th Street. Currently, there does not appear to be a warrant for pedestrian signals within the project area, however mid-block HAWK signals can be considered when warranted.

4.12 Turn-Bay Storage

The method used to compute turn-bay storage requirements at the two signalized intersections is provided in the *2003 Transportation Access Management Guidelines for the City of Tucson*. This method estimates the storage requirements as the average number of vehicles stored per cycle, times a storage length factor that accounts for the variation in vehicle arrivals at a signalized intersection during a given cycle. Application of this method resulted in a recommended length for the turn lanes at each signalized intersection. It should be mentioned that the minimum storage length is 75 feet for a right-turn lane and 150 feet for a left-turn lane according to the Transportation Access

Management Guideline. However, to be consistent with the design of other Houghton Road sections, the City specified 200 feet and 300 feet as the minimum right-turn and left-turn storage respectively where feasible.

Turn bay storage recommendations for the signalized intersections on Houghton Road at Tanque Verde Road and Speedway Boulevard are given in Table 15.

Table 15 - Turn-Lane Storage Requirements

Intersection	Turn Bay	2030 Design Volume, vpd	Estimated Queue, ft	Recommended Minimum Storage,ft	Comment
Tanque Verde Rd./ Houghton Rd.	EB LT	102	90	300	Minimum requirement
	EB RT	210	140	200	Minimum requirement
	WB LT	190	160	300	Minimum requirement
	WB RT	51	35	200	Minimum requirement
	NB LT	222	175	300	Minimum requirement
	NB RT	214	125	200	Minimum requirement
	SB LT	33	30	300	Minimum requirement
	SB RT	98	0	200	Free-flow right-turn lane
Speedway Boulevard/ Houghton Rd.	EB LT	346	270	2 x 300	Dual left-turn lanes
	EB RT	558	N/A	200	Free-flow right-turn lane
	WB LT	38	35	300	Minimum requirement
	WB RT	27	15	200	Minimum requirement
	NB LT	772	450	2 x 300	Dual left-turn lanes
	NB RT	85	N/A	N/A	Lane Drop
	SB LT	63	60	300	Minimum requirement
	SB RT	463	185	200	Minimum requirement

4.13 Transit, Pedestrians and Bicycles

Currently, fixed-route transit service is not available within the Houghton Road corridor. The 2030 Regional Transportation Plan (RTP) includes a park-and-ride lot at Houghton Road/Broadway Boulevard which will tie into express bus service on Broadway Boulevard. A regular bus route will be added on Houghton Road as surrounding development generates sufficient ridership demand. Existing bus routes on Speedway

will also be extended to Houghton Road. In order to ensure optimal capacity along Houghton Road, bus pull outs should be provided at the far side of the signalized intersections along with mid-block bus stops. The roadway designer should consult with SunTran to identify appropriate bus stop and pull-out locations; however the following locations will likely be required:

- Houghton Road at Speedway Boulevard – WB and SB departures.

The bus pullouts at the Speedway Boulevard intersection should be included in the roadway improvements that are constructed since planned transit routes are funded by the RTA.

The Regional Transportation Plan designates Houghton Road as a priority corridor for bicycles and pedestrians. A primary trail runs within the Houghton Road corridor, as well as along Speedway Boulevard east of Houghton Road. Accordingly, the roadway widening will include 6-foot wide bicycle lanes on the roadway for the entire length of the project. South of Speedway Boulevard multi-use pedestrian corridors will be provided along both sides of Houghton Road. On the east side, a recreational corridor is planned, including a paved multi-use path and a designated trail. On the west side a paved sidewalk will be provided. North of Speedway Boulevard sidewalks will be provided on both sides of the roadway. Signalized pedestrian crossings will initially be provided at the signalized intersections spaced 1-mile apart. Additional HAWK crossings can be considered in the future at locations where warranted by pedestrian demand. Unsignalized pedestrian crossings should not be provided.

4.14 Lighting and ITS

Continuous lighting is typically installed on roadways that have a relatively high density of access points/activity and/or pedestrian activity or which have a history of accidents in which added roadway illumination could prove beneficial. The City of Tucson is proactive in assessing roadway lighting needs and installing lighting systems. Based on

the most recent assessment, the Tucson Comprehensive Roadway Illumination Study (January 2003), roadway lighting is not recommended for installation along Houghton Road. However, intersection lighting is recommended for safety consideration.

Per City of Tucson policy, 4-inch conduit with (4) 1-inch innerducts for future fiber optic communications will need to be installed along one side of Houghton Road. The conduit will need to tie into the signalized intersections.

4.15 Traffic Engineering Report Conclusions and Recommendations

- Future daily traffic demand north of Speedway Boulevard is projected to range from 16,800 to 28,000 vpd. To the south, traffic demands are expected to range from 40,000 to 47,000 vpd between Speedway Boulevard and Old Spanish Trail.
- A review of crash data covering the most recent 3-year period did not indicate any trends or unusual conditions along Houghton Road or at the major signalized intersections. Widening the roadway should reduce the potential of rear-end and single vehicle crashes.
- Based on planning roadway service volume levels, 4 lane roadways can carry 43,000 vpd. A more detailed capacity and level of service analysis of the two signalized intersections shows that four lanes with appropriate turn-lane capacity will adequately serve the projected future traffic demands. Considering that Houghton Road is intended to function as a high capacity corridor and that the City desires to build the ultimate roadway improvements initially, a 6-lane section is recommended south of Speedway Boulevard. North of Speedway Boulevard, a 4-lane section is recommended.
- The recommended lane configuration at the Tanque Verde Road and Speedway Boulevard intersections are provided in Figure 9. Recommended minimum turn lane storage is provided in Table 15.
- The recommended access plan provided in Table 14 is intended to address access requirements of existing and future developments, while accomplishing the objective of minimizing direct access onto Houghton Road. The proposed location of median openings follows the City's Transportation Access

Management Guidelines. Limiting left-turn out movements at driveways and side streets will result in high volumes of U-turns at median openings. At these locations, the left-turn storage should be a minimum of 200 feet.

- Right-turn deceleration lanes are not warranted north of Speedway Boulevard. South of Speedway Boulevard, the outside third lane will serve as the right turn deceleration lane. Due to right of way constraints, provisions for right-turn lanes at each unsignalized access point is not possible.
- No additional traffic signals are warranted based on existing traffic conditions. Considering future development, a traffic signal could possibly be warranted at 5th Street. Conduit and pull boxes should be installed as part of the roadway improvements.
- Based on planned transit routes on Houghton Road, bus stops and pullouts need to be identified through consultation with Sun Tran. Pull outs at Speedway Boulevard should be installed as part of the roadway improvements.
- Based on the most recent assessment by the Tucson Comprehensive Roadway Illumination Study (January 2003), roadway lighting is not recommended for installation at Houghton Road: Tanque Verde Road to Speedway Boulevard. However, intersection lighting is recommended for safety consideration.
- Fiber optic communications conduit (4-inch with 4 1-inch innerducts) will need to be installed along one side of Houghton Road, tying into each signalized intersection. Roadway lighting is recommended at all signalized intersections.

5.0 Design Standards and Criteria

5.1 Geometric Standards

This project DCR has been developed in accordance with the scoping meetings and discussions held with TDOT and the following guides:

Transportation Access Management Guidelines-2003 (TDOT)
Traffic Signal Design Manual-2003
Roadway Design Manual (RDM), 2nd edition, December 2003 (PCDOT)
Policy on Geometric Design of Highways and Streets 'Green Book,' AASHTO 2004
Manual on Uniform Traffic Control Devices, 2003
Highway Capacity Manual, 2000
Roadside Design Guide-2002
Pavement Marking Design Manual, 1st Revision, October 2002
The *Houghton Corridor Study (HRC)*
Houghton Area Master Plan (HAMP)

A list of applicable design standards for the Houghton Road project was compiled from information contained in the Pima County RDM, Chapter 2, *Elements of Design* which also relate to TDOT. Also used are topics from *A Policy on Geometric Design and Streets* ('Green Book') backed by *American Association for State Highway and Transportation Officials* (AASHTO). The *Transportation Access Management Guidelines for the City of Tucson* was used as well.

In selecting the applicable criteria, the following factors were taken into consideration:

- The terrain is generally sloping toward the crossings of Tanque Verde Creek and Agua Caliente Wash.
- The road is classified as a major arterial with a posted speed limit of 45 mph.

- 3:1 slopes are used beyond the clear zone to reduce right-of-way (ROW) impacts.
- The 2007 average daily traffic volume is 13,500 between Tanque Verde Road and Speedway.

5.2 Pavement Structure

A *Preliminary Geotechnical Report* for this section of roadway dated May 29, 2009 was prepared by NCS Consultants, LLC, (NCS). The purpose of this report is to present the preliminary geotechnical recommendations for the various new and existing structures associated with this project, including the two multi-span bridges, drainage structures, and utilities.

Since much of the existing roadway will be retained for use for northbound traffic north of Speedway, four (4) pavement cores were advanced to assess the thickness and condition of the existing Houghton Road corridor pavement structure and base materials within the project limits. In addition, four (4) 10-ft deep borings were advanced along the project corridor to provide recommendations in support of the pavement and embankment design. The pavement analysis was performed in general conformance with the Active Practice Guidelines for flexible pavement design of the City of Tucson (COT, 1987). Table 16 summarizes the Structural Numbers (SN) and minimum pavement thicknesses.

Table 16 - Required Flexible Pavement Parameters

Surface Course	Required Minimum Structural Number (COT, 1987)	Calculated Required Structural Number	Required Minimum Asphaltic Concrete Thickness
AC / ARAC	3.04	2.80	5.0

Based on their findings and analysis, two alternative pavement structures were recommended as shown in Table 17 below:

Table 17 - Recommended Pavement Alternatives

Alternative	ARAC (in.)	AC (in.)	AB (in.)	SN
A	--	5.0	5.0	3.08
B	2.5	2.5	5.0	3.08

The difference between Alternative A and B is whether Asphalt Rubber Asphaltic Concrete (ARAC) is used as a surface layer. ARAC is often preferred over standard asphalt concrete based on reports of its noise reduction quality. This consideration may be of importance since the section of Houghton Road is in an area of sensitive receptors, including approximately 45 residences immediately adjacent to the roadway in the project area between Tanque Verde Road and Fifth Street. Alternative B is the preferred pavement structure design for Houghton Road.

5.3 Other Geotechnical Considerations

In addition to the pavement structure alternatives mentioned above, three additional recommendations were made regarding signal structures, the two new bridge structures over Agua Caliente Wash and Tanque Verde Creek and temporary excavations:

- The report recommended that the proposed signal structure foundations shall conform to the *City of Tucson and Pima County Standard Details for Public Improvements (COT, 2003)*.

- Regarding the two new bridge structures, the report stated that deep foundations are more suitable because of scour concerns. Due to the proximity of existing bridges, driven piles are not considered to be feasible as they will create

vibrations that may be intolerable from the perspective of structural damage to existing structures. Drilled shafts, whose construction generates less noise and vibration than driven piles, are considered to be more feasible and are therefore recommended for this project. From the as-built drawings it is apparent that drilled shaft foundations were used for the construction of the existing bridges.

- The report recommended that for excavations of less than 20-feet the maximum allowable unshored slope should be 1.5H:1V (H=horizontal, V=Vertical). This recommendation is based on the soil moisture contents being maintained at or near optimum moisture content for fill slopes and at or near in-situ moisture contents for cut slopes. Significant moisture increases in the soils within the slope could weaken the slopes due to a reduction in shear strength. The soils within a cut slope should be carefully observed and evaluated since soft soils were encountered at shallow depths in borings at various locations across the site. Cuts made in such soils may be susceptible to local slope stability problems. Therefore excavations in such soils will require trench shields or shoring.

  Should slopes steeper than 1.5H:1V be required due to the proximity of a cut to existing structures or for purposes of construction economy, the stability of such slopes should be verified through analysis by a registered Professional Engineer in the State of Arizona with demonstrated geotechnical engineering knowledge and experience.

  Moderate to severe raveling and erosion of excavation faces may occur due to water infiltration and/or surface runoff. Therefore, the perimeter of all excavations should be protected against water infiltration from surface runoff or other sources.

  Heavy equipment or traffic should not be allowed within 10-feet from the edge of any excavation.

5.4 Design Speed

The City of Tucson defined the design speed for this segment of Houghton Road based upon the following criteria:

- Functional classification as Major Arterial
- Safe minimum Stopping Sight Distance of proposed vertical curves
- Future traffic projections
- Projected land use
- Proposed ROW takes, with necessary earthwork

It was concluded that the design speed for the Houghton Road project along the construction corridor mainline to be 50 miles per hour.

5.5 Drainage Design

The *Draft Preliminary Drainage Report* proposes to accommodate both onsite and offsite runoff, and is described in qualitative terms within the body. Only offsite (Major Cross Drainage) drainage analyses are evaluated for the DCR report. Onsite (Pavement) drainage analyses will be addressed during the design segment(s) of the Houghton Road segment.

The work for the drainage portion of this project, for the DCR, is as follows:

- The quantity of runoff affecting this project based on future projections for growth using the following methods:
    - The City of Tucson Storm Water Management Study (TSMS) which generates the currently accepted value for the 100-year peak flows, as well as the 10-year event peak flows.
    - The City of Tucson Method for Estimating Flood Peaks and Flood Hydrographs referred to as the 'City of Tucson Method,' used to generate offsite peak discharge rates. The concept of balanced watersheds

provides that the current "existing" conditions will be the same as those in the future.

- To design new conveyance structures, typically concrete box culverts, and to replace existing dip crossings located throughout the project limits.
- To provide adequate design for Environmental Resource Zone (ERZ) regulatory washes where feasible; which, include structure height requirements.

5.5.1 Design Criteria for Drainage

Where possible, the drainage improvements designed and documented in the drainage report shall meet the following criteria:

1. Cross Drainage facilities shall be designed such that the 100-Year event will be conveyed under the roadway providing for "All Weather Access".
2. Proposed water surface elevations shall not significantly impact surrounding properties and shall be approximately equal to existing condition elevations.
3. Culverts shall be designed such that the structure will convey the sediment load of the upstream segment.
4. ERZ/WASH Ordinance washes shall be designed in accordance with current regulations with the exception of the structure height requirement. This project is in the process of obtaining a variance for structure height. It is expected that some areas will not meet the required structure height due to roadway profile limitations. Each area will be evaluated to determine if the structure height can meet the requirements.
5. Culverts shall have a minimum height requirement of 4-feet for reinforced concrete boxes and a minimum diameter of 24-inches for pipe culverts.
6. Culvert material shall be reinforced concrete unless extending an existing culvert. Culvert extensions shall match the existing culvert material.

5.6 Access Control

As mentioned in the Section 4.8 Median and Access Control**,** the *Transportation Access Management Guidelines for the City of Tucson* recommends median openings should be spaced no closer than 660 feet on a suburban arterial and ¼ mile is preferred. The spacing of traffic signals is dependent upon signal timing requirements; however the City has a ½ mile minimum spacing for traffic signals

Access to adjacent parcels will be controlled in two ways. Left turn access south of Speedway Boulevard will be restricted by raised median openings. Right turn access will typically be limited to existing streets and driveways. The existing land uses along Houghton Road between Tanque Verde and Speedway Boulevard are primarily undeveloped land zoned for low density residential development. Both the Tanque Verde Creek and Agua Caliente Creek cross Houghton Road in this section and, as a result, proposed access will meet standard criteria.

5.7 Roadway Typical Section

Four typical sections have been developed for different segments of Houghton Road for the study area of this DCR:

North of Tanque Verde Road:

- 2 lane section without outside curbs
- 14-foot wide travel lane in each direction adjacent to the median
- 6-foot wide bike lane on outside edges
- 20-foot wide raised median with left-turn bays where appropriate
- Right turn bays will be provided the signalized intersection when warranted
- Sidewalks will not be provided in this segment
- The existing marked crosswalks at Tanque Verde Road will be maintained

Tanque Verde Road to Agua Caliente Wash:

- 4 lane section without outside curbs
- 14-foot wide left lane in each direction adjacent to the median and one 12-foot right lane in each direction
- 6-foot wide bike lane on outside edges
- 20-foot wide raised median with left-turn bays where appropriate
- Right turn bays will be provided at the signalized intersection when warranted
- 5-foot wide concrete sidewalk on the east and west sides

Agua Caliente Wash to Speedway:

- 4 lane section without outside curbs
- 14-foot wide left lane adjacent to the median and one 12-foot right lane in each direction
- 6-foot wide bike lane on outside edges
- 20-foot wide raised median with left-turn bays where appropriate
- Right turn bays will be provided at the signalized intersection when warranted
- 5-foot wide concrete sidewalk on the east and west sides
- The existing marked crosswalks at Speedway Boulevard will be maintained

Speedway to 5th Street:

- 6 lane section with outside curbs
- 14-foot wide left lane in each direction adjacent to the median and two adjacent 12-foot lanes in each direction
- 6-foot wide bike lane on outside edges
- 20-foot wide raised median with left-turn bays where appropriate
- Right turn bays will be provided at the signalized intersection when warranted
- 6-foot wide concrete sidewalk on the west side
- 10-foot multi-use paved path on the east side

The typical sections were developed through review of the guidelines in the City's MS&R and review of the HRC typical sections. Arterial roadways, as stated in the MS&R, should have curbed medians included in the design of all roadways where the curb to curb width exceeds 75 feet. This is the case within the project limits of Houghton Road. The MS&R also provided guidelines for typical sections for several roadway ROW widths, but does not include one for the 200 foot planned ROW width of Houghton Road. The closest ROW width shown for a 4-lane roadway, 100 foot, was used as reference.

5.7.1 Pedestrian/Bike Facilities

Pedestrian and bike facilities are part of the proposed roadway improvement package for this segment of Houghton Road. Bike lanes will be 6-feet wide and be located on the outside edges of the roadway section throughout the length of the project. This is a favorable alternative (as opposed to no bike facilities) due to the existing signed bike route and recreational activity in the corridor. Sidewalks provided will vary by roadway section. South of Speedway Boulevard a 6-foot sidewalk will be provided on the west side of the roadway and a 10-foot paved multiuse path on the east side in the Houghton Greenway linear parkway. Between Speedway Boulevard and Tanque Verde Road 5-foot sidewalks will be provided on both sides of the roadway. North of Tanque Verde Road sidewalks will not be provided.

