NOISE ANALYSIS - FINAL REPORT

CORTARO FARMS ROAD – MAGEE ROAD PROJECT

THORNYDALE TO ORACLE

Tucson, Arizona

Sound Solutions Project No. 07109

PCDOT Project Numbers

4MCFTL Corataro Farms Road/Magee (Thornydale Rd to La Cañada Dr)
4RTMLI Magee Road/La Cholla Boulevard Intersection
4MRLCO Magee Road (La Cañada Drive to Oracle Road)
STP-PPM-0(209)A
0000 PM PPM SS693 01C

Prepared for

EcoPlan Associates, Inc.

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April 2009

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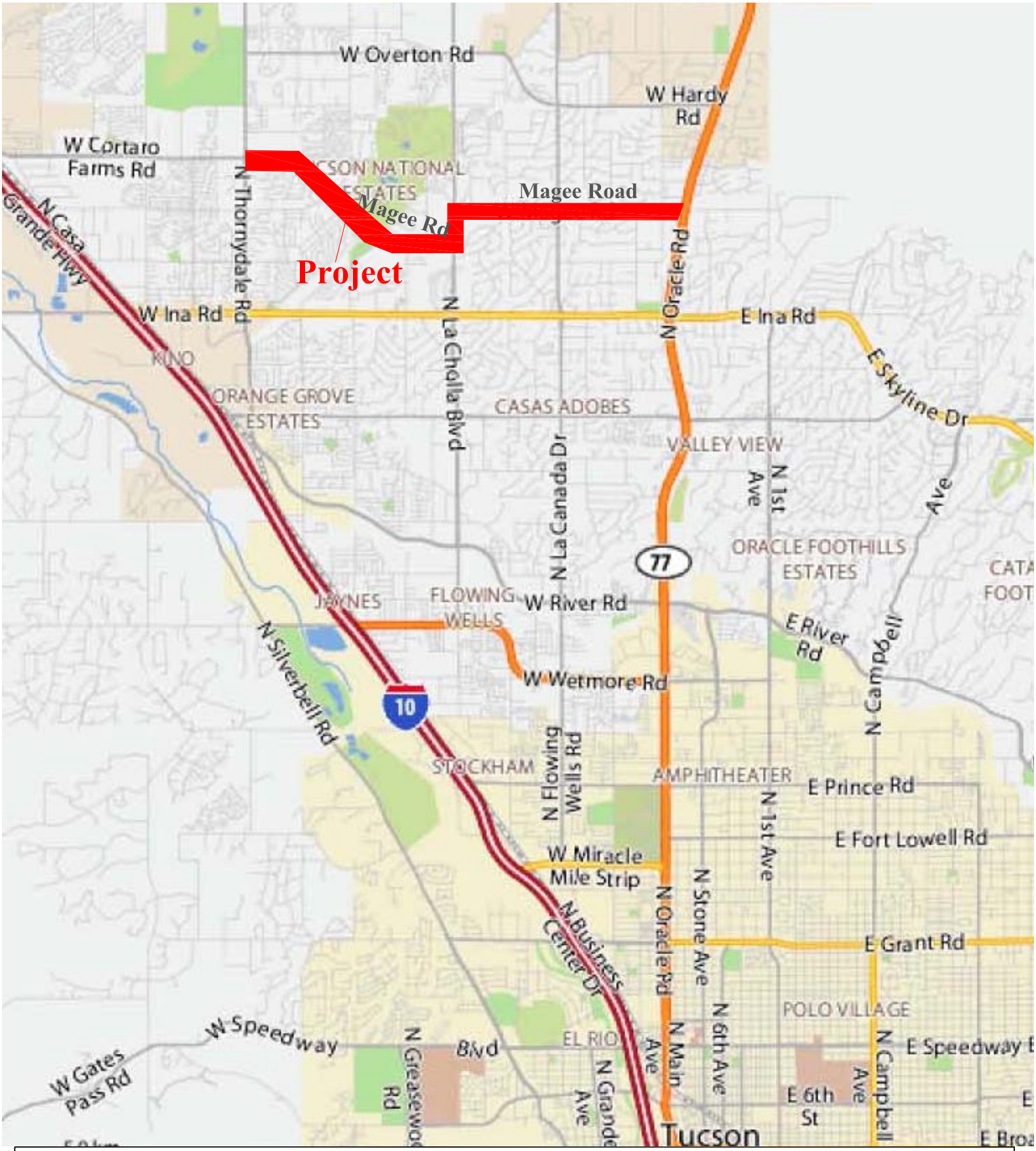
1 Summary

The widening of Magee Road/Cortaro Farms Road from Thronydale Road to Oracle Road is a Regional Transportation Authority (RTA) funded project.