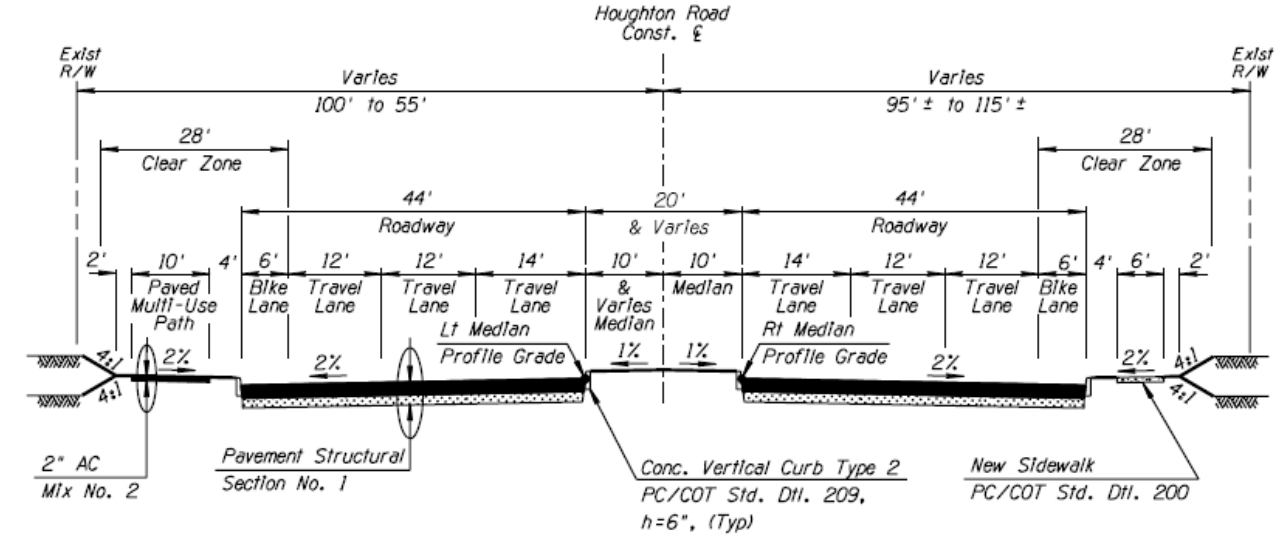
5.8 Roadway Geometrics

The RDM specifies the roadway geometrics that supplement the AASHTO design guide, which will be used for the development of this proposed Houghton Road project. The stated minimum horizontal curve lengths, minimum vertical curve lengths, and the minimum and maximum profile grades shall be incorporated into the pavement widening design.

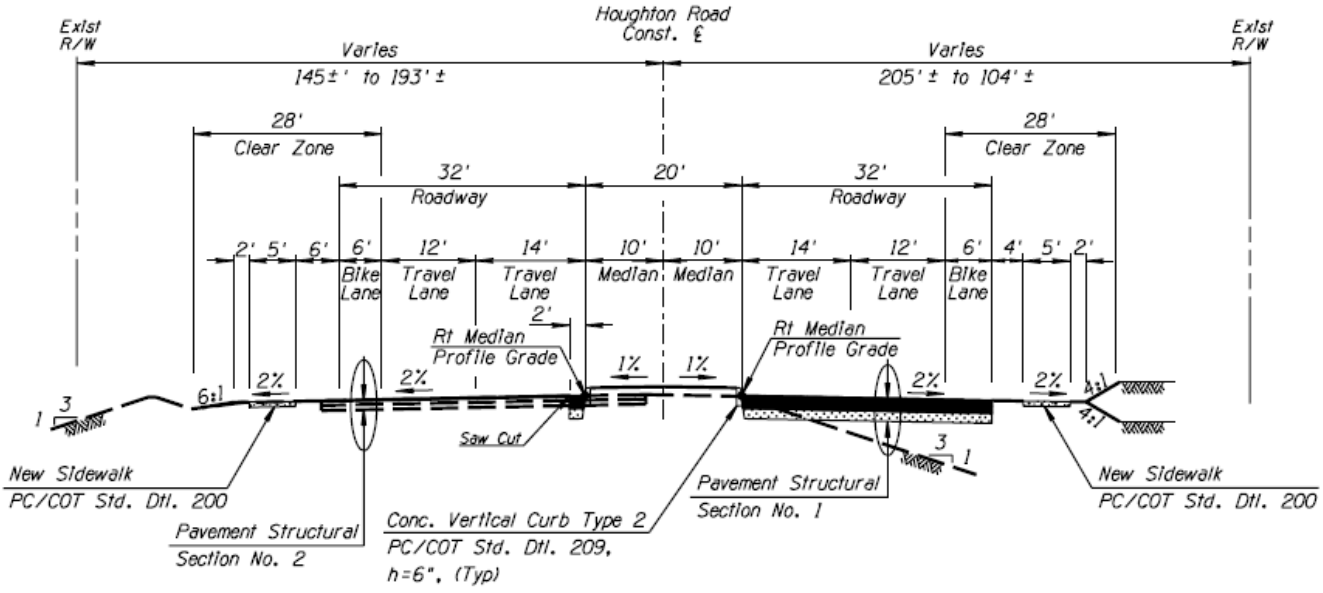
The HRC found that: “The existing horizontal alignment…caused the least impact to the surrounding developed areas. Maintaining the existing alignment and widening within the 150’ of right-of-way does not impact any existing homes or businesses; however, the existing overhead (high voltage) power line on the east side will require relocation…” Based on this finding, the existing roadway centerline was used as a starting basis for the new horizontal alignment for this project. South of Speedway the centerline corresponds with the section line. North of Speedway Boulevard the existing centerline does not follow the section line but contains a reverse curve aligning it with the section line north of Tanque Verde Road. In the section between Tanque Verde Road and Speedway Boulevard a new centerline was created offset from the existing centerline in order to maximize the use of the existing roadway and bridge widths.

The proposed new vertical alignment for the Houghton Road project will generally follow the ‘lay-of-the-land’ and correct for sub-standard existing vertical curves (Table 1 Existing Vertical Curves in Section 3.2).

The design criteria for the Houghton Road project are summarized in Table 18. Figure 11 shows the proposed 4-lane typical section north of Speedway Boulevard and the 6-lane typical section south of Speedway Boulevard.



HOUGHTON ROAD
TYPICAL SECTION
South of Speedway Boulevard



HOUGHTON ROAD
TYPICAL SECTION
Between Agua Caliente Wash and Tanque Verde Creek

Figure 11 - Proposed 4-lane and 6-Lane Typical Section

Table 18 - Roadway Design Criteria

Category	Criteria
Design Speed	50 mph
Posted Speed	45 mph
Inside Travel Lane	14 ft (12' w/2 ft. inside shoulder) – Houghton Road 13 ft (12' w/1 ft. inside shoulder) – Side Roads
Travel Lane	12 ft (11 ft min)
Median Width	20 ft. with 4-lanes
Curbs	No vertical curb on outside of roadway. Vertical curbs adjacent to median with 4-lanes.
Design Vehicle	WB-50 (semi-trailer combination) for roadway. P (passenger car) for median openings for U-turns.
Vertical Grade	0.5% Min, 7% Max
Cross Slope	2%
Horizontal Clear Zone (Based on ADT and Design Speed, AASHTO Roadside Design Guide Table 3.1)	24 ft (w/o curb, fore slopes) 18 ft (w/o curb, back slopes) 10 ft min. (side roads w/o curb)
Stopping Sight Distance	425 ft Min for a 50 mph design speed
Superelevation	0.04 '/ft Max
Horizontal Curve Length	500 ft Min
Angle Break	1 Degree 8 Minute Max
Vertical Curve Length	150 ft Min 0.5 % Max Grade Break w/o Vertical Curve
Horizontal Taper Rate	50:1
Cross Drainage Criteria	Convey 100-yr Storm
Roadway Drainage	Analyze 100-yr Storm not to exceed 1 ft of depth at any point within the paved section

5.9 Right-of-Way

The City of Tucson's *Major Streets and Routes Plan* describes the ultimate ROW for Houghton Road as 200 feet. Pima County's *Major Streets & Scenic Routes Plan* also calls for Houghton Road to have a planned ROW of 200 feet.

6.0 Major Design Features

6.1 Horizontal and Vertical Alignment

This segment of the Houghton Road corridor will begin just north of Tanque Verde Road and extend to 5th Street, for approximately 9,875 feet.

The horizontal alignment and construction centerline will generally follow the existing centerline. South of Speedway the centerline corresponds with the section line. North of Speedway Boulevard the existing centerline does not follow the section line but contains a reverse curve aligning it with the section line north of Tanque Verde Road. In the section between Tanque Verde Road and Speedway Boulevard a new centerline was created offset from the existing centerline in order to maximize the use of the existing roadway and bridge widths.

The proposed vertical alignment generally follows the lay-of-the-land in order to minimize earthwork balance and extensive right-of-way acquisitions. As stated in Chapter 5, the segment deficiencies of the roadway will be corrected for minimum sight distance standards in accordance with AASHTO guidelines. The driveway tie-ins will not create any 'standing water' and roadway runoff will be directed away and into ditch drainage systems.

6.2 Access Control

The Transportation Access Management Guidelines for the City of Tucson recommends median openings should be spaced no closer than 660 feet on a suburban arterial and ¼ mile is preferred. The proposed plan as stated in the Traffic Engineering Report, limits access of most properties fronting Houghton Road to right-in/right-out only and provides intermediate U-turn opportunities at approximately every ¼ mile. Limiting the number of median openings may result in fairly heavy turning activity at each opening.

As such, the storage provided for each of the left-turn bays should be increased from the standard of 150 feet to 200 feet.

On the west side of Houghton Road, north of 5th Street, access to the five existing residential driveways will need to be maintained. A frontage road is recommended to provide the 5 residences access via 5th Street.

In addition, the traffic report noted one issue relating to commercial property. On the southwest corner of the Houghton Road/Speedway Boulevard intersection, the existing commercial driveway closest to the intersection should be closed or moved to the south since it will be closer than 100 feet once the intersection is reconstructed. The second driveway serving the gas station/convenience store will provide Houghton Road access.

6.3 Right-of-Way

The widening of Houghton Road within the project limits from north of Tanque Verde Road to south of Speedway Boulevard near 5th Street will, for the most part, be included within the existing ROW. ROW acquisitions will be needed in limited areas where the proposed roadway widening extends beyond the existing ROW such as south of Speedway Boulevard and at the Houghton Road / Tanque Verde Road intersection. In addition, there are a few areas that drainage easements and slope easements will be needed.

The segment of Houghton Road north of Tanque Verde Road will only be widened at the approach to Houghton Road to accommodate southbound left and right turn lanes. These lanes, coupled with single thru lanes in each direction will fit within the existing 120’ ROW without the need for any acquisition.

Houghton Road between Tanque Verde Road and Speedway Boulevard will be widened from the existing two lanes in each direction to a four lane divided roadway. However, because ROW was acquired for Houghton Road back in the early 1990’s for

that reconstruction project and the existing ROW limits to the west were retained, there is sufficient ROW now to allow for construction of the mirrored image of the existing roadway to the west. The ROW in this vicinity varies from nearly 150' to over 300' in width. No acquisitions are anticipated for construction of the four lane divided Houghton Road roadway here. One parcel on W. Drachman Street, a frontage road west of Houghton Road near the Tanque Verde Creek, will be impacted with the reconstruction of this road. A partial ROW acquisition is proposed along the frontage to W. Drachman Street.

Houghton Road south of Speedway Boulevard will require additional ROW beyond what is available for the 6-lane divided Houghton Road typical section. The existing ROW is only 40' wide east of the section line and 100' wide west of it. On the approach from the south to Speedway Boulevard, there is a Pima County easement along the east side of Houghton Road that will need to be acquired. Here, Houghton Road is widened from two lanes in each direction with a left turn lane approaching Speedway Boulevard to three lanes in each direction and dual left turn lanes.

South of the Pima County easement to near 5th Street, Houghton Road has an existing 200' ROW which matches the MS&R proposed ROW. Due to a shift to the east in the proposed Houghton Road roadway centerline as a result of the a frontage road between Packard Street and 5th Street, the proposed Houghton Road encroaches into buffers along the existing ROW on the east side of Houghton Road. Here, slope easements are proposed that will cover the existing buffer areas. Slope easements begin on the east side of Houghton Road opposite Packard Street and extend south to a point approximately 500' north of the project limit.

South of 5th Street, the existing ROW is only 40' wide east of the section line and 100' wide west of the section line. Roadway widening and slope limits extend to the east beyond the existing ROW. A proposed ROW line was offset 100' east from the section line that begins opposite 5th Street and continues south to the project limit. An additional 20 slope easement is needed in the vicinity of 5th Street to include the slopes

from Houghton Road that are extended to the east as Houghton Road shifts to the east for the proposed frontage road.

Tanque Verde Road will be widened west of Houghton Road matching a typical section proposed for the Pima County Tanque Verde Road project. The roadway and slope limits will encroach on the existing 35'+/- ROW on the south side of the roadway. ROW will need to be acquired to a width of 75' to match the existing ROW further west.

At the Tanque Verde Road / Houghton Road intersection, culvert extensions will require both additional ROW and drainage easements. The drainage easements are proposed to limits that will allow for maintenance of the culverts. The SE corner of the intersection will not need additional ROW or a drainage easement due to the culvert outlet being within the existing Houghton Road ROW.

Further east on Tanque Verde Road, the approach tapers and proposed lane configuration to Houghton Road will fit within the existing 95' ROW.

Limited work is proposed on Speedway Boulevard with the project matching another proposed City of Tucson project on Speedway Boulevard that will make improvements on Speedway Boulevard through the Houghton Road / Speedway Boulevard intersection. On the southeast corner, a Pima County easement is proposed to be acquired to accommodate the Houghton Road widening. This easement extends to the east on Speedway Boulevard for approximately 200' to where the existing ROW on Speedway Boulevard widens to 75'. The acquisition of the easement to the limits of the existing Speedway Boulevard ROW of 75' is proposed in order to provide a uniform ROW along Speedway Boulevard through the Houghton Road intersection.

Figure 12 shows the proposed ROW impacts and the proposed acquisitions and slope easements are listed in Tables 19 and Table 20, respectively.

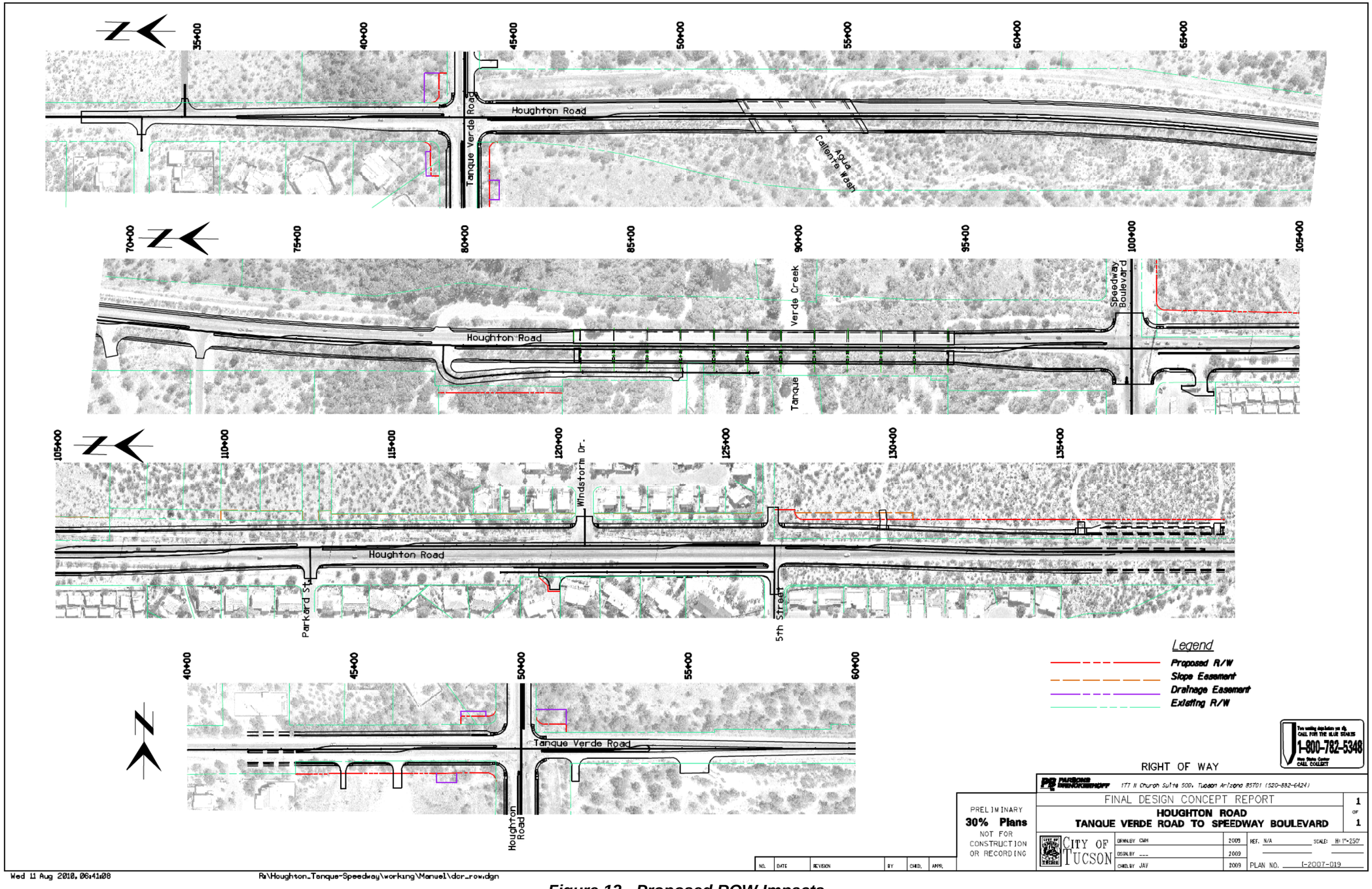


Figure 12 - Proposed ROW Impacts

Table 19 - Proposed Right-of-Way Acquisition

Parcel	Station	Ownership	Prop. Acquisition	
			S.F.	(Ac.)
1	Houghton Road 81+00 RT	133-03-311B 1411 N. Houghton Road Private	7,429	0.17
2	Houghton Road 103+00 LT	133-37-010D Pima County Flood Control Public	44,830	1.03
3	Houghton Road 120+00 RT	133-43-0780 721 N. Houghton Road Private	2,008	0.05
4	Houghton Road 126+52 LT	133-37-017B 520 N. Houghton Road Private	58,867	1.35
5	Tanque Verde Road 96+00 RT	133-03-281A 10290 E. Tanque Verde Rd Private	22,627	0.52
6	Tanque Verde Road 98+00 LT	114-55-1920 10250 E. Winding Tr Private	129	< 0.01
7	Tanque Verde Road 98+00 LT	114-55-1930 10274 E. Winding Tr Private	1,719	0.04
8	Tanque Verde Road 100+00 LT	114-57-063N Private	2,383	0.06
9	Speedway Boulevard 157+00 RT	133-37-010D Private	88	< 0.01
10	Speedway Boulevard 158+00 RT	133-37-010C Pima County Flood Control Public	13,054	0.30
Total			**153,134**	**3.52**

Table 20 - Proposed Slope Easements

Parcel	Station Begin	Area	
		S.F.	(Ac.)
1	Houghton Road 111+00 LT	7,333	0.23
2	Houghton Road 113+00 LT	1,116	0.05
3	Houghton Road 116+00 LT	14,501	0.03
4	Speedway Boulevard 124+00 LT	9,894	0.05
5	Speedway Boulevard 129+00 LT	6,947	0.05
Total		**39,791**	**0.91**

Drainage easements are anticipated for 4 of the parcels covering an area of approximately 0.16 acres. In these areas, slope grading for inlet and discharge ends of proposed drainage structures and subsequent maintenance will need to be accomplished. The drainage easements are presented in the following table:

Table 21 - Proposed Drainage Easements

Parcel	Station Begin	Area	
		S.F.	(Ac.)
1	Tanque Verde Road 97+00 RT	1,800	0.04
2	Tanque Verde Road 97+50 LT	341	0.01
3	Tanque Verde Road 98+00 LT	784	0.02
4	Tanque Verde Road 100+00 LT	3917	0.09
Total		**6,842**	**0.16**

In addition, temporary construction easements may be necessary along the Houghton Road project limits. Temporary easements are anticipated for several minor areas regarding construction at new driveways. In these areas, there will be the need for driveway reconstruction limits for proposed grading work.

6.4 Drainage

Proposed drainage improvements for the Houghton Road-Tanque Verde Road to Speedway Boulevard project include the following:

- New bridges across the Agua Caliente Wash and Tanque Verde Creek parallel to the existing bridges at these washes
- Culvert extensions
- Stormdrain trunk line
- Pavement drainage system
- Removal of existing concrete lined channels

Improvements described below begin at the Houghton Road and Tanque Verde Road intersection and extending south to approximately 5th Street.

6.4.1 On-site Drainage

The on-site proposed pavement runoff will be routed to properly-spaced catch basins, scuppers, and storm drain pipes along the proposed roadway. For cost estimating purposes, a conceptual storm drain system was laid out for the accompanying plans. Hydrologic or hydraulic analyses for this system will be completed during the design phase for this project.

Catch basins for the pavement drainage system were located at curb returns and along the roadway with a minimum spacing of approximately 300-foot spacing.
The storm-drain sizes were based on the following:

- Single Catch Basin – 24”
- Four Catch Basins – 30”
- Five to Eight Catch Basins (In Series) – 36”
- Greater than Eight Catch Basins – 42”

Pavement drainage inlets will be sized based on the 10-Year event meeting the pavement drainage design criteria. The stormdrain systems that contain what is considered offsite runoff will be designed for the 100-Year event from the offsite drainage confluence to the outfall; whereas, the upstream portion will be designed for the 10-Year event. Please refer to the roadway plan and profile sheets for an overview of the conceptual storm-drain systems.

6.4.2 Off-site Drainage

Offsite drainage structures were preliminarily designed to accommodate runoff without significant impact to the existing washes and adjacent residences. The improvements

consisted of constructing two new bridges, extending existing culverts and adding minor drainage components along Houghton Road.

The drainage improvements on the east side of the Tanque Verde Road and Houghton Road intersection include the extension of the existing box culvert to accommodate the larger roadway footprint. The existing box culvert is a 3-8'x4'x89' and is recommended to be extended 12' upstream and downstream.

On the west side of the Tanque Verde Road and Houghton Road intersection the existing structure is a 2-36"x100 CMP pipe culvert. It is recommended that the structure be extended 32' upstream and 30' downstream to accommodate the wider roadway footprint for Tanque Verde Road. Rather than using end sections similar to the existing configuration, headwalls should be used in order to provide the additional bevel increasing the hydraulic capacity for this inlet.

The existing box culvert crossing Speedway Boulevard, west of Houghton Road, is the cross drainage structure that is most affected by the widening of Houghton. The existing box is a 1-10'x4'x172' and needs to be extended downstream by 92'. The downstream extension includes 2-15º angle points to shift the outlet away from the proposed fill slope for Houghton Road. The existing riprap plunge basin will be removed and reconstructed at the proposed outlet. The inlet requires modification as well. First, the existing grated inlet will be reconstructed and second, a 48" diameter storm drain trunk line will connect to the existing box. This trunk line replaces the existing concrete lined channel along the west side of Houghton Road south of Speedway Boulevard.

Just east of the Speedway Boulevard-Houghton Road intersection the existing pipe culvert, a 2-36"'x132' RCP, will remain without the need to extend the existing culvert. It is necessary, however, to reconstruct either a grated inlet or junction structure at the upstream side. Since the proposed roadway eliminates the need for the existing

concrete lined channel south of Speedway Boulevard and reduces the majority of the contributing watershed, this is the logical outfall for the proposed stormdrain.

New bridges will be constructed downstream of the existing bridges at the Agua Caliente Wash and Tanque Verde Creek bridges which will effectively "widen" each structure. The widening of the Agua Caliente Bridge results in a slight increase in the amount of flow that breaks out of the wash and flows south to the Tanque Verde Creek on the upstream side of Houghton Road. However, this does not result in significant changes to the water surface elevations (WSELs) or floodplains for either Tanque Verde Creek or Agua Caliente Wash, as the increase in WSELs are <0.1' in most places. The only location that the proposed condition WSEL increases by more than 0.1' is on Tanque Verde Creek immediately upstream and downstream of Tanque Verde Bridge (0.14' max). Grading can most likely mitigate the increase of WSE in this area and will be addressed during the final design stage for this project. Another possibility to mitigate the increased water surface elevation is to revise the regulatory flood elevations for the Tanque Verde Creek by submitting a LOMR to FEMA.

A summary of the proposed drainage improvements is included in Table 22. Additional analysis may be needed during the final design phase depending on the limits of potential break-out projects.

Table 22 - Summary of Proposed Drainage Improvements

Location	Existing Structure	Preliminary Structure	Comments
Sta 97+39 Tanque Verde Rd	2-36”x100’ CMP	2-36”x162’ CMP	Extending existing pipes. 32’ North, and 30’ South
Sta 100+10 Tanque Verde Rd.	3-8’x4’ RCBC 89’Long	3-8’x4’ RCBC 113’ Long	Extending existing box. 12’ North and 12’ South
Tanque Verde Bridge	50-ft wide bridge that spans Tanque Verde Creek	Identical structure to be placed parallel to existing	The parallel structures will be divided by a 20’ open median.
Agua Caliente Bridge	50-ft wide bridge that spans Agua Caliente Wash	Identical structure to be placed parallel to existing	The parallel structures will be divided by a 20’ open median.
Sta 51+00 Speedway Blvd.	2-36”x132’ RCBC	2-36”x132’ RCP	Construct new area inlet Catch Basin. Proposed storm drain will insert flow into the existing structure.
Sta 49+10 Speedway Blvd.	1-10’x4’x172’ RCBC	1-10’x4’x262’ RCBC 48” Diameter Storm drain	Extend existing structure 90’ North. Replace channel along west side of Houghton Road south of Speedway with a storm drain trunk line.
Sta 102+00 Houghton Road	4-36”x57’ RCP	To be removed	Storm drain Trunk line.
Sta 112+50 Houghton Road	3-24”x52’ RCP	To be removed	Storm drain Trunk line
Sta 121+80 Houghton Road	4-24”x83’ RCP	2’x3’ Grated inlet	Storm drain.

6.5 Earthwork Considerations

The earthwork for the Houghton Road improvement for the Tanque Verde Road to Speedway Boulevard project is related to placing a large amount of fill on the west side of the existing embankment of Houghton Road between Tanque Verde Road and

Speedway Boulevard to construct the two southbound lanes. North of Tanque Verde Road, the Houghton Road alignment will closely match existing grade with limited widening. South of Speedway Boulevard, Houghton Road follows the existing grade, but will have fill and cut areas outside the existing roadway typical section as a result of the wider Houghton Road section.

Reconstruction of Tanque Verde Road through the Houghton Road intersection will also require embankment, especially west of Houghton Road where the proposed typical section will require fill on either side of Tanque Verde Road in the area between Houghton Road and the proposed improvements to the west by Pima County.

Speedway Boulevard will have minimal earthwork associated with this project as a result of the close tie-in with the project currently proposed for Speedway Boulevard

W. Drachman Street, north of the Tanque Verde Creek bridge crossing will require fill material for the reconstruction and realignment of the roadway as a result of the shift in the alignment to the west and the need to tie into the widened Houghton Road roadway embankment.

The anticipated earthwork for the project is as follows:

- Roadway Excavation 31,446 CY; Borrow 60,783 CY

6.6 Intersections and Driveways

All existing intersections within the project limits are listed in Table 23. The current traffic control of the existing intersections will not be changed with the design of this Houghton Road project.

Table 23 - Existing Project Intersections

Intersection	Location	Type	Control
Houghton Rd./Flintlock Tr.	Sta. 27+67 RT	"T", Three-way	Stop Sign
Houghton Rd./Desert Flower Pl.	Sta. 29+03 LT	"T", Three-way	Stop Sign
Houghton Rd./Shady Rock Ln.	Sta. 33+35 LT	"T", Three -way	Stop Sign
Houghton Rd./Rancho Del Este Dr.	Sta. 34+64 RT	"T", Three-way	Stop Sign
Houghton Rd./Tanque Verde Rd.	Sta. 43+46 LT & RT	"X", Four-way	Signal
Houghton Rd./ Private Entrance	Sta. 69+30 LT	"T", Three-way	No Sign
Houghton Rd./La Mariposa Entrance	Sta. 72+20 LT	"T", Three-way	Stop Sign
Houghton Rd./Frontage Rd.	Sta. 79+40 LT & RT	"X", Four-way	Stop Sign
Houghton Rd./Speedway Boulevard	Sta. 100+00 LT & RT	"X", Four-way	Signal
Houghton Rd./ Commercial Entrance	Sta. 102+08 LT	"T", Three-way	Stop Sign
Houghton Rd./Packard St.	Sta. 112+64 LT	"T", Three-way	Stop Sign
Houghton Rd./ Windstorm Dr.	Sta. 120+80 RT	"T", Three-way	Stop Sign
Houghton Rd./5th St.	Sta. 126+50 LT	"T", Three-way	Stop Sign

The *Traffic Engineering Report* provided recommendations for the turn lane storage at the Tanque Verde Road / Houghton Road and Speedway Boulevard / Houghton Road intersections. The summary of the analysis is included on Table 15, Section 4.12.

There are five residential and two commercial properties with driveway access from Houghton Road. The five residential properties are on the west side, just north of 5th Street. The two paved commercial entrances are located at the southwest corner of Speedway Boulevard/Houghton Road and at the La Mariposa entrance location about a half mile north of Speedway Boulevard on the west side of Houghton Road. The remaining side streets lead into residential subdivisions from Houghton Road.
The side streets and commercial/institutional driveways that intersect with Houghton Road all have single lane approaches.

The access to the five residences on the west side of Houghton, north of 5th Street, will be resolved with a frontage road intersecting 5th Street. Approach work will be limited to the amount necessary to account for the grade adjustments.

6.7 Utilities

Some of the existing underground and above ground utility facilities within the Houghton Road DCR study limits will be impacted by the roadway widening and the construction of a storm drain system. Table 24 shows the location of existing facilities and if any relocation is required. Figure 4 at the end of Section 3.9 shows the location of the utilities with respect to Houghton Road.

Table 24 - Utilities Along Houghton Road

Utility	Facility	Location	Relocation
Cox Communication	Cable TV (Fiber Optic and Coaxial)	Crossings & Underground line segments	Probable
Southwest Gas	Natural Gas	Crossings & Underground (east/west side)	Probable
Tucson Electric Power (TEP)	Electric	Crossings & Overhead/ Underground	Yes, due to roadway widening
Tucson Water	Water/Reclaimed Water	Along West side & Sideroad laterals	@ drainage locations
Qwest	Telephone (coaxial)	Crossings & Underground line segments	Probable
Pima County Wastewater Mngt.	Sanitary Sewer	Crossings & Underground line segments	@ drainage locations
Pima County DOT	Traffic Signals (electric)	Tanque Verde /Speedway Blvd	Yes, due to roadway widening

See Appendix for detailed list of project utility contacts.

A discussion on individual utility facility impacts is as follows:

Fiber Optic – Cox Communications

There may need to be relocation of the Cox Communications fiber optic television line that is on the east side of Houghton Road from Tanque Verde Road to south of Speedway Boulevard, especially at the Speedway Boulevard crossing due to conflict with proposed culverts.

Natural Gas – Southwest Gas

All gas line crossings along Houghton Road will be analyzed for any horizontal and vertical conflicts. These conflicts will be researched during the design phase of Houghton Road. A discussion of potential impacts in areas where there are Southwest Gas lines follows:

North of Tanque Verde Road: Widening of Houghton Road is proposed to match existing grade with no new drainage culverts. No impacts are anticipated to the 2" polyethylene (PE) gas line.

Tanque Verde Road: Widening of Tanque Verde Road will match existing grade. The 4" and an 8" high pressure steel gas lines north of Tanque Verde Road are beneath the existing culvert at the intersection are not anticipated to be impacted.

Between Tanque Verde Road and Speedway Blvd: Gas lines on the west and east side of Houghton Road are nearly all outside the proposed slope limits. North of the Drachman Street frontage roads, an 8"steel line crosses Houghton Road but shouldn't be impacted by construction. At W. Drachman Street, a 2" PE gas line from west of the existing roadway may be impacted by the reconstruction of Drachman Street. Also, this gas line crosses beneath the existing bridge and likely will be impacted by construction of the drilled shaft and piers for the new bridge.

Speedway Boulevard: The 8" steel and 2" PE gas line crossing Speedway Boulevard on the east side of Houghton Road is will be outside the limits of work for the project and not impacted by construction. The 8" steel and a 4" PE gas lines that cross Houghton Road from the west just south of the intersection may be in conflict with proposed storm drain.

Between Speedway Blvd and 5th Street: No relocations are anticipated in this vicinity with the existing lines on the east side of Houghton Road being outside the proposed slope limits.

Electric – Tucson Electric Power (TEP)

Power poles outside the existing ROW are assumed to have prior rights and are subject to reimbursement by the City for relocation and those within are assumed to not have prior rights and their relocation costs are to be covered by TEP. Final prior rights determination will need to be done during final design.

North of Tanque Verde Road: Overhead power lines on the east side of Houghton Road from Flintlock Trail to Tanque Verde Road will not be impacted by the widening.

Tanque Verde Road: The overhead power lines running east and west along the north side of Tanque Verde Road will be impacted with the widening of Tanque Verde Road, west of Houghton Road. East of Houghton Road, fill limits don't extend to the poles.

Between Tanque Verde Road and Speedway Boulevard: Overhead power lines south of W. Drachman Street will likely be impacted by the construction of the new bridge over the Tanque Verde Creek. Lines over Houghton Road will need to be reviewed during final design. Overhead power lines along the west side of Houghton Road to Speedway will be impacted by the embankment for the north Houghton Road approach to Speedway Boulevard.

Speedway Boulevard: The tall, metal, transmission pole located on the southeast corner of the intersection will need to be relocated due to the reconstruction of the Houghton Road / Speedway Boulevard intersection. Lines to this pole from the west along Speedway Boulevard and south along the east side of Houghton Road will need to be relocated. The southeast corner pole's relocation costs are estimated to be paid for by the City.

Between Speedway Boulevard and 5th Street: All the overhead power lines on the east side of Houghton Road from Speedway Boulevard southward past 5th Street will need to be relocated due to the widening of Houghton Road and the shifting of the alignment to the east. An assumption was made that all the poles between Speedway Boulevard and Broadway Boulevard will need to be relocated with this project and that (8) poles total will need to have their relocation costs reimbursed to TEP by the City since they are outside the existing ROW and assumed to be there with prior rights.

Water – Tucson Water

Since the design profile does not change dramatically, only incidental modifications or temporary shut-offs to the existing mains at drainage structures are anticipated. Coordination will need to be made with Tucson Water concerning the installation of proposed drainage cross-structures at these water main crossings.

At the Tanque Verde Creek, the existing Tucson Water well site is not anticipated to be impacted by the project. PB reviewed the impacts to the site from reconstructing W. Drachman Street and is proposing to end W. Drachman Street just north of the well site at an existing driveway. This driveway parallels a similar driveway south of the well site and at the terminus of W. Drachman Street. That southern drive, however, connects back to the drive north of the well site at a point further west of the project providing continuous access around the well site. The relocated roadway alignment would pass over the well site if it were continued south.

Also at the Tanque Verde Creek, there are waterlines along the W. Drachman Street alignment that will be impacted by the construction of the new bridge abutments, piers, and drilled shafts.

At Speedway Boulevard, the intersection widening that will occur as part of this project will not likely impact the 24" concrete cylinder (CC) line and a 12"/16" (DI) reclaimed water (RW) line that run to the east on Speedway Boulevard, crossing Houghton Road. From Speedway Boulevard southward, however, the 12" (ACP) that continues along the west side of Houghton Road to 5th Street will be crossed with five storm drain pipes that will run from proposed catch basins on the east side of Houghton Road to a trunk line proposed along the west side. In addition, the existing waterline goes along the proposed frontage road, north of 5th Street where it may be impacted by construction of the frontage road retaining wall. South of 5th Street to the project limit, no existing waterlines were found.

Telephone - Qwest

North of Tanque Verde Road: Qwest telephone lines are not anticipated to be impacted in this vicinity.

Tanque Verde Road: Qwest lines are beneath the existing culverts crossing Tanque Verde Road near Houghton Road and are not anticipated to be impacted by the culvert extensions or roadway widening. Just south of the intersection, on the east side, underground telephone lines likely will be impacted by the culvert extension. There are several lines in this vicinity, but none identified as fiber optic.

Between Tanque Verde Road and Speedway Boulevard: There are underground telephone lines west of the frontage road on the west side of Houghton Road that may be impacted by the W. Drachman Street reconstruction. These lines are nearly parallel to the Southwest Gas gas lines and will also be impacted by the construction of piers and drilled shafts for the new bridge over the Tanque Verde Creek.

Speedway Boulevard: An existing pedestal on the northeast corner of the Houghton Road / Speedway Boulevard intersection as well as the underground lines that run to it will need to be relocated due to widening of the intersection.

South of Speedway Boulevard: Impacts will be limited to relocation of a pedestal and lines on the east side of Houghton Road, opposite Packard Street. From here, south to Windstorm Drive lines along the east side of Houghton Road will be impacted by the widening with the lines running to several overhead power poles that will need to be moved due to the widening.

Sanitary Sewer – Pima County Regional Wastewater Reclamation Department

The 8" PVC sewer lateral located west of Houghton Road at Shady Rock Lane won't be impacted by the project improvements. The 18" VCP sanitary sewer that crosses Houghton Road just north of the Tanque Verde Creek may be impacted by construction of the drilled shafts and piers for the new bridge over the Tanque Verde Creek. South of Speedway Boulevard at Packard Street, the lateral has manholes in the existing Houghton Road pavement that will likely need to be rebuilt and there is potential conflicts with a proposed storm drain cross pipe.

Like the water main facilities, conflicts with the underground sewer lines will be examined more closely and designs modified to minimize the extent of their relocation.

Cable – Cox Communication

Fiber optic lines on the east side of Houghton Road in the vicinity of the Tanque Verde Road intersection are not anticipated to need to be relocated. It appears from our initial locating efforts that these lines pass beneath the existing culvert crossing Tanque Verde Road on the east side of Houghton Road. Between Tanque Verde Road and Speedway Boulevard, these lines are east of Houghton Road and outside the limits of the improvements. These lines cross Speedway Boulevard, east of Houghton Road and are not anticipated to be impacted here. South of Speedway Boulevard, these lines

shift to the west and run to an overhead power pole that is approximately 300 feet south of the intersection. This pole will need to be relocated along with all utility lines to it.

Traffic Signals – Pima County DOT

Traffic signals at both the Tanque Verde Road intersection and Speedway Boulevard intersection will need to by redesigned and rebuilt as part of the construction project to widen Houghton Road.

6.8 Structures

There are currently two bridges located along the limits of this Houghton Road segment. New bridges will be placed west of and adjacent to both bridges in order to widen the roadway for the proposed roadway cross-section. The two new bridges will be similar in design to the existing structures. Section 10.0 Alternatives describes the analysis conducted to determine the recommendation for the new structures.