The project is located approximately 10 miles north of downtown Tucson and is slightly less than 5 miles long, as shown in Figure 1.

Potential noise impacts from the proposed project were assessed following the Arizona Department of Transportation (ADOT) procedures. The analysis assessed the impact of traffic noise from the expansion on nearby properties and compared them to the Federal Highway Administration (FHWA) criteria to determine whether traffic noise mitigation is necessary.

The noise analysis results show that noise impacts could occur and that seven barriers should be considered, as shown in Section 8.



Vicinity Map

Magee Road - Thornydale to Oracle

Figure No. 1

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Date	Project No.	Drawn By
April 28, 2009	07109	wmh

2 Project Description

The project is located approximately 10 miles north of downtown Tucson and is slightly less than 5 miles long, as shown in Figure 1. The roadway lies primarily within Pima County with a small portion, from Northern Avenue to Oracles Road, within the Town of Oro Valley. The existing roads and nearby residences are shown in Figures 2, 3, and 4.

A mix of single family homes, apartments, condominiums, and retail buildings are found adjacent to the roads.

The proposed widening will add capacity to the Magee and Cortaro Farms Roads. The La Cholla Blvd and Magee Road intersection is proposal to include a loop ramp.

The project will use Rubberized Asphalt Concrete (RAC) which has been shown to reduce noise levels from traffic by over 3 dBA. Pima County allows a 3 dBA noise reduction for the use of RAC; however, ADOT and FHWA do not permit this noise reduction; hence, none was taken in this analysis.

FIGURE 2

Figure 3

Figure 4

3 Noise Impact Analysis Procedure

Sound Solutions conducted a sound study to determine the noise impacts that will be associated with the Magee/Cortaro Road Project.

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The sound study was conducted using the following six steps:

1. The existing noise radiating from traffic was predicted utilizing the Federal Highway Administration's (FHWA) Traffic Noise Model (TNM 2.5) and peak traffic noise hour.
2. The noise currently found at representative residences along the project was measured during peak traffic hours to verify the traffic sound model.
3. Noise radiating from the future no-build condition during peak traffic hours was predicted using TNM 2.5.
4. Noise radiating from the future build condition during peak traffic hours was predicted using TNM 2.5.
5. The prediction results were compared with the FHWA guidelines to determine if noise mitigation measures were warranted.
6. Noise mitigation measures were evaluated to identify if they were feasible.

This report presents the results of the study.

4 Noise Impact Criteria

Table 1 displays the Federal Highway Administration (FHWA) Noise Abatement Criteria (NAC) for varying land activity categories as presented in FHWA's Procedures for the Abatement of Highway Traffic and Construction Noise (23 CFR 772). These criteria specify noise levels considered to be the upper levels of acceptability for outdoor and certain indoor activities.

Table 1 Federal Highway Administration Noise Abatement Criteria

Land Use Category	Leq Noise Limit	Description of Land Use Category
A	57 dBA (exterior)	Tracts of land in which serenity and quiet are of extraordinary significance and serve an important public need, and where the preservation of those qualities is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks or open spaces which are recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B	67 dBA (exterior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, picnic areas, playgrounds, active sports areas, and parks.
C	72 dBA (exterior)	Developed lands, properties or activities not included in categories A and B above.
D	—	Undeveloped lands.
E	52 dBA (interior)	Residences, motels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.
Source: Title 23, Code of Federal Regulations, Part 772		

Pima County Department of Transportation & Flood Control District Department Procedure (December 1, 2003) states that the predicted exterior noise level for a sensitive receiver is 66 dBA L_{eq} or above or the predicted exterior noise levels at a sensitive receiver are 15 dBA or more above the existing levels.

As stated earlier Pima County allows a 3 dBA noise reduction for the use of RAC; however, since ADOT and FHWA do not permit this noise reduction. No noise reduction for the use of RAC was taken in this analysis.