In addition, drainage structures consisting of reinforced concrete boxes and culvert pipes will be installed at crossings along this roadway segment. The significant improvements related to drainage will be the installation of a storm drain system along the west side of Houghton Road, south of Speedway Boulevard where there currently is an open concrete channel. In addition, the existing concrete channel on the east side of Houghton Road is proposed to be removed and filled in by the Houghton Road widening. Runoff currently conveyed in this channel will be collected in pavement storm drains and directed to the storm drain system.

Aside from these significant drainage improvements south of Speedway Boulevard, the remaining drainage improvements consist of extensions to existing culverts at the corners of Speedway Boulevard and Tanque Verde Road.

6.9 Landscaping

South of Speedway Boulevard, this project will include the Houghton Road Greenway. The Greenway is planned to run along the Houghton Road Corridor from Interstate 10 to Speedway Boulevard. At Speedway it connects to a planned multi-use path running to the east. In addition to the Greenway, limited landscaping utilizing water harvesting will be provided in the median and on the west side of the roadway. North of Speedway Boulevard, where the greenway will not continue, sidewalks will be provided on both sides of the roadway. Water harvesting is proposed along with limited irrigation for landscaping along Houghton Road and the median. The City has cited reduced funding for landscaping and dwindling water resources as the primary factors for this consideration. The City of Tucson will be developing a landscaping scheme for Houghton Road during the detailed design phases of the various Houghton Road construction projects.

The typical section for Houghton Road included in the HRC includes a 40-50' wide strip on the east side of the street for the Houghton Road Greenway. According to the 2004 Pima County Bond Improvement Plans Ordinance No. 2004-18, the greenway is to be developed using the Divided Urban Pathway model as adopted by both Pima County and the City of Tucson. This model includes a 12' striped asphalt path and an 8' soft surface path, each separated from the roadway and from each other by a vegetated buffer. Figure 13 illustrates a typical cross-section for this pathway. The design concept for the greenway emphasizes the use of native plants and natural groupings to create the feel of natural desert and to provide habitat for compatible wildlife. The use of native trees to provide shade along the path, shrubs and cacti for both wildlife cover and visual interest and other natural elements such as boulders are used to create a desert "greenway" which provides recreational and natural space along the length of the corridor.

The frontage road that is proposed for this project on the west side of Houghton Road north of 5th Street requires that the Houghton Road roadway alignment shift to the east.

This shift to the east reduces the available width for the greenway within the existing ROW to the point where it is not feasible to have dual paths. In this area, a single, paved, 10' multi-use path is proposed for Houghton Road.

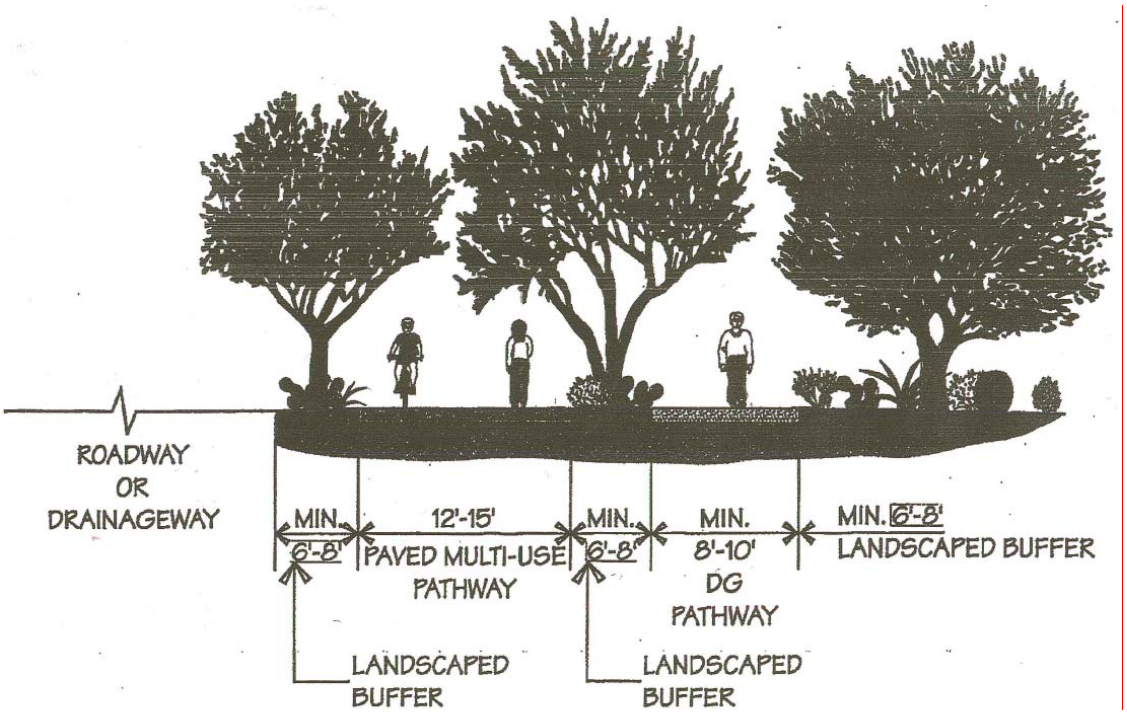


Figure 13 - Proposed Divided Urban Pathway

6.10 Construction Sequencing

The segment of Houghton Road from Tanque Verde Road to Speedway Boulevard will likely be constructed in one phase with the possibility of advancing the construction of the frontage road on the west side of Houghton Road near 5th Street earlier in the overall scheduling of Houghton Road projects. One phase of construction is anticipated primarily due to the close proximity of Speedway Boulevard to the Tanque Verde Creek and the need to build the north Houghton Road approach to Speedway Boulevard at the same time as the bridge in order to accommodate both the number and alignment of the lanes on the approach. Both the bridge over the Agua Caliente Wash and the Tanque Verde Creek could be built at the same time with minimal impact to existing thru traffic

on Houghton Road since both these bridges are offset from the existing alignment and the existing bridges would still be able to be used for traffic.

Advancing the frontage road construction on the west side of Houghton Road near 5th Street ahead of the Houghton Road widening would allow for minimal disruption to the residents along this road and could be constructed without significant disruption to the existing Houghton Road roadway. The frontage road would consolidate access to Houghton Road at 5th Street eliminating the need of the contractor to maintain access to these residents during both the construction of the frontage road and the Houghton Road widening.

6.11 Jurisdictional Delineation

The City of Tucson recommended that the jurisdictional delineation (JD) be completed for this project prior to beginning final design. The jurisdictional limits will be determined using guidelines provided by the US Army Corps of Engineers for delineating Waters of the United States which includes evaluating wash characteristics such as bed and bank, presence of litter, natural line impressed on the bank, shelving, vegetation matted or absent, sediment sorting, scour, deposition and other soil, vegetative, and hydrological characteristics.

Briefly, there are 2 major washes located within the project limits that are presumed to be potentially jurisdictional: the Agua Caliente Wash and the Tanque Verde Creek. Tributaries to both these washes could also be considered jurisdictional with the drainage on the northwest corner of the Houghton Road / Speedway Boulevard intersection being the most significantly impacted. Here, the embankment to the new southbound Houghton Road lanes will likely fill in the existing waterway and new grading will be needed to redirect runoff to the Tanque Verde Creek.

7.0 Social, Economic, and Environmental Considerations

7.1 Biological Resources

The purpose of this section is to identify the potential impacts of the proposed project on biological resources in the project area. The analysis of potential impacts is limited to the special status species that were identified as potentially occurring in the project area in Section 3.8.

7.1.1 Protected Native Plants

The City of Tucson Native Plant Preservation Ordinance restricts the removal of the native plant species that are on the City's list of protected native plants. As part of the project, protected native plants will be assessed, inventoried, salvaged if appropriate, and replanted in the project area.

7.1.2 Wildlife

Roadway improvements could result in a wider roadway that is an impediment to wildlife movements and increased threat for wildlife that may attempt to cross. The existing structures at Agua Caliente Wash and Tanque Verde Creek (both multi-span bridges) provide highly critical wildlife linkages and function as primary movement corridors between large blocks of undeveloped lands. It is recommended that the bridge structures at these two washes are maintained so these washes can continue to function in this capacity.

7.1.3 Special Status Species

A Biological Evaluation will be prepared to address potential impacts of the project on threatened, endangered, candidate, and conservation agreement species. Potential impacts based on preliminary project information are identified below.

Tumamoc Globeberry

This species could potentially occur along drainages within the project area. A native plant inventory will be conducted later in the design process. If present, individual plants may be impacted during construction; however because of the narrow, linear aspect of the project any potential impacts to this species would not result in a trend towards federal listing.

Western Yellow-billed Cuckoo

This species is found in association with large blocks of riparian habitat below 6,500 feet; in southeastern Arizona primarily nests at elevations below 5,000 feet amsl (Corman 2005). Available information suggests that native riparian tree species (such as cottonwood or willow) are an important component of suitable yellow-billed cuckoo habitat (Corman and Magill 2000; USFWS 2001). Surveys conducted by Pima County in 2002/2003 indicated the presence of yellow-billed cuckoo near the Houghton Road-Tanque Verde Creek crossing. Potential impacts to the cuckoo could result if substantial improvements (e.g. bridge replacement) are conducted along Houghton Road in this area. Species specific surveys are recommended prior to construction to determine if this species is present within the project area along Tanque Verde Creek. This species of cuckoo is currently listed as a candidate species under the ESA, meaning that full protection under the ESA may be warranted, but precluded by other higher priorities listings activities. If the cuckoo receives full protection under the ESA prior to construction, the City may need to initiate consultation with the US Fish and Wildlife Service to determine impacts.

7.2 Air Quality

PAG is the designated air quality planning agency and the metropolitan planning organization for the greater Tucson region. The design of this project has been included in the Transportation Improvement Plan (TIP) for 2008-2012, while the construction of the project is part of the 2030 Regional Transportation Plan (RTP), which is included in the 2030 Regional Transportation Plan.

The Clean Air Act Amendments of 1990 require that the TIP conform to the State's air quality implementation plan's (SIP) purpose of eliminating or reducing the severity and number of violations of the National Ambient Air Quality Standards (NAAQS) and achieving expeditious attainment of such standards and that TIP activities will not cause or contribute to any new violation of any standard in any area; increase the frequency or severity of any existing violations of any standard in any area; or delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

In April 2000, the EPA promulgated a final rule that re-designated the Tucson Air Planning Area to attainment for the carbon monoxide NAAQS and approved a maintenance plan that will insure that the area remains in attainment.

The PAG Regional Council and the US Department of Transportation made an air quality conformity determination for the 2030 Regional Transportation Plan in 2006. This finding was made following the procedures outlined in the federal transportation conformity rule (40 CFR Part 93) and the State of Arizona conformity rule (R18-2-1401 et seq.).

By the adoption of the 2008-2012 TIP, the PAG Regional Council found that the Regional Transportation Improvement Program for FY2008-2012 is in conformity with the State Improvement Plan and also affirmed that the TIP is consistent with the 2030 Regional Transportation Plan.

In addition, the Houghton Road Corridor Study states that air quality tends to be better when the traffic congestion is less. The improvements recommended to the corridor will tend to reduce the carbon monoxide levels by improving the roadway LOS. Regional air quality impacts have been thoroughly addressed in the RTP and should not be considered an issue for the Houghton Road project.

7.3 Noise

Noise is often considered 'unwanted sound' originating from acoustic energy. Many of the noise decibels entering a subdivision comes from highway traffic. The consideration of noise-abating materials for the proposed Houghton Road improvements includes installing an asphalt rubber asphaltic concrete (ARAC) layer. This ARAC layer will be placed as the finished surface of the new roadway for its noise reduction quality. The benefits of the noise reducing material will affect the approximately 150 residences and commercial developments adjacent to the roadway.

In accordance with ADOT, a high-cost noise-abatement barrier is not warranted due to the widening effects of the new roadway. This policy of applying rubberized asphaltic surface pavement is also per the City of Tucson (COT) *Active Practice Guidelines*.

7.4 Hazardous Materials

A specific hazardous materials study of the project area has not been conducted as part of this DCR, however, a preliminary hazardous materials evaluation was conducted as part of the HRC which included this project segment of Houghton Road from Tanque Verde Road to near 5th Street south of Speedway Boulevard. The preliminary evaluation found one site within this project area which is listed in Table 26.

Table 25 - Possible Hazardous Materials Site

Site	US EPA #	Priority	Reason
Circle K #1933 10290 East Speedway	FAC # 0-004307	Mid	UST

ROW acquisition is not planned for this site but it is anticipated that a Phase I Environmental Assessment study will need to be done for all parcels with ROW acquisition, prior to the construction, to determine suitable mitigation .

7.5 Visual/Aesthetic Resources

The Houghton Road corridor is subject to landscape standards and development regulations specified in the City of Tucson Land Use Code as outlined in Article III, Division 7 Landscaping and Screening Regulations and Division 8 Native Plant Preservation. The intent of the Landscaping and Screening code is to "establish regulations for the installation and maintenance of landscaping and screening according to recognized xeriscape principles and to provide for the protection of native vegetation". The Native Plant Preservation ordinance was established to "encourage the preservation-in-place of healthy, native plants through sensitive site design…". These codes work together to preserve the unique biological setting of Tucson within the Sonoran Uplands.

The City of Tucson Major Streets and Routes Plan (MS&R) begins to address this: "Tucson has a unique physical setting and climate which are major-factors in attracting visitors and residents. Their key image of the City is derived from the views along major routes. Streets which are heavily traveled, those that lead from transportation terminals to hotels and resorts, and those that lead to recreational facilities are routes which provide the basic impression of Tucson's character." This goal to address these major "image" streets resulted in the creation of classifications for Gateway routes and Scenic Routes – the former being located in more developed urban areas, the latter in less developed areas with a more rural character. The segment of Houghton Road from Tanque Verde Road to Speedway Boulevard is designated as a Scenic Route in the City's MS&R.

Guidelines for scenic routes include the preservation of prominent viewsheds and the features which produce them, preservation of the "scenic quality" of the surrounding desert and mountain environment and the siting and design of development elements to preserve view windows and the natural quality of the area. The landscaping is to be kept as natural as possible, in an effort to enhance natural beauty instead of replacing it with a sense of imposed design. Although these regulations may not apply to this

stretch of Houghton, they may be used to guide design decisions in order to preserve the unity of the corridor. Some methods for achieving these goals include:

- Using a palette of plants native to the immediate area of the project, including salvaged specimens of differing sizes and ages and supplemental nursery plants including cacti and succulents.

- Planting larger plants and trees with sensitivity to the location of utilities, traffic site lines and adjacent properties to reduce future maintenance and impacts.

- Grouping plantings in a irregular way that mimics natural patterns rather than utilizing formal geometries or forms.

- Designing structural elements such as walls and channels using natural materials whenever possible or earth colored materials when man-made materials are required.

- Following best practices for plant placement and relationships within the overall context to best utilize micro-climates, exposures and clustering for the purpose of adequate irrigation.

All plant materials will be selected from the approved Landscape Plant Materials list from City of Tucson Development Standard 2-16.0. Water to the plants shall be supplied by a water-conserving, underground irrigation system that includes weather monitors, rain sensors and controllers that are capable of being adjusted to changes in weather, season and water use. Wherever possible, plants should be located to make maximum use of harvest rainwater from stormwater runoff.

This section of the Houghton Road Corridor includes the northern end of the Houghton Road Greenway which is planned to extend along the Corridor from I-10 to Speedway Boulevard where it connects to a mulit-use path extending to the east along Speedway

Boulevard. The Greenway is a 40-50' wide strip on the east side of the roadway. According to the master plan, the greenway is to be developed using the Divided Urban Pathway model as adopted by both Pima County and the City of Tucson. This model includes a 12' striped asphalt path and an 8' soft surface path, each separated from the roadway and from each other by a vegetated buffer. North of Speedway Boulevard where the Greenway is not planned concrete sidewalks will be provided on both sides of the roadway.

Public art will be integrated into the design of the project. Most frequently, this includes the use of structural elements in the roadside, including retaining walls and bridge structures. Art can also be incorporated into safety treatments for projects such as safe routes to schools. Figure 14 identifies possible art locations along the project.

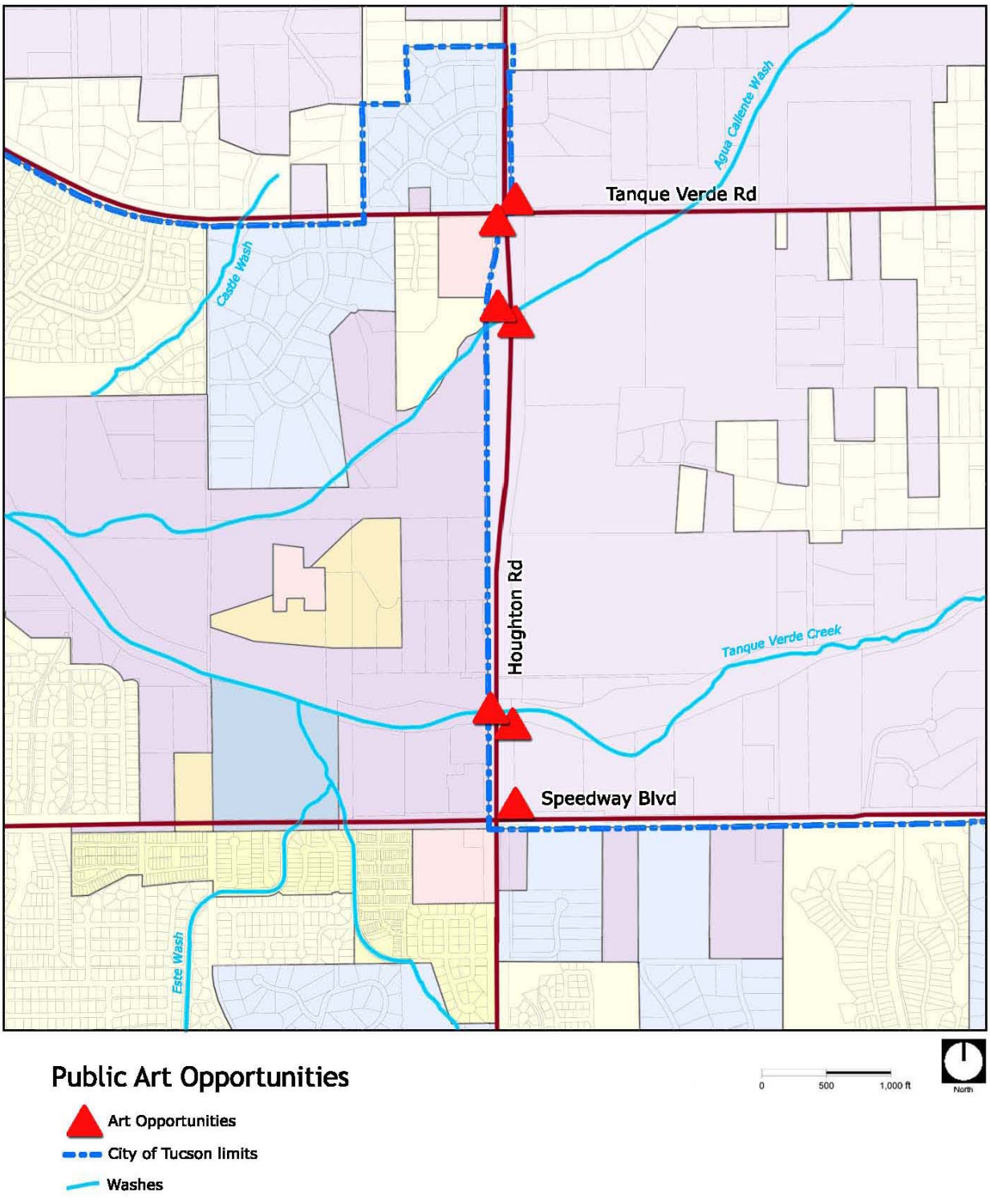


Figure 14 - Proposed Public Art Opportunities

7.6 Cultural Resources

Tierra Right of Way Services, Ltd. Conducted a Class III cultural resource survey on October 10, 2008 along the Houghton Road corridor right-of-way from Speedway Boulevard to Old Spanish Trail. The survey revealed that the project crosses portions of three previously recorded prehistoric sites:

- The Tanque Verde Wash site (AZ BB:13.68[ASM])
- The Houghton Road site (AZ BB:13.398[ASM])
- An unnamed artifact scatter (AZ BB:13.654[ASM]) – since destroyed.

The Tanque Verde Wash site and the Houghton Road site are multi-component prehistoric villages that have been recommended eligible for inclusion in the National Register of Historic Places (NRHP). Previous investigations at both sites have demonstrated that each contains significant buried cultural resources including human burials. Therefore, it is recommended that an archaeological testing plan be developed and implemented at the portions of these two sites likely to be affected by the proposed widening of Houghton Road.

For areas outside the recorded boundaries of the Tanque Verde Wash site and the Houghton Road site, it is recommended that the project be allowed to proceed with no further need for archaeological work. Additional surveys for cultural resources will be required if the right-of-way is extended beyond the study corridor. In addition, all work shall cease immediately when incidentally encountering cultural deposits more than 50-years old. The Director of the Arizona State Museum and the Pima County Archaeological and Historic Preservation Office shall be notified so a consultation process can begin and a course of treatment decided upon.

7.7 Neighborhood Impact

There will be several impacts to the neighborhoods along Houghton Road as a result of widening the existing two lane roadway to a four lane divided roadway. One benefit will

be improved safety at many of the side roads to Houghton Road with access limited to right turns in and right turns out of the neighborhoods. This will reduce the number of vehicular conflicts along Houghton Road. On the negative side, these residents will not have the direct access that they now have due to the construction of the raised median and limited locations for left turns. Access across Houghton Road will be limited to median openings that will be spaced a minimum of 660' apart.

Connectivity between neighborhoods will be improved with a sidewalk along the west side of Houghton Road and either a sidewalk (north of Speedway) or the proposed greenway (south of Speedway) along the east side of Houghton Road. Currently, there are no pedestrian facilities like these through the project limits.

7.8 Community Resource Impact

The TAG Elementary charter school is the only school located within the study area. It is located on the north side of Speedway Boulevard about 1000 feet west of Houghton Road.

The Club at Mariposa is a private club west of Houghton Road between Tanque Verde Creek and Agua Caliente Wash. Primary all-weather access is off Houghton Road at the north end of the Tanque Verde Creek bridge.

There are no churches located within the study area, although the Rincon Church of God is located just across Tanque Verde Road from the study area, and Saint John on the Desert Presbyterian Church is located ¼ of a mile further north on Houghton Road.

There are no fire station facilities in the project area to be impacted by construction, the closest being Tucson Fire Department Station 12 on Harrison south of Broadway Boulevard.

8.0 Public Involvement

8.1 Public Involvement Process

The public involvement process for this project is conducted by Gordley Design Group (Gordley). Their work included creation of a public involvement plan (PIP) for the entire project for both the DCR and design phases. The plan included production of a fact sheet to provide information and clarification to interested parties regarding the public process for the entire project. Interested parties may include the Regional Transportation Authority (RTA), Citizens Accountability for Regional Transportation (CART) Committee, Citizen Transportation Advisory Committee (CTAC) and neighborhood and business associations. Components of the plan also addressed public meetings, general outreach, and roles of other advisory committees such as CART and CTAC.

8.2 Project Website

A project website has been set up for projects along Houghton Road. Its address is http://www.houghtonroad.info/. There currently are three projects on the website: the Tanque Verde Road to 22nd Street project, the 22nd Street to Valencia Road project, and the Valencia Road to I-10 project. The website lists project information such as meeting notices, public comments, open house presentations, and general project information.

8.3 Public Open Houses

A public open house has been held for segment of Houghton Road from Tanque Verde Road to 22nd Street on March 22nd, 2009 at the East Tucson Baptist Church, 9000 E. Speedway Boulevard from 6:00 p.m. to 7:30 pm. This open house was the first open house to present the improvements for the section of Houghton Road from Tanque Verde Road to Speedway Boulevard. Gordley Design Group conducted the open

house and prepared a report including all pertinent materials, the public response forms and a summary of the results.

Improvements presented at the open house included the frontage road concept on the west side of Houghton Road north of 5th Street.

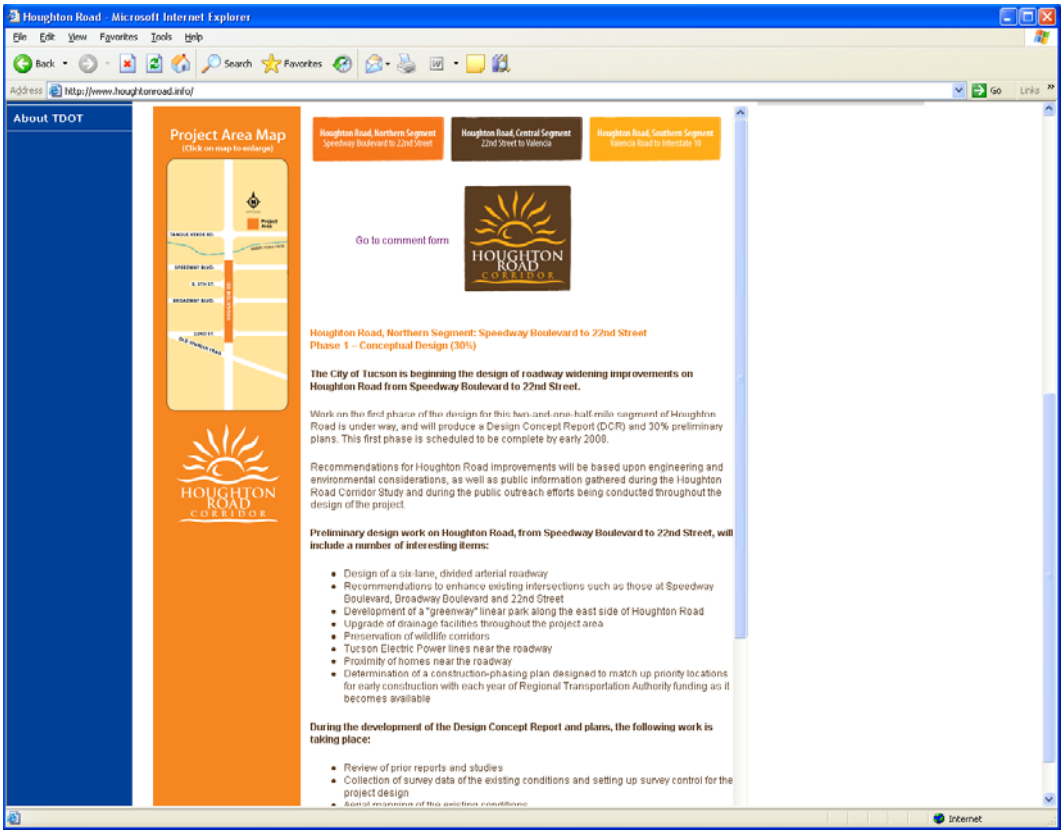


Figure 15 - Houghton Road Website

Area residents, property owners, stakeholders and jurisdictional representatives attended the open house. Members of the project team answered questions from the public and solicited input and concerns. Sixty-Eight people signed in, outside the project team, and a total of 17 Comment Forms were received, from which a Comment Summary was prepared. Comment summaries are posted to the project web site.

Comments from this meeting related to the Tanque Verde Road to Speedway Boulevard segment included the following issues:

- Six-lane roadway need verses four-lane roadway for Houghton Road north of Broadway Boulevard
- Property home value impact as a result of widening Houghton Road to six lanes
- Need for evaluation of a traffic signal at the intersection of 5th Street and Houghton Road
- Need for a full median to allow a "U" turn at Windstorm Drive verses either the one at Packard Street or 5th Street.

8.4 Small Meetings

Parsons Brinckerhoff and city staff also held the following meetings on April 29, 2009 with individuals or small groups along the corridor to deal with site specific issues:

- At the Ward 2 office with one of the five property owners located at the northwest corner of 5th Street and Houghton Road to discuss the impacts of the proposed frontage road to serve those properties.
- A meeting on site at Packard Street and Houghton Road with residents to review the proposed improvements.
- A meeting on site at Windstorm Drive and Houghton Road with residents to review the proposed improvements.
- A meeting on site at Kensington Street and Houghton Road with residents to review the proposed improvements.
- A meeting on site opposite Rancho del Este and Houghton Road with residents to review the proposed improvements.

8.5 Citizen Design Review Committee (CDRC)

A Citizen Design Review Committee (CDRC) was formed through the City of Tucson Ward 2 office to provide an opportunity for stakeholders in the vicinity of the northern segment of Houghton Road to provide comments on the progress and development of projects within this segment. On March 2nd 2009, the City held a CDRC meeting and provided an overview of the proposed improvements on Houghton Road from Tanque Verde Road to Speedway Boulevard. Highlighted design features included the two new bridges, one for the Agua Caliente Wash and one for the Tanque Verde Creek. Both these new structures were said to be proposed to be constructed on the west side of Houghton Road. Among other topics discussed was the need for six lanes on Houghton Road north of Broadway Boulevard and only four lanes for Houghton Road north of Speedway Boulevard to Tanque Verde Road.

9.0 Agency Coordination

PB will perform coordination with TDOT, team members and other project stakeholders on an ongoing basis. PB will also facilitate project team meetings throughout the duration of the project development, and prepare meeting minutes to distribute to team members. The meetings will be regularly attended by the PB Project Manager and the Project Engineer. Other PB team members may attend as required to address specific issues. The meetings anticipated or held thus far for this project include:

- Kick-off Meeting - held on September 17, 2008.
- Seven regular monthly meetings with the TDOT project manager and the design team between December 2008 and June 2009. Included will be coordination meetings with TDOT and the other design consultants working on other portions of the corridor.
- Several design review meetings were held in the field on April 29th, 2009 with TDOT staff and residents from the neighborhoods adjacent to Houghton Road.
- Three additional meetings were held with PCDOT and TDOT staff to discuss the design criteria for the project for the area of Houghton Road within the Pima County ROW north of Speedway Boulevard as well as the configuration of the bridges across the Agua Caliente Wash and Tanque Verde Creek.

Utility coordination has been limited to the information that the City provides the utility agencies at the City's monthly coordination meeting. Any information or prior plans from these agencies will contribute to the design of this project. In turn, these agencies will receive developed 30% plan sets from PB (as they are available) in order to make any final adjustments.

10.0 Alternatives

The alternatives for the Houghton Road: Tanque Verde to Speedway Boulevard project developed from review of the design in three areas: the west side of Houghton Road between 5th Street and Speedway Boulevard, the location of the alignment and typical section at the Tanque Verde Creek and Agua Caliente Wash, and the northbound alignment between Packard Street and Speedway Boulevard.

10.1 West side of Houghton Road between 5th Street and Speedway Boulevard

The area on the west side of Houghton Road between 5th Street and Speedway Boulevard has five residential properties with access to Houghton Road. The widening of Houghton Road will eliminate the gravel area that is used for access as well as a gravel frontage road serving the northern most two parcels. Homes here are at a higher elevation than Houghton Road. Five alternatives were considered:



Frontage Road and gravel area north of 5th Street

Alternative 1 – provide a frontage road along the west side of Houghton Road and shift the Houghton Road centerline to the east. The frontage road ties into 5th Street near the Houghton Road/5th Street intersection.

Alternative 2 – provide direct driveway access to Houghton Road for the five residential properties and shift the Houghton Road centerline to the east as in Alternative 1. The

shift in the Houghton Road centerline is needed to provide separation between the road and the properties to develop suitable driveway profiles.

Alternative 3 – provide a frontage road and Houghton Road centerline shift as in Alternative 1, but to adjust the tie-in point at 5th Street to the west to provide storage for vehicles waiting to turn onto Houghton Road. An option within this alternative is to continue the frontage road to the north and connect with Packard Street.

Alternative 4 – provide direct access to four of the five residences without a Houghton Road centerline shift to the east. The northernmost parcel has an extended drive to the north to allow for a reasonable driveway profile grade down to Houghton Road.

Alternative 5 – eliminate direct access to Houghton Road and either acquire the parcels or modify their accesses so that access comes from the west side of the parcels rather than the east side onto Houghton Road.

These alternatives were submitted to the City of Tucson for review in May, 2008. These alternatives were briefly discussed at the June 11th, 2008 CDRC meeting and shown at the March 2nd 2009 CDRC meeting. These alternatives were also on display at the March 24th project public open house.

PB received feedback from the CDRC at the March 2nd meeting in favor of Alternative 1 and the City has expressed interest in pursuing Alternative 1.

The advantages of Alternative 1 are:

- It consolidates driveways.
- Does not provide direct access to Houghton Road for the private driveways.
- City does not need to acquire the parcels.

The disadvantages of the other alternatives are:

- Direct access is not eliminated in alternatives 2 and 4.

- The Alternative 3 alignment impacts a wash near 5th Street and places traffic next to yard walls north of the five residences.
- Alternative 5 has significant cost impacts with the property acquisitions or changing the access from directly from Houghton Road to the west side of their properties.

10.2 Alignment and Typical Section crossing the Washes

There are two significant bridge structures within the project limits from Tanque Verde Road to Speedway Boulevard: the Aqua Caliente Wash Bridge and the Tanque Verde Creek Bridge. These structures were designed in the early 1980's and built in the early 1990's. The intent of those designs was to accommodate a two-lane roadway that would serve as one half of an ultimate four-lane roadway section. The additional two lanes would be constructed on an alignment parallel and to the west of the two-lane roadway. Future structures across the Agua Caliente Wash and Tanque Verde Creek for those new two lanes would mirror those built in the early 1990's. The Houghton Road: Tanque Verde Road to Speedway Boulevard project now will complete the ultimate four-lane roadway.

PB reviewed the as-built plans and discussed the design of additional structures across the Aqua Caliente Wash and Tanque Verde Creek with both the City and Pima County. While building the second two lanes west of the existing Houghton Road alignment is the logical course of action due to the available existing right-of-way, several features of the existing typical section and their relationship to the approach to Speedway Boulevard required evaluation. These features include:

- Shoulder width
- Median width/configuration
- Sidewalk width

Shoulder Width – The existing roadway shoulders are 8' wide and those on the bridges 9'. PB's initial alternative was to reduce the existing shoulders to the current standard of 6' by shifting the Houghton Road travel lanes to the east by 2'. The as-built drawings show the same pavement section beneath the shoulder as is under the travel lane which would allow for this shift. One advantage of shifting the roadway to the east is that this minimizes embankment for the new two lanes of Houghton Road to the west. The 2' shift, however, leaves a 7' shoulder on the bridge which was not acceptable to PCDOT. PCDOT requested 8' outside shoulders on the bridges over the Tanque Verde Creek due to their length of approximately 1100' and the desire to provide a distress lane for vehicles. Through discussions with PCDOT and the COT, a consensus was reached to provide 8' shoulders on the bridge over the Aqua Caliente wash as well in order to provide a consistent design for the bridges in this area of Houghton Road.

The inside shoulders off the bridges are proposed to be 2' which is the design for Houghton Road south of Speedway Boulevard. While the existing bridge configuration has two-way traffic on two 12' lanes with 9' outside shoulders, the proposed typical section will have one-way traffic with an outside shoulder of 8' and a resulting inside shoulder of 10'. Several options were evaluated to reduce this width such as channelization striping, retaining the wider shoulder, or shifting the roadway to the west and have the extra width used for a wider sidewalk. PCDOT requested that a half section barrier be added to the existing bridge to reduce the visible inside shoulder to 2' rather than using channelizing striping or retaining a wider shoulder. Shifting the roadway to the west would result in increased earthwork on the bridge approaches.

Median Width – The determination of the median width along Houghton Road between Tanque Verde Road and Speedway Boulevard was evaluated with consideration of utilizing as much of the existing bridge decks of the bridges across the Agua Caliente Wash and Tanqe Verde Creek as possible. Both bridges have 12' lanes and 9' shoulders. The proposed roadway will only require a 6' outside shoulder and 2' inside shoulder resulting in 10' of bridge deck that could potentially be used as part of the median.

The proposed Houghton Road median south of Speedway Boulevard is 20' wide, curb to curb. The Pima County Roadway Design Manual (RDM) describes use of a 24' median. With 10' of available bridge deck width for potential use, PB considered the following options:

- A narrow raised median with a close spaced joint between the existing bridges and the new bridges.
- A 20' raised median with a closed spaced joint between the existing bridges and the new bridges.
- A 20' open median
- An open median wider than 20'

A narrow raised median would utilize the 10' of available bridge deck as part of the raised median and provide a more open view of Houghton Road across the bridges. The Pima County has used a similar configuration on the bridges across the Rillito River on Alvernon Way.



View of an existing narrow raised median on Alvernon Way

A 20' raised median would match the proposed median for Houghton Road south of Speedway and part of the width would come from the existing 10' available bridge deck. Pima County has uses a similar configuration for the bridges across the Canada Del Oro Wash on La Canada Drive.

A 20' open median is a configuration that wouldn't require any additional bridge deck to accommodate a raised median. This configuration essentially has a larger open space between the parallel bridges protected by a half section median barrier. A similar



View of an existing 20' raised median on La Canada

configuration for two parallel bridges recently was constructed in Oro Valley on First Avenue across the Canada Del Oro Wash just west of SR 77 (Oracle Road).

A wider open median than 20' was considered only from the fact that the Tanque Verde bridge is very close to the Speedway Boulevard intersection to the south and approach tapers to widening at the intersection could potentially extend to the bridge. Having tapers on the bridge are not desirable from a design standpoint and are not economical from a construction standpoint. An open median wider than 20' would keep tapers off the structures.



View of an existing open median on First Avenue in Oro Valley

A 20' open median is recommended for use over the other options for the following reasons:

- A narrow raised median would result in the bridges over the Tanque Verde Creek having transition tapers from Speedway Boulevard extend onto the structures from the south and would require widening of the bridge on the north to accommodate a left turn bay to the W. Drachman Street frontage road.
- A 20' raised median would require additional bridge deck width on the new bridge to construct the raised median. In the case of the Tanque Verde Creek, the

bridge is approximately 1100' long and the extra width would be a considerable cost increase to the structure.

- An open median wider than 20' is not needed to keep the transition tapers off the structures. In evaluating the shoulder widths for the typical section, selecting the 8' shoulders for the bridge over the Tanque Verde Creek results in an "out to out" bridge width that keeps most of the tapers off the structures. A small portion of the tapers from the south do extend onto the new Tanque Verde bridge, but this can be accommodated in the pavement markings and modification to the half section median barrier.

Sidewalk Width – The sidewalk on the existing Tanque Verde bridge is only 4' wide. The City of Tucson proposes 6' sidewalks for Houghton Road south of Speedway Boulevard. Pima County is using 5' sidewalks on their Tanque Verde Road project just west of Houghton Road. Through discussions with Pima County and the City, 5' sidewalks were recommended for Houghton Road north of Speedway Boulevard.