FHWA guidelines indicate that abatement should be considered if either of the criteria described above are exceeded; however, the abatement measures must be reasonable, feasible, and desired by the affected individuals.

5 Noise Modeling

The noise modeling software used for the analysis was FHWA Traffic Noise Model (TNM) Version 2.5. Three conditions were modeled using TNM. The models developed estimated the peak hour traffic noise levels for existing (2007) traffic and projected design year (2030) traffic in the project vicinity both with and without the proposed project. The existing traffic conditions model included the current street configurations and 2007 traffic volumes. Future "build" traffic conditions were modeled to include the proposed street modifications and the projected 2030 traffic. The proposed design is shown in Figures 5, 6, and 7.

The receiver locations are representative locations selected to determine the noise impacts along the project.

The TNM computer model requires a considerable amount of input data regarding the geometry of the roadways as well as traffic volumes, vehicle mix, and speeds. Detailed traffic analysis was completed along with preliminary roadway alignments for the proposed improvements. Site physical conditions were derived from topographic maps, design drawings, and site visits. Input data were obtained from these sources for the models.

In general, the following data were used in the models:

- Vehicle Speeds – as follows
  - Cortaro Farms Road/Magee Road from Thornydale Road to Northern Ave – 45 mph
  - Magee Road from Northern Ave to Oracle Road – 35 mph
  - Magee Road south of Cortaro Farms Road – 35 mph
  - Shannon Road north of Cortaro Farms Road – 45 mph
  - Shannon Road south of Magee Road – 35 mph
  - La Cholla Blvd – 45 mph
  - La Cañada Drive – 45 mph
  - Northern Ave – 35 mph
  - Oracle Road – 50 mph
  - Side streets and frontage roads have a 25 mph posted speed limit
- Traffic Volumes were provided by Kittelson & Associates, Inc.
- Vehicle Mix – it was assumed that 4% of the vehicles were 'heavy vehicles' (2 axle 6 tire vehicles through more than 6 axle vehicles) and 96% were automobiles.
- Elevations – topographic information was used for the roads and receivers.
- Ground – "Hard soil"

The accuracy of these parameters was checked by comparing the results with measured sound levels.

Figure 5

Figure 6

Figure 7

6 Noise Model Verification

The noise modeling software used for the analysis was FHWA Traffic Noise Model (TNM) Version 2.5. Two scenarios were modeled using TNM: peak hour traffic noise levels for existing (2008) traffic and peak hour traffic noise for the design year (2030) traffic in the project vicinity.

Noise measurements were conducted on three mornings and three afternoons to document existing conditions and verify the noise model. Seventeen representative locations were selected, are shown in Figures 2-4 and 5-7 and are as follows:

1 8366 Washakie Way – southeast corner of W Cortaro Farms Road and N Albany Avenue

2 3361 Broward Trail – southeast corner of W Cortaro Farms Road and Broward Trail

3 3220 Moondance Way – southwest corner of W Cortaro Farms Road and Wheatfield Drive

4 3205 Coraro Farms Road #103 – south side

5 2980 Trevi Place – southwest corner of W Magee Road and N Cortina Place

6 2830 Medallion Drive – southeast corner of W Magee Road and N Royal Sunset Drive

7 7801 N Tuscany Drive – northwest corner of W Magee Road and N Tuscany Drive

8 770 N Via Piccolina – north side of W Magee Road

9 W Via di Silivio – south side of W Magee Road

10 Sonora Terrace – west side of La Cholla Boulevard

11 W Paseo Maserrat – southeast of the corner of La Cholla Boulevard and W Magee Road

12 17415 W Magee Road – south side

13 8021 N Totavi Trail – Santa Fe Park, north side

14 1431 W Magee Rd – St Marks Methodist Church, southwest corner of La Canada Drive and W Magee Road

15 7955 Leonardo da Vinci Way – southwest corner of Leonardo da Vinci Way and W Magee Road

16 1040 Magee Road – north side

17 8001 Plaza Feliz – north side of W Magee Road

Noise levels were measured using two Larson Davis 820 sound level meters, which meet the American National Standard Institute (ANSI) requirements for Type 1 sound level meters. The detectors of the meters were set for "slow" response. The microphones were located approximately five feet above the ground. The sound level meters were calibrated prior to and immediately after each noise measurement. Noise levels were measured for three 10 minutes periods at each of the seventeen measurement locations.