With relation to the Tanque Verde bridge, two options were reviewed for obtaining a 5' sidewalk width. One was to shift the existing half section median barrier that separates the roadway shoulder and sidewalk to the west and one was to remove the existing parapet and detail a new railing attached to the existing bridge deck. The parapet is approximately 1' wide. Removing the existing parapet and detailing a new railing attached to the existing bridge deck is recommended. Shifting the barrier to the west one foot would cover existing bridge scuppers that provide drainage for runoff from the bridge. Openings at the base of a new half section barrier were considered, but runoff would cross the sidewalk which currently does not occur.

10.3 Northbound alignment between Packard Street and Speedway Boulevard

The northbound alignment of Houghton Road between Packard Street and Speedway Boulevard was reviewed upon examining the lane shift the drivers would experience as a result of the centerline shift due to the frontage road option on the west side of

Houghton Road north of 5th Street, the transition back to the west after the shift, and the shift back to the east for the taper transitions approaching Speedway Boulevard. Southbound Houghton Road only experiences a shift to the east, then back to the west through this area.

An option considered was to provide one transition along the east side of Houghton Road from Packard Street to Speedway Boulevard. The benefits of one transition would be to provide a consistent alignment for the driver to minimize any safety issues associated with vehicles drifting out of their lane.

PB reviewed the impacts associated with providing this one transition and they are as follows:

- Shift in the slope limits to the east towards the existing ROW.
- Encroachment of the slope limits into a floodplain that extends within the parcels of the Vista Verde subdivision adjacent to the existing ROW.
- Reduction in available width for the Greenway.

Slope limits would extent just beyond the existing 100' half ROW, as established from the section line of Houghton Road, but within a 30' buffer area that is between the existing ROW and the parcels of the subdivision. This situation will be occurring further south in the area where Houghton Road is fully shifted to the east due to the frontage road. In that area, slope easements are proposed for the buffer area.

Encroachment of the slope limits into the floodplain is minimal as a result of the roadway alignment with the one transition. PB recommends reevaluating the drainage in this area during final design when grading and slope limits are finalized.

The Greenway in this vicinity has already been reduced just south of this location by the shift of Houghton Road to the east due to the frontage road. A 10' paved mult-use path

is proposed in this area and the transition would still be able to accommodate this path along Houghton Road.

In reviewing the impacts of having one transition along the east side of Houghton Road from Packard Street to Speedway Boulevard, no significant impacts were found. The additional width to the roadway typical section will require some increase in earthwork, but not require additional ROW. Slope easements within the buffer area, however, will be needed. PB recommends providing this transition in the design of Houghton Road.

11.0 Conclusions and Recommendations

Several conclusions were reached in the study of Houghton Road from Tanque Verde Road to Speedway Boulevard:

- The existing Houghton Road roadway does not contain any significant geometric deficiencies along its alignment from Tanque Verde Road to south of 5th Street
- The existing Houghton Road ROW configuration between Tanque Verde Road and Speedway Boulevard allows for widening of Houghton Road to the west since the existing roadway is on the east side of the ROW.
- The project area does not include any areas proposed for or designated as critical habitat.
- Three recorded prehistoric sites exist within the project area:
    - The Tanque Verde Wash site (AZ BB:13.68[ASM])
    - The Houghton Road site (AZ BB:13.398[ASM])
    - An unnamed artifact scatter (AZ BB:13.654[ASM]) – since destroyed.
- One possible hazardous waste site has been found at the Circle K convenience store at 10290 E. Speedway Boulevard.
- Existing traffic operations at the Tanque Verde Road and Speedway Boulevard signalized intersections range from LOS of B to D.
- Future traffic projections show that Houghton Road from Tanque Verde Road to Speedway Boulevard will increase from 16,825 ADT to 25,600 ADT in 2030 resulting in an annual growth rate of 2.1%.
- Future traffic projections on Houghton Road between Speedway Boulevard and Broadway Boulevard show an increase in traffic from 18,356 ADT to 40,100 ADT in 2030.
- Direct access to Houghton Road from five parcels on the west side of Houghton Road north of 5th Street poses a safety concern due to the close spacing of the drives.
- ROW impacts are limited to a few areas within the project limits, namely along Tanque Verde Road, W. Drachman Street, the southeast corner of the Houghton

Road / Speedway Boulevard intersection, and portions of the east side of Houghton Road south of Speedway Boulevard. Total ROW impacts are estimated at 3.5 AC with 0.9 AC for drainage easements.

- Impacts to drainage facilities primarily require extensions to existing culverts.
- The existing concrete lined channels on either side of Houghton Road, south of Speedway Boulevard will be impacted by the Houghton Road widening.
- Significant amounts of embankment will be required with an estimated 60,800 CY of Borrow.
- Significant utility impacts include:
    - TEP pole relocations on the east side of Houghton Road, highlighted by the large metal pole on the SE corner of the Houghton Road / Speedway Boulevard intersection.
    - Relocation costs for eight TEP poles plus one very large pole on the southeast corner of Houghton Road / Speedway Boulevard will need to be paid for by the City since these are assumed to have prior rights.
    - Potential conflicts with gas, water, sanitary sewer, telephone, and cable in areas south of Speedway Boulevard where there is a proposed storm drain system
    - Potential conflicts between drilled shafts/piers with gas, water, sanitary sewer, and telephone for the new Tanque Verde Creek bridge.
- A Tucson Water well site on the west side of Houghton Road, north of the Tanque Verde Creek will not likely be impacted by the construction of the new bridge over the Tanque Verde Creek.
- The dual path greenway will not fit within the existing ROW for the segment of Houghton Road south from Speedway Boulevard to the southern project limit south of 5th Street primarily due to the proposed frontage road on the west side of Houghton Road north of 5th Street.
- A total of seven locations have been identified for art opportunities within the project limits and they include areas near both the Tanque Verde Road and Speedway Boulevard intersections as well as by both the Agua Caliente Wash and Tanque Verde Creek bridges.

Several recommendations for project improvements along Houghton Road from Tanque Verde Road have resulted from study of the project area, discussions from with the CDRC, feedback from the public open house, and coordination with both the City of Tucson and Pima County. The recommendations for the project are as follows:

- Construct two new lanes for Houghton Road, west of the existing two lane roadway, so as to develop a 4-lane divided roadway for Houghton Road between Tanque Verde Road and Speedway Boulevard. The existing roadway will become the future northbound Houghton Road lanes.
- Construct a 6-lane divided roadway for Houghton Road between Speedway Boulevard and Broadway Boulevard to accommodate the 2030 traffic projections. The project limits for this report end midway between Speedway Boulevard and Broadway Boulevard so the recommendation is to construction a 6-lane divided roadway south from Speedway Boulevard to the project limit.
- A design speed of 50 mph with a posted speed of 40 mph is recommended.
- Access points along Houghton Road should be as follows:
    - Median openings spaced at a minimum of 660', ¼ mile preferred
    - Traffic signal spacing at ½ mile minimum
    - Access limited for to right-in, right-out only and provide U-Turn opportunities at approximately every ¼ mile.
    - Turn bay storage lengths of 200' and 300' respectively for right turn lanes and left turn lanes, where feasible
- Bus pullouts are to be investigated during final design with review of the Houghton Road / Speedway Boulevard intersection and the possibility of locating pullouts on the westbound and southbound departures.
- Arterial roadway lighting is not recommended for Houghton Road. A 4" conduit with (4) 1" innerducts is recommended to be installed along the length of the project for future fiber optic communication cable.

- Asphalt rubber asphaltic concrete (ARAC) is recommended as the surface layer for the roadway pavement based on its noise reduction qualities and the fact that there are residential homes adjacent to Houghton Road.
- A storm drain system is recommended for Houghton Road, south of the Tanque Verde Creek, along the curbed roadway section.
- The storm drain system south of Speedway Boulevard is recommended to replace the existing concrete lined channels.
- A 10' paved multi-use path is proposed for Houghton Road between Speedway Boulevard and the southern project limit south of 5th Street.
- Construct parallel bridges to the existing bridges over the Agua Caliente Wash and Tanque Verde Creek and use a similar prestressed concrete AASHTO girder superstructure and drilled shaft foundations similar to the existing bridges.
- Remove the outside parapet of the bridges across the Agua Caliente Wash and Tanque Verde Creek and construct a new railing attached to the outside of the bridge decks in order to obtain a 5' sidewalk width.
- Water harvesting is recommended instead of extensive irrigation due to recent funding issues and dwindling water resources.
- A frontage road is recommended as the solution to consolidating access onto Houghton Road for the five residential parcels on the west side of Houghton Road north of 5th Street.
- Construction of a 20' open median is recommended between the new and existing bridges in order to minimize bridge costs.
- 5' sidewalks are recommended for the Pima County segment of Houghton Road between Speedway Boulevard and Tanque Verde Road. Sidewalks north of Tanque Verde Road are not included. A 6' sidewalk is provided on the west side of Houghton Road south of Speedway Boulevard within the Tucson city limits.
- A variable width median is recommended for Houghton Road south of Speedway Boulevard to minimize alignment shifts for northbound Houghton Road traffic.
- The new bridge over the Tanque Verde Creek and the Houghton Road / Speedway Boulevard intersection are proposed to be constructed at the same

time due to the close proximity of the bridge to Speedway Boulevard and the lane requirements of the north approach to Speedway Boulevard.

- A Phase I Environmental Assessment study will be needed done for all parcels with ROW acquisition, prior to the construction, to determine suitable mitigation.

12.0 Cost Estimate

The overall preliminary construction cost estimate on the Houghton Road project for the recommended design is $21,421,000. Only 2009 dollars and no inflationary costs were considered for future construction within this estimate. A breakdown of costs is presented in Table 27 and a detailed breakdown is in the Appendix.

Table 26 - Estimated Construction Cost, 2009 Dollars

Items	Costs (Rounded)*
Roadway Construction	$5,271,000
Drainage	$2,495,000
Utility Relocations and Modifications	$198,000
Signing	$38,000
Striping	$38,000
Landscaping	$294,000
Traffic Signals	$580,000
Subtotal Roadway Construction Cost	**$8,914,000**
Bridge (Agua Caliente Wash)	$1,690,000
Bridge (Tanque Verde Creek)	$5,246,000
Subtotal Bridge Construction Cost	**$6,936,000**
NPDES (Original)	$158,000
NPDES (Modifications)	$79,000
Mobilization (Est. 10%)	$892,000
Maintenance and Protection of Traffic (Est. 9%)	$803,000
Construction Survey and Layout (1%)	$90,000
Contingencies (20%)	$1,783,000
Miscellaneous Construction Subtotal	**$3,805,000**
Construction Subtotal	**$19,655,000**
Design Fee (6%)	$1,180,000
Right-of-Way (Est. $150,000 / AC)	$528,000
Easements (Est. $40,000 / AC) (not incl. TCE's)	$43,000
Total Project Cost (Rounded)	**$21,406,000**

13.0 Budget Considerations

The section of Houghton Road from Tanque Verde Road to Speedway Boulevard is part of the RTA project: *Houghton Road, I-10 to Tanque Verde Rd.: Widen to 4- and 6-lane desert parkway, new bridges (wash and rail), bike lanes & sidewalks.* This RTA project is budgeted at $160,642,000 in 2006 dollars of which $95,342,000 is planned on being funded through the ½ cent tax approved by Pima County voters May 16, 2006 and the remaining $65,300,000 paid for through committed Non-RTA Revenues. The RTA plan has the sections from I-10 to Tanque Verde programmed for the first and third periods of the 20 year plan (FY 2007 thru FY 2011 and FY 2017 thru FY 2021).

Houghton Road from Tanque Verde Road to Speedway Boulevard is also part of the Pima Association of Governments 2030 Regional Transportation Plan projects with the Tanque Verde Road to Speedway Boulevard project (ID #7.02) budgeted at $10,000,000. This project is programmed for the "Late", or third period.

The Pima Association of Governments 5-Year Regional Transportation Improvement Plan 2009-2013 includes the segment of Houghton Road from Tanque Verde to Speedway Boulevard in the *Houghton Rd. #1 – Old Spanish Trail to Tanque Verde* project (TIP ID 58.07) project. That project has a total project cost of $4,800,000 for completion of the DCR. With $1,000,000 and $2,500,000 in funding approved for 2009 and 2010 respectively.

The estimated construction cost, including ROW of the Houghton Road segment from north of Tanque Verde Road to approximately 5th Street is $21,406,000. This is for 2.0 miles or approximately 15% of the 13 mile segment programmed for $160,000,000. Evaluating cost percentages, the $21.4 million is approximately 13% of the total budget.

REFERENCES

Transportation Access Management Guidelines for COT-2003

Traffic Signal Design Manual-2003

Roadway Design Manual, 2nd edition, December 2003 (Pima County)

Policy on Geometric Design of Highways and Streets 'Green Book,' AASHTO 2004

Manual on Uniform Traffic Control Devices, 2003

Highway Capacity Manual, 2000

Roadside Design Guide-2002

Roadway Development Policies, 1998

Development Standards-Revised, 2000

Pavement Marking Design Manual, 1st Revision, October 2002

The *Houghton Corridor Study (HRC)*

Houghton Area Master Plan (HAMP)

Guide for the Development of Bicycle Facilities, AASHTO 1999

City of Tucson's Major Streets and Routes Plan

APPENDIX A

Preliminary Engineers' Construction Cost Estimate

HOUGHTON ROAD
TANQUE VERDE ROAD - SPEEDWAY BOULEVARD
JOB NO. SR1C
PRELIMINARY CONSTRUCTION COST ESTIMATE - 30% SUBMITTAL

PLAN NO. I-2007-019

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
	Storm Water Pollution Prevention Plan				
1070001	NPDES (Original) (2% of #3)	L.S.	1	$157,674	$157,674
1070011	NPDES (Modifications) (50% of NPDES (Original))	F.A.	78,837	$1.00	$78,837
		#1 Subtotal			$236,510
	Miscellaneous Construction Items				
2010001	Clearing and Grubbing (0.35% of #3)	L.S.	1	$27,592.86	$27,593
2020001	Removal of Structures and Obstructions (0.4% of #3)	L.S.	1	$31,534.70	$31,535
2020007	Removal of Miscellaneous Concrete (0.3% of #3)	L.S.	1	$23,651.03	$23,651
2020034	Removal of Signs and Delineators (0.05% of #3)	L.S.	1	$3,941.84	$3,942
5110001	Miscellaneous Utility Relocations (2.5% of #3)	F.A.	197,092	$1.00	$197,092
6080000	Signing (0.47% of #3)	L.S.	1	$37,053.27	$37,053
7010006	Construction Area Elements (Predetermined Reimbursement Rates) (6% of #3)	F.A.	473,021	$1.00	$473,021
7040000	Striping (0.47% of #3)	L.S.	1	$37,053.27	$37,053
8010000	Landscaping (2.5% of #3)	L.S.	1	$197,091.88	$197,092
		#2 Subtotal			$1,028,031
	Construction Items				
2020020	Removal of Curb	L.F.	1,161	$6.00	$6,966
2020029	Removal of Bituminous Pavement	S.Y.	57,864	$3.50	$202,524
2020040	Remove Pipe	L.F.	1,206	$20.00	$24,120
2020051	Remove Soil Cement Bank Protection	C.Y.	4,191	$25.00	$104,775
2020053	Remove Catch Basin	E.A.	2	$1,500.00	$3,000
2020101	Removal of Fence	L.F.	2,510	$3.00	$7,530
2020132	Remove & Salvage Riprap	C.Y.	20	$100.00	$2,000
2020162	Remove Shotcrete Channel Lining	S.Y.	24,555	$5.00	$122,775
2030300	Roadway Excavation	C.Y.	31,446	$10.00	$314,460
2030401	Drainage Excavation	C.Y.	282	$20.00	$5,640
2030500	Structural Excavation	C.Y.	204	$30.00	$6,120
2030506	Structural Backfill	C.Y.	239	$45.00	$10,755
2030901	Borrow	C.Y.	60,783	$12.00	$729,396
3030003	Aggregate Base	C.Y.	9,582	$40.00	$383,280
4040111	Tack Coat	TON	24.6	$525.00	$12,915
4060001	Asphaltic Concrete (No. 1)	TON	11,760	$55.00	$646,800
4130040	Asphaltic Concrete (Asphalt-Rubber)	TON	9,603	$75.00	$720,225
4130042	Asphalt Rubber Material (For AR-AC)	TON	768	$700.00	$537,600
4130044	Mineral Admixture (For AR-AC)	TON	89	$90.00	$8,010
5011243	Pipe, Reinforced Concrete, Class HE III, 38" x 24"	L.F.	33	$225	$7,425
5012524	Storm Drain Pipe, 24"	L.F.	2,969	$130.00	$385,970
5012530	Storm Drain Pipe, 30"	L.F.	966	$145.00	$140,070
5012536	Storm Drain Pipe, 36"	L.F.	1,748	$160.00	$279,680
5012542	Storm Drain Pipe, 42"	L.F.	422	$175.00	$73,850
5012548	Storm Drain Pipe, 48"	L.F.	776	$200.00	$155,200
XXXXXXX	Catch Basin	EACH	41	$8,500.00	$348,500
XXXXXXX	Area Inlet	EACH	4	$3,500.00	$14,000
XXXXXXX	5-Grate Inlet	EACH	2	$17,500.00	$35,000

HOUGHTON ROAD
TANQUE VERDE ROAD - SPEEDWAY BOULEVARD
JOB NO. SR1C
PRELIMINARY CONSTRUCTION COST ESTIMATE - 30% SUBMITTAL

PLAN NO. I-2007-019

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
XXXXXXX	10-Grate Inlet	EACH	1	$35,000.00	$35,000
5050000	Manholes	EACH	13	$8,500.00	$110,500
6010002	Structural Concrete (f'c = 3,000)	C.Y.	195	$350.00	$68,250
6016090	Concrete Headwall (D<48")	EACH	2	$6,000.00	$12,000
6010201	Retaining Wall (ADOT Std. B-18.10)	S.F.	3,174	$65.00	$206,310
6050001	Reinforcing Steel	LB	27,230	$1.00	$27,230
6050101	Dowels	EACH	41	$50.00	$2,050
7310052	Traffic Signals (Speedway & Tanque Verde Intersections)	L.S.	1	$580,000.00	$580,000
8030022	Decomposed Granite	C.Y.	182	$10.00	$1,820
9080005	Concrete Curb, (PC/COT Std. Dtl. 209) (Type 2)	L.F.	28,941	$14.00	$405,174
9080201	Concrete Sidewalk	S.F.	94,570	$5.00	$472,850
9080281	Curb Access Ramp (Type 2) (Std Dtl 207)	EACH	16	$2,000.00	$32,000
9080282	Curb Access Ramp (Type 3) (Std Dtl 207)	EACH	14	$1,800.00	$25,200
9130001	Riprap (Dumped)	C.Y.	73	$100.00	$7,300
9200401	Soil Cement Bank Protection	C.Y.	6,332	$80.00	$506,560
XXXXXXX	Culvert Berm	C.Y.	284	$30	$8,520
9320050	Concrete Pavers	S.F.	13,475	$7.00	$94,325
		#3 Subtotal			$7,883,675
XXXXXXX	Bridge (Agua Caliente Wash)	L.S.	1	$1,689,178.00	$1,689,178
XXXXXXX	Bridge (Tanque Verde Creek)	L.S.	1	$5,245,081.00	$5,245,081
		#4 Subtotal			$6,934,259
	Mobilization and Administration				
9010001	Mobilization (10% of(#2+#3))	L.S.	1	$891,171	$891,171
7010001	Maintenance and Protection of Traffic (9% of (#2+#3))	L.S.	1	$802,054	$802,054
9250101	Construction Surveying and Layout (1% of (#2+ #3))	L.S.	1	$89,117	$89,117
	Construction Contingencies (20% of (#2+#3))	L.S.	1	$1,782,341	$1,782,341
		#5 Subtotal			$3,564,682
	CONSTRUCTION SUBTOTAL (Rounded) (#1 + #2 + #3 +#4+#5)				**$19,647,158**
	FINAL DESIGN		6.0%		$1,178,829
	RIGHT-OF WAY	ACRE	3.52	$150,000	$528,000
	EASEMENTS	ACRE	1.07	$40,000	$42,800
	TOTAL				**$21,396,787**

HOUGHTON ROAD
TANQUE VERDE ROAD - SPEEDWAY BOULEVARD
JOB NO. SR1C
PRELIMINARY CONSTRUCTION COST ESTIMATE - 30% SUBMITTAL

PLAN NO. I-2007-019

BID ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
	Roadway Construction				$5,271,000
	Drainage				$2,495,000
	Utility Relocations and Modifcations				$198,000
	Signing				$38,000
	Striping				$38,000
	Landscaping				$294,000
	Traffic Signals				$580,000
	Subtotal Roadway Construction Cost				$8,914,000
	Bridge (Agua Caliente Wash)				$1,690,000
	Bridge (Tanque Verde Creek)				$5,246,000
	Subtotal Bridge Construction Cost				$6,936,000
	NPDES (Original)				$158,000
	NPDES (Modifications) (50% of NPDES (Original)				$79,000
	Mobilization (Est. 10%)				$892,000
	Maintenance and Protection of Traffic (Est. 9%)				$803,000
	Construction Survey and Layout (1%)				$90,000
	Contingencies (20%)				$1,783,000
	Miscellaneous Construction Subtotal				$3,805,000
	Construction Subtotal				$19,655,000
	Design Fees (6%)				$1,180,000
	Right-of-Way (Est. $150,000/AC)				$528,000
	Easements(Est. $40,000/AC)				$43,000
	Total Project Cost (Rounded)				$21,406,000

APPENDIX B

UTILITY RECORDS CONTACTS

UTILITY RECORDS CONTACTS

Houghton Road: Tanque Verde Road to Speedway Boulevard

ADOT
Culverts, Storm Drain, Traffic Electric
1444 West Grant Road
Tucson, AZ 85745
(520) 838-2815

CITY OF TUCSON INET
Fiber Optics
4004 South Park Ave Bldg #2
Tucson, AZ 85714
(520) 791-3121
Bob Morten

CITY OF TUCSON D.O.T.
Traffic Signal, Street Lighting, Irrigation
4004 South Park Ave Bldg #2
Tucson, AZ 85714
(520) 791-3191
Bobby Herran

COX COMMUNICATIONS
Coaxial Cable T.V. and Fiber Optics
1440 East 15th Street
Tucson, AZ 85719
(520) 629-8435
Debbie Mason

PIMA COUNTY WASTEWATER MNGT.
Sanitary Sewer
201 North Stone Ave. 5th Floor
Tucson, AZ 85701-2805
(520) 740-6602
Maps and Records

QWEST
Telephone and Fiber Optics
2550 North Dragoon Street Suite 150
Tucson, AZ 85745
(520) 292-8255
(520) 869-2351 Cell #
Matthew Thompson

SOUTHWEST GAS
Natural Gas
3401 East Gas Road
Tucson, AZ 85714-1994
(520) 794-6087
Jodi Settles

TUCSON ELECTRIC POWER
Electric
3950 East Irvington Road
P.O. Box 711
Tucson, AZ 85702-0711
(520) 918-8246
Cynthia Garcia

TUCSON WATER
Water
310 West Alameda
P.O. Box 27210
Tucson, AZ 85726-7210
(520) 791-5080 EXT 1223
Pete Kosanske

APPENDIX C

Bridge Technical Memorandum

HOUGHTON ROAD IMPROVEMENT PROJECT:

TANQUE VERDE ROAD TO SPEEDWAY BOULEVARD

COT PLAN NO. I-2007-019

COT Job No. SR1C

BRIDGE TECHNICAL MEMORANDUM FOR AGUA CALIENTE WASH AND TANQUE VERDE CREEK

Prepared for:

CITY OF TUCSON DEPARTMENT OF TRANSPORTATION

Prepared by:

Parsons Brinckerhoff

177 North Church Avenue, Suite 500

Tucson, Arizona 85701

(520) 882-6424

August 9, 2010

HOUGHTON ROAD: TANQUE VERDE ROAD TO SPEEDWAY BOULEVARD

Bridge Technical Memorandum for Agua Caliente Wash and Tanque Verde Creek

OVERVIEW

The existing segment of Houghton Road from Tanque Verde Road to Speedway Boulevard had been designed in the late 1980's and constructed in the early 1990's under the Pima County Department of Transportation and Flood Control District project: Houghton Road Speedway Boulevard to Tanque Verde Road, Project No. W.O. 4BHTVC. That project constructed one half of an "ultimate" four lane divided arterial roadway by shifting the alignment of Houghton Road to the east and constructing a new two lane roadway and new bridges over the Tanque Verde Creek and Agua Caliente Wash. The existing Houghton Road roadway was demolished. Right-of-way was purchased to construct the two lane roadway.

The City of Tucson Houghton Road project segment from Tanque Verde Road to Speedway Boulevard will utilize the existing two lane roadway for the northbound lanes of a divided four lane roadway. Two new lanes will be constructed in the right-of-way west of the existing roadway alignment. New bridges across the Agua Caliente Wash and Tanque Verde Creek will be required for those new lanes.

BRIDGE CONFIGURATIONS

Existing Conditions

The existing Houghton Road bridges at the Tanque Verde Creek and Agua Caliente Wash currently carry one lane of traffic in both the northbound and southbound directions. The typical section consists of one 12'-0" traffic lane and a 9'-0" shoulder in each direction with a barrier-separated 4'-0" pedestrian walkway outside of the northbound roadway. The existing bridges have a concrete barrier with metal handrail at

the inside edge of deck, a concrete barrier along the outer edge of the traffic lane and a concrete parapet with metal handrail on the outside edge of deck.

The bridges were constructed with precast prestressed AASHTO Type IV Girders and a cast-in-place concrete deck. There are 7 girders spaced at 7'-2" with overhangs of 3'-6". The Agua Caliente Wash bridge combines 3 equal span lengths of 100'-0" for a total bridge length of 305'-10". The Tanque Verde Creek bridge has 11 span lengths of 100'-0" for a total bridge length of 1105'-0". The approximate superstructure depth on both bridges is 5'-4". The existing piers on both bridges consist of a pier cap with three 48" diameter columns supported on 48" diameter drilled shafts. The abutments are a stub type with cantilever wingwalls and are supported on a single row of 48" diameter drilled shafts. There is also soil cement bank protection around the existing abutments that will need to be partially removed in order to construct the new abutments.

There are existing utilities within the footprint of the new bridges that may require relocation, especially at Tanque Verde Creek. At that location, several of the utilities may conflict with the substructures, while others may pose safety hazards during construction, such as overhead power lines and gas lines. Additionally, there is an existing frontage road named West Drachman Street that will need to be reconstructed west of its current location.

General

The proposed Houghton Road bridges will allow southbound traffic to pass over the Tanque Verde Creek and Agua Caliente Wash and will accommodate two traffic lanes and a sidewalk. The southbound roadway will consist of an 8'-0" outside shoulder, two 12'-0" traffic lanes, a 2'-0" inside shoulder and a 5'-0" sidewalk. The structures will have 32-inch F-Shape bridge concrete barriers along the inside edge of deck, 32-inch F-Shape barriers along the outside edge of travel way and pedestrian fence/parapets along the outside edge of deck, resulting in an out-to-out bridge width of 42'-8". The northbound bridge will be re-striped with an 8'-0" outside shoulder, two 12'-0" traffic lanes and a 2'-0" inside shoulder. A new 32" F-Shape bridge concrete barrier will be

added adjacent to the inside shoulder establishing a 20'-0" median between the northbound and southbound roadways. The existing median barrier will remain in place.

In order to widen the existing sidewalk from 4'-0" to 5'-0", the existing pedestrian barrier and handrail will be removed and replaced by a new metal pedestrian rail which will be attached to the edge of the deck. In addition to all of the new construction, the expansion joints at the abutments of both bridges and at Pier 6 on the Tanque Verde bridge will be replaced with new expansion joints. The Houghton Road mainline horizontal alignment is on a tangent through the bridge crossing with a normal crown and 2% cross slope. The northbound and southbound profiles are on a combination of vertical tangents and a crest vertical curve over Tanque Verde Creek and vertical tangent over Agua Caliente Wash. The northbound and southbound profile grade lines for Houghton Road are symmetrically offset 10'-0" from the construction centerline.

Agua Caliente Wash

The Agua Caliente Wash is typically a dry wash but can experience significant flows during major rainfall events. Although falsework for cast-in-place structures can be designed to withstand moderate flows, it is common practice in Arizona to minimize the risk of falsework damage/loss by utilizing precast girders. To minimize the hydraulic impacts in the wash due to the addition of the adjacent bridge, the proposed substructures will be aligned to match the existing structure. Therefore, a three-span precast prestressed AASHTO Type IV girder bridge is recommended. The bridge will require 6 girders with an approximate spacing of 7'-2" and overhangs of approximately 3'-4". This arrangement results in an overall bridge width of 42'-8" and allows deck drains to be placed at the front face of the outside barrier without conflict.

The southbound bridge will have 3 span lengths equal to 100'-0". The total bridge length will be 305'-10" to match the existing structure. The approximate structure depth will be 5'-4".

According to an initial scour analysis, scour depths of approximately 30 feet may be expected at this location, thereby making the use of shallow foundations impractical. Driven piles may be viable but are not recommended as a result of their proximity to the existing structures and the amount of vibration caused by their installation. Also to match the existing hydraulics, columns supported on drilled shafts are recommended. Thus, a drilled shaft foundation system originating from adequately below the maximum scour depth is the recommended foundation type for this structure. For hydraulic purposes, the piers for the southbound bridge will be set in line with and along the same bearing as the existing bridge piers. The resulting skew of the piers is 31°0′ 00″ left on both bridges. Each pier will have three 48" diameter columns spaced at 18 feet along the pier centerline. The columns will be supported on 60" diameter drilled shafts. The abutments, which will be stub abutments with cantilever wingwalls supported on a single row of 48" diameter drilled shafts, will be oriented parallel to the piers. The abutments will be protected using soil cement bank protection.

This three-span precast prestressed AASHTO Type IV girder bridge is the most economical alternative, is highly constructible by local contractors, and typically requires minimal maintenance.

Tanque Verde Creek

The Tanque Verde Creek is typically a dry wash but can experience significant flows during major rainfall events. Although falsework for cast-in-place structures can be designed to withstand moderate flows, it is common practice in Arizona to minimize the risk of falsework damage/loss by utilizing precast girders. Due to hydraulic concerns, the proposed substructures will be aligned to match the existing structure. Therefore an eleven-span precast prestressed AASHTO Type IV girder bridge is recommended. The bridge will require 6 girders with an approximate spacing of 7'-2" and overhangs of approximately 3'-4". This arrangement results in an overall bridge width of 42'-8" over most of the bridge and allows deck drains to be placed at the front face of the outside barrier without conflict. The only variation to this arrangement occurs in Span 1 where the inside overhang is on a taper, creating a bridge of variable width. The overall width

at Abutment 1 is approximately 41'-0" and tapers toward the median until reaching its ultimate width of 42'-8" at Station 93+78.00.

The southbound bridge will have 11 spans at 100'-0" each. The total bridge length will be 1105'-0" with an approximate structure depth of 5'-4" to match the existing structure.

According to an initial scour analysis, scour depths of approximately 30 feet may be expected at this location thereby making the use of shallow foundations impractical. Driven piles may be feasible but are not recommended as a result of their proximity to the existing structures and the amount of vibration caused by their installation. Also to match the existing hydraulics, columns supported on drilled shafts are recommended. Thus, a drilled shaft foundation system originating from adequately below the maximum scour depth is the recommended foundation type for this structure. For hydraulic purposes, the piers for the southbound bridge will be set in line with the existing bridge piers. Each pier will have three 48" diameter columns spaced at 15 feet along the pier centerline. The columns will be supported on 60" diameter drilled shafts; designed to withstand the anticipated waterway flows and scours. The abutments, which will be stub abutments with cantilever wingwalls supported on a single row of 48" diameter drilled shafts, will be oriented parallel to the piers. The abutments will be protected using soil cement bank protection.

This eleven-span precast prestressed AASHTO Type IV girder bridge is the most economical alternative, is highly constructible by local contractors, and typically requires minimal maintenance.

DESIGN CRITERIA

The technical design specifications and guidelines followed in the development of this Technical Memorandum are:

- *AASHTO LRFD Bridge Design Specifications* – Fourth Edition, 2007 including the current Interim Revisions

- *City of Tucson/Pima County Standard Specifications for Public Improvements, 2003 (Revised to Date)*
- *Arizona Department of Transportation Bridge Design Guidelines – current version*

COST ESTIMATE

The unit costs used in estimating the construction cost for these bridges are based on the most recent bid history. The estimated cost of these bridges based on 2009 dollars, including a 15% contingency to compensate for any unidentified construction items, is shown below.

Agua Caliente Wash

--Three-span precast prestressed AASHTO Type IV girder bridge
--Stub abutments on a single row of 48" diameter drilled shafts
--48" diameter columns on 60" diameter drilled shafts

Total structure cost: $1,689,200
Unit bridge cost/sf: $129.45

Tanque Verde Creek

--Eleven-span precast prestressed AASHTO Type IV girder bridge
--Stub abutments on a single row of 48" diameter drilled shafts
--48" diameter columns on 60" diameter drilled shafts

Total structure cost: $5,245,100
Unit bridge cost/sf: $111.25

Assumptions

The costs for design, environmental clearance, potential environmental mitigation measures, geotechnical investigation, pavement marking, signing, traffic control, drainage and field administration are not included in the estimate.

HOUGHTON ROAD: TANQUE VERDE ROAD TO SPEEDWAY BOULEVARD

Structure Name:	**Agua Caliente Wash Bridge**	**No. of Spans:**	3
		Span Lengths:	100'-0"
Superstructure Type:	Prestress Concrete Girder	**Skew:**	31° 00' 00"
Substructure Type:	Stub Abutments on Drilled Shafts	**Total Bridge Length:**	305.83 ft
Pier Foundation Type:	Drilled Shafts	**Bridge Width (Out to Out):**	42.67 ft
		Bridge Area:	13,049 ft²

LUMP SUM BRIDGE ITEMS

ITEM NUMBER	ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITY	COST
	STRUCTURAL CONCRETE (CLASS S) (F'C = 3,500)	CU.YD.	$360.00	282	$101,520
	STRUCTURAL CONCRETE (CLASS S) (F'C = 4,500)	CU.YD.	$400.00	523	$209,200
	F-SHAPE BRIDGE CONCRETE BARRIER AND TRANSITION (32 INCH)	L.FT.	$80.00	672	$53,760
	METAL HAND RAILING	L.FT.	$50.00	336	$16,800
	DECK JOINT ASSEMBLY (STRIP SEAL JOINT)	L.FT.	$200.00	100	$20,000
	APPROACH SLAB (SD 2.01)	SQ.FT.	$15.00	1285	$19,275
	PRECAST, P/S MEMBER (AASHTO TYPE 4 GIRDER)	L.FT.	$225.00	1798	$404,550
	RESTRAINERS, VERTICAL EARTHQUAKE (FIXED)	EACH	$200.00	24	$4,800
	RESTRAINERS, VERTICAL EARTHQUAKE (EXPANSION)	EACH	$225.00	24	$5,400
	REINFORCING STEEL	LB.	$1.00	176160	$176,160
	DRILLED SHAFT FOUNDATION (48")	L.FT.	$325.00	480	$156,000
	DRILLED SHAFT FOUNDATION (60")	L.FT.	$400.00	480	$192,000
				SUBTOTAL:	$1,359,465
				15% CONTINGENCY:	$203,920
				TOTAL COST:	$1,563,385
				TOTAL COST/SF:	$119.81

EXISTING BRIDGE MODIFICATION

ITEM NUMBER	ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITY	COST
	REMOVE EXISTING CONCRETE PARAPET WITH METAL HAND RAILING	L.FT.	$60.00	341	$20,460
	REPLACE EXISTING DECK JOINT	L.FT.	$250.00	117	$29,250
	F-SHAPE BRIDGE CONCRETE BARRIER AND TRANSITION (32 INCH)	L.FT.	$100.00	341	$34,100
	METAL HAND RAILING	L.FT.	$75.00	341	$25,575
				SUBTOTAL:	$109,385
				15% CONTINGENCY:	$16,408
				TOTAL COST:	$125,793
				TOTAL COST/SF:	$9.64

TOTAL COST

BRIDGE SUBTOTAL:	**$1,468,850**
15% CONTINGENCY:	**$220,328**
TOTAL BRIDGE COST:	**$1,689,178**
TOTAL BRIDGE COST/SF:	**$129.45**

HOUGHTON ROAD: TANQUE VERDE ROAD TO SPEEDWAY BOULEVARD

Structure Name:	**Tanque Verde Creek Bridge**	**No. of Spans:**	11
		Span Lengths:	100'-0"
Superstructure Type:	Prestress Concrete Girder	**Skew:**	0° 00' 00"
Substructure Type:	Stub Abutments on Drilled Shafts	**Total Bridge Length:**	1105.00 ft
Pier Foundation Type:	Drilled Shafts	**Bridge Width (Out to Out):**	42.67 ft
		Bridge Area:	47,147 ft²

LUMP SUM BRIDGE ITEMS

ITEM NUMBER	ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITY	COST
	STRUCTURAL CONCRETE (CLASS S) (F'C = 3,500)	CU.YD.	$360.00	683	$245,880
	STRUCTURAL CONCRETE (CLASS S) (F'C = 4,500)	CU.YD.	$400.00	1744	$697,600
	F-SHAPE BRIDGE CONCRETE BARRIER AND TRANSITION (32 INCH)	L.FT.	$80.00	2270	$181,600
	METAL HAND RAILING	L.FT.	$50.00	1135	$56,750
	DECK JOINT ASSEMBLY (STRIP SEAL JOINT)	L.FT.	$200.00	129	$25,800
	APPROACH SLAB (SD 2.01)	SQ.FT.	$15.00	1280	$19,200
	PRECAST, P/S MEMBER (AASHTO TYPE 4 GIRDER)	L.FT.	$225.00	6568	$1,477,800
	RESTRAINERS, VERTICAL EARTHQUAKE (FIXED)	EACH	$200.00	108	$21,600
	RESTRAINERS, VERTICAL EARTHQUAKE (EXPANSION)	EACH	$225.00	48	$10,800
	REINFORCING STEEL	LB.	$1.00	577510	$577,510
	RETAINING WALL	SQ.FT.	$65.00	1600	$104,000
	DRILLED SHAFT FOUNDATION (48")	L.FT.	$325.00	360	$117,000
	DRILLED SHAFT FOUNDATION (60")	L.FT.	$400.00	1800	$720,000
				SUBTOTAL:	$4,255,540
				15% CONTINGENCY:	$638,331
				TOTAL COST:	$4,893,871
				TOTAL COST/SF:	$103.80

EXISTING BRIDGE MODIFICATION

ITEM NUMBER	ITEM DESCRIPTION	UNIT	UNIT COST	QUANTITY	COST
	REMOVE EXISTING CONCRETE PARAPET WITH METAL HAND RAILING	L.FT.	$60.00	1140	$68,400
	REPLACE EXISTING DECK JOINT	L.FT.	$250.00	150	$37,500
	F-SHAPE BRIDGE CONCRETE BARRIER AND TRANSITION (32 INCH)	L.FT.	$100.00	1140	$114,000
	METAL HAND RAILING	L.FT.	$75.00	1140	$85,500
				SUBTOTAL:	$305,400
				15% CONTINGENCY:	$45,810
				TOTAL COST:	$351,210
				TOTAL COST/SF:	$7.45

TOTAL COST

BRIDGE SUBTOTAL:	**$4,560,940**
15% CONTINGENCY:	**$684,141**
TOTAL BRIDGE COST:	**$5,245,081**
TOTAL BRIDGE COST/SF:	**$111.25**

APPENDIX D

Design Recommendations for Wildlife Crossings

Houghton Road, Speedway to Old Spanish Trail
Design Recommendations for Wildlife Crossings

Revised, May 2009

Prepared by Logan Simpson Design Inc.

Project Area The City of Tucson (City) has identified Houghton Road for widening from Speedway Boulevard to Interstate 10 in eastern Tucson, Pima County, Arizona. The purpose of the project is to address the current and future growth trends in this section of Tucson. The City is considering widening Houghton Road from its existing two-lane configuration to a four or six-lane configuration with median. The project limits match or over-lap with other on-going transportation design projects by the City (Houghton Speedway to Interstate 10; Speedway Boulevard, Camino Seco to Houghton Road; and Tanque Verde Road, Catalina Highway to Houghton Road). The project limits for this wildlife crossing study are defined as a 1-mile portion of Houghton Road from Tanque Verde Road south to Speedway Boulevard.

The project area is primarily undeveloped lands, with some low-density residential developments in the vicinity of Tanque Verde Creek, along an existing transportation corridor (Figure 1). The greater project vicinity occurs within the Arizona Upland subdivision of the Sonoran Desertscrub biotic community (Turner and Brown 1994). Vegetation associations within the project area include the Sonoran riparian scrubland, and Sonoran riparian deciduous forests and woodlands, as described below.

Sonoran riparian scrubland: The Sonoran riparian scrubland community is represented in the planning area by a complex of xeroriparian shrub and tree species that occur in the floodplains of major washes and line the banks of smaller washes in the project area. Xeroriparian species are those species supported by intermittent or ephemeral stream flows that increase the amount of water available to the plants beyond that available by direct rainfall. Xeroriparian habitats commonly contain the same plant communities as the adjacent upland vegetation, but have larger plants and denser growth due to the availability of water. This xeroriparian vegetation provides an element of vertical habitat structure for birds attracted to dense thickets and high perches.

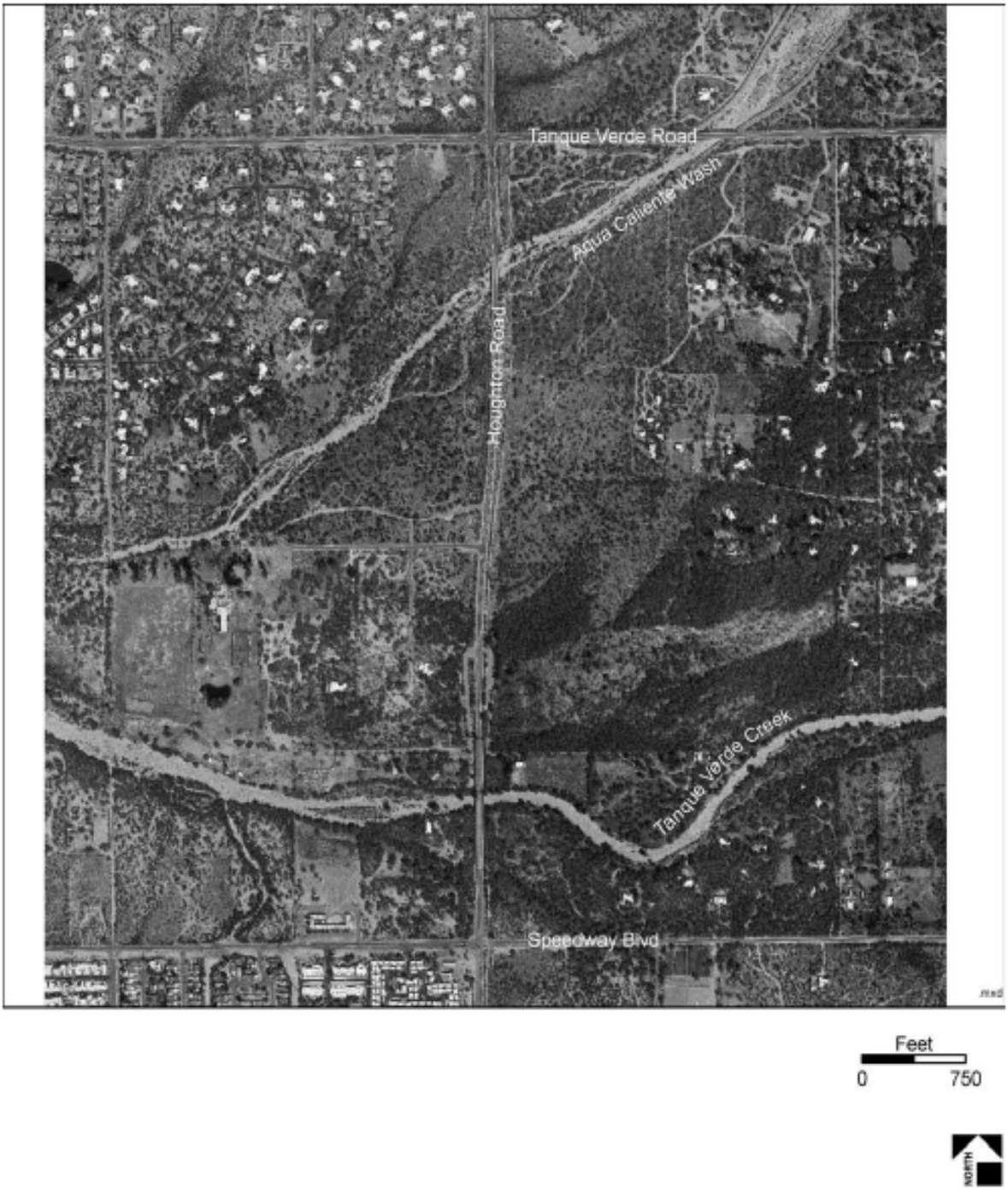


Figure 1. Project vicinity.

Sonoran riparian deciduous forests and woodlands: Sonoran riparian deciduous forests and woodlands are streamside associations of sub-tropic vegetation, including cottonwood (*Populus fremontii*), willow (*Salix goodingii*), and velvet mesquite (*P. velutina*). Within the project area vegetation representative of the Sonoran riparian deciduous forests and woodlands is found along the banks of Tanque Verde Creek, north of Speedway Boulevard.

The undeveloped areas and xeroriparian washes in the vicinity of the project area allow for a moderate degree of wildlife movement, as well as connectivity among habitat patches used for foraging, cover, and reproduction. Wildlife that is likely to occur in the project area includes small mammals, reptiles, and birds. Medium-sized mammal species such as javelina (*Tayassu tajacu*) or coyote (*Canis latrans*) may forage in the project vicinity and move through the project area. The lack of permanent water sources precludes the presence of many species associated with aquatic or wet riparian habitats; however, water may accumulate in depressions providing temporary aquatic habitat that may provide breeding sites for amphibians. While there is typically less native plant and animal diversity within developed areas, some species, particularly small mammals and reptiles, are more tolerant of human disturbance and development. T

The project area includes two major ephemeral drainages within the Tucson Basin: Tanque Verde Creek and Agua Caliente Wash. Agua Caliente Wash drains to Tanque Verde Creek approximately one half mile southwest of the project area. Tanque Verde Wash converges with the Rillito River approximately 8 miles northwest of the project area. The Rillito River continues to the west and converges with the Santa Cruz River approximately 10 miles to the northwest.

Wildlife crossings, the built structures that facilitate wildlife movements across roadways, are becoming increasingly necessary due to the proliferation of roads and resulting habitat fragmentation. Wildlife crossings are typically implemented to decrease wildlife-vehicle collisions and their impacts on human safety and wildlife populations. Wildlife crossings are also implemented to allow for increased wildlife movements resulting in healthier populations.

Two washes were identified (Tanque Verde Creek and Agua Calients Wash) as potential wildlife crossings because they are the largest and most heavily vegetated within the project area. They

are also protected under the City's environmental regulations, making them more appropriate locations for investment in wildlife crossing structures.

Analysis

An analysis of these two washes was undertaken to determine if they have attributes that would facilitate their use as wildlife crossings. These attributes include:

- Connectivity to other natural drainages
- Connectivity to habitat blocks outside the Tucson urban area
- Existing or planned culvert crossings that are a minimum of 36 inches in diameter

Tanque Verde Creek – Currently crossed by an 8 span bridge just north of Speedway Boulevard. Tanque Verde Creek supports a wide tract of undisturbed native vegetation and provides a critical link in connecting wildlife among the Rincon, Santa Catalina, and Tucson mountains. Tanque Verde Creek originates in the Coronado National Forest in the Rincon Mountains, approximately 6.5 miles east of Houghton Road. From its point of origination to its confluence with the Rillito River, the creek provides a corridor of vegetation that ranges in width from 400–1,000 feet. This swath of vegetation includes the creek and adjacent uplands. Tanque Verde Creek at Houghton Road has the following attributes to facilitate wildlife movements: Provides connectivity to other natural drainages; provides connectivity to large blocks of undisturbed lands outside of the Tucson urban area; and has a bridge crossing at Houghton Road large enough to facilitate wildlife movements. Because Tanque Verde Creek supports all three of the wildlife crossing attributes, it is a critical linkage for moving wildlife species across Houghton Road and the greater landscape.

Agua Caliente Wash – Currently crossed by a 3 span bridge just south of Tanque Verde Road. Agua Caliente Wash supports a wide tract of undisturbed native vegetation and provides a critical link in connecting wildlife to the Rincon, Catalina, and Tucson mountains. Aqua Caliente Wash originates in the Coronado National Forest in the Santa Catalina Mountains, approximately 6.5 miles northeast of Houghton Road. From its point



Aqua Caliente Wash Bridge

of origination to its confluence with Tanque Verde Creek, the wash provides a corridor of vegetation that ranges in width from 350–600 feet. This swath of vegetation includes the wash and adjacent uplands. Agua Caliente Wash at Houghton Road has the following attributes to facilitate wildlife movements: Provides connectivity to other natural drainages; provides connectivity to large blocks of undisturbed lands outside of the Tucson urban area; and has a bridge crossing at Houghton Road large enough to facilitate wildlife movements. Because Agua Caliente Wash supports all three of the wildlife crossing attributes, it is a critical linkage for moving wildlife species across Houghton Road and the greater landscape.

Design Considerations

The size and type of crossing structure affects both wildlife use and project cost. The existing bridge crossings at Aqua Caliente Wash and Tanque Verde Creek are adequate structures to provide crossing opportunities for a wide suite of species. The following general design recommendations should be considered for any additional, small wash crossing that may be planned for this stretch of Houghton Road.

Crossing Size and Design

The standard method to sizing wildlife crossings is to consider the largest animal that is expected to utilize the crossing. Small- to medium-sized mammals (e.g., coyotes, javelinas, foxes) are the largest animals that would be expected to occur in the Houghton Road project area based on existing levels of urbanization, development, and existing habitat.

- The *minimum* size for small- to medium-sized mammals is a 36-inch culvert. A 48-inch culvert is more appropriate, and larger structures, or alternative designs such as concrete box culverts or bridges are better for facilitating wildlife movement.
- Concrete structures are preferred over metal, as concrete more resembles a natural material.
- The substrate within the crossing should consist of native material that mimics the adjacent substrate.
- Steep grades within the crossing should be avoided – the crossing should be as level as possible.
- Supplemental lighting can be provided through the use of grates or gaps in the median. Wildlife is more apt to use a crossing if it can clearly see through to the other side.



Researchers at the AZ Game and Fish Department have shown that wildlife prefer the sloped, more natural underpass (right) to hard-edged walls (left) on State route 260.

Approaches

Approaches to a crossing should appear as natural as possible in order to facilitate use by wildlife species that are often wary of unnatural situations or objects.

- Avoid obstructing an animal's view through the crossing structure. Habitat features should be visible on either side of the structure; avoid dog-legs and placing above-ground utilities too close to the approach.
- If possible, avoid clearing vegetation from a crossing location during other construction activities (i.e., geotechnical investigations, utility relocations). When clearing vegetation is unavoidable, consider supplementing or restoring the vegetaton near the crossing structure approach to provide a more natural setting. Vegetation provides many benefits for a wildlife crossing; it minimizes the distance animals must travel between habitats on both sides of the highway, it shields animals from light and noise, and it also provides cover which is often important to animals that are feeling vulnerable.
- Riprap, utility structures (poles, pull boxes, etc.), and other built features are undesirable within the approach area.

Fencing

Fencing may be used to direct wildlife toward a suitable crossing structure, or to close off areas where wildlife may enter roadways and become a threat to motorists. Fencing should be used minimally in strategic locations as it can trap garbage and has regular maintenance costs associated with its upkeep. Fencing is important for small and mid-sized mammals, although there is limited information on what fence type works best. For many species, standard height

highway fencing (4 foot high wire mesh) is adequate. Skunks and other small mammals will fit through 4 inch size mesh, but a variety of fencing material can be used, including variable mesh or welded fencing that has small-sized mesh openings at the bottom and larger openings on top. One half inch mesh screening can be used for badger, amphibians and other small animals. Three or four foot high, 2 inch x 4 inch mesh welded fencing should be adequate to funnel small mammals into culverts.

- Construct fencing at the top of the crossing structure and not across the bottom of the wash (see photos below) that has been identified as a wildlife crossing. Making the approach as wide as possible will not only minimize the corral or funneling effect, but will also minimize wildlife from getting around the structure and onto the roadway. The length of the fencing along the top of the structure is variable to site topography and target wildlife species.
- Bury the bottom of the mesh fencing to reduce the chances of wildlife digging underneath.
- Consider herpetofauna walls – low, lipped walls for reptiles, amphibians, and small mammals – at certain locations along the right-of-way to funnel these animals into culvert crossings.

Example of good fencing that ties into the top of a crossing structure:



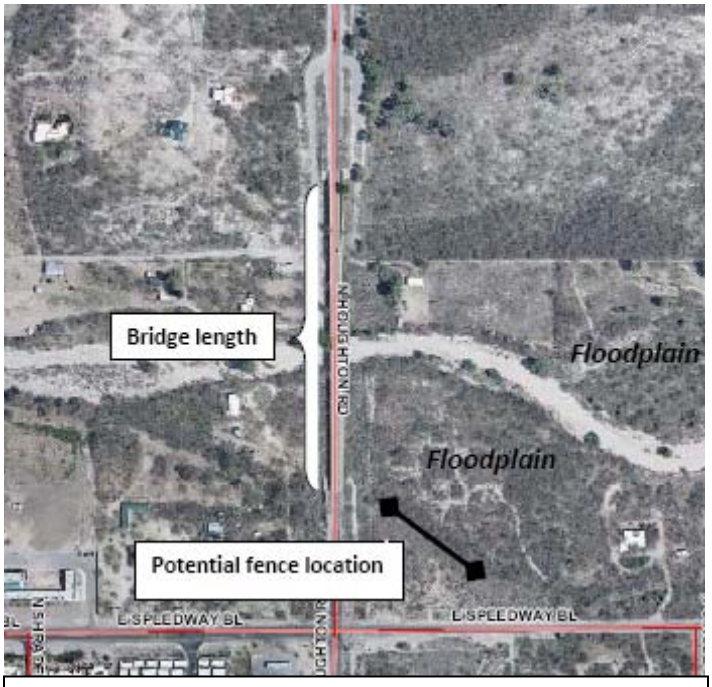
Multi-plate arch on US Highway 40, Berthoud Pass, Colorado.

Examples of poor fencing:

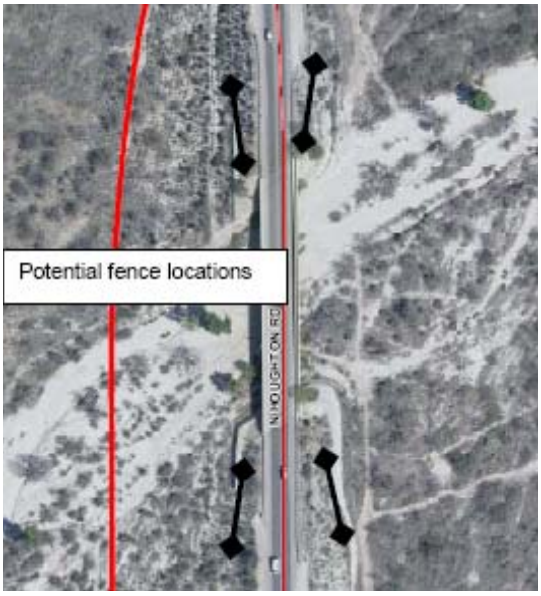


Livestock fencing blocking an underpass on Hwy 50 in Colorado (left) and corral effect fencing on US 550, New Mexico (right).

At Tanque Verde Creek, the bridge spans the floodplain, in addition to the wash bottom, providing a wide swath of vegetation and habitat for wildlife using the creek. Minimal fencing would be needed at this location to prevent animals from crossing over Houghton Road, specifically within the area south of the Creek and east of Houghton Road. A variable mesh fence would be appropriate for this location to funnel small and medium sized mammals away from the road and back towards the creek.



Aerial view of Houghton Road at Tanque Verde Creek



Aerial view of Houghton Road at Agua Caliente

The Agua Caliente Wash bridge spans approximately 300 feet across the wash bottom and incorporates a much narrower portion of the floodplain then at Tanque Verde Creek. Wildlife fencing placed along the top of the existing bridge protection could help funnel wildlife species back towards the wash and away from Houghton Road. The bridge protection at this location is already steep enough to function as a barrier to wildlife at the edge of the wash. Extending a variable mesh fence that slightly angles away from the roadway would redirect wildlife using the adjacent floodplain back towards the wash.

Summary of Recommendations

Of the two washes identified as potential wildlife crossings, both Aqua Caliente Wash and Tanque Verde Creek provide highly critical wildlife linkages and function as primary movement corridors between large blocks of undeveloped lands. They both originate in the Coronado National Forest on the east side of the Tucson Basin and continue to the west, ultimately connecting to the Santa Cruz River and Tucson Mountains on the west side of the Basin. It is recommended that the bridge structures at these two washes are maintained so these washes can continue to function in this capacity. The recommendations included in this report will be provided to the design consultant for consideration during the design stage of this project.

APPENDIX E

Alternatives on Houghton Road north of 5th Street