Noise was measured during peak AM and PM traffic hours on Tuesday, November 18, 2008, Wednesday, November 19, 2008 and Thursday, November 20, 2008 from 7 to 9 AM and 4 to 6 PM. These times were selected to represent peak traffic hours.

The verification model was used to compare measured sound levels to predicted sound levels from comparable modeled conditions. This comparison was used to make parameter adjustments to model components to reflect site conditions. All measurements and predictions were on the road side of all barriers. Table 2 shows the results.

Table 2 Field Verification Model Results Without Any Barriers

Receiver Location	Measured Noise Level (dBA) During Peak Traffic Hours				Modeled Noise Level (dBA)
	1	2	3	Average	
1 – 8366 Washakie Way	62	64	61	62	66
2 - 3361 Broward Trail	65	65	64	65	65
3 - 3220 Moondance Way	63	60	60	61	65
4 – 3205 Cortaro Farms #103	64	62	61	62	64
5 – 2980 Trevi Place	62	63	63	63	66
6 – 2830 Medallion Drive	61	63	61	62	65
7 – 7801 N Tuscany Drive	66	64	63	64	66
8 – 770 Via Piccolina	61	62	58	61	65
9 – W Via di Silivaio	63	63	64	63	65
10 – Sonora Terrace Apartments	66	68	67	67	68
11 – W Paseo Maserrat	55	55	57	56	58
12 – 17415 Magee Road	64	63	62	64	64
13 – 8021 N Totavi Trail	64	65	65	65	65
14 – St Marks Methodist Church	60	59	62	60	65
15 – 7955 Leonardo da Vinci	65	65	63	64	65
16 – 1040 Magee Road	64	63	61	63	65
17 – 8001 Plaza Feliz	58	57	55	57	65

As shown in Table 2, the modeled noise levels are equal to or higher than the measured noise levels, showing that the predictions are conservative. The measurement locations were on the road side of any barriers or in the road next to barriers; hence, no barrier reduction is included in the results above. The predicted existing noise levels exceed the noise limits at locations 1, 5, 7, 10, and 14.

These results reflect good agreement between measured and modeled values and show that the noise model is generally conservative in predicting noise levels.

Tuesday, November 18, 2008 AM – During the morning measurement period the temperature was about 70°F, the relative humidity was about 13%, and there was a slight wind from the east (2-5 mph).

Tuesday, November 18, 2008 PM – During the evening measurement period the temperature was about 76°F, the relative humidity was about 13%, and there was a breeze from the east (0-5 mph).

Wednesday, November 19, 2008 AM – During the morning measurement period the temperature was about 60°F, the relative humidity was about 22%, and there was a slight wind from the east (3-7 mph).

Wednesday, November 19, 2008 PM – During the evening measurement period the temperature was about 71°F, the relative humidity was about 17%, and there was a slight wind from the west (0-5 mph).

Thursday, November 20, 2008 AM – During the morning measurement period the temperature was about 52°F, the relative humidity was about 29%, and there was a breeze from the southeast (2-6 mph).

Thursday, November 20, 2008 PM – During the evening measurement period the temperature was about 68°F, the relative humidity was about 18%, and there was a slight wind from the west (0-5 mph).

The primary noise source at all of the locations was traffic on Magee Road and Cartaro Farm Road, local traffic and aircraft.

7 Noise Prediction Results

Table 3 summarizes the TNM model prediction results at the seventeen measurement locations plus five prediction locations as shown in Figures 5, 6, and 7 and described below. Potential traffic noise impacts were evaluated relative to the Pima County noise limit of 66 dBA. The future no-build and built were computed using projected future traffic data provided by Kittelson & Associates, Inc. Noise attenuation due to barriers was included in Table 3.

A W Calle de Manzanillo – north side of W Cortaro Farms Road
B W Fairway View Circle – north side of W Cortaro Farms Road and lower elevation
C W Paseo Maserrat – southeast of the corner of La Cholla Boulevard and W Magee Road
D Tierra Vida Condo – north of W Magee Road
E W Comobabi Drive – south side of W Magee Road

As shown in Table 3, the predicted Future No-Build noise levels are approximately 2 dBA higher than the existing noise levels. The predicted Future No-Build noise levels exceed the Pima County noise limits at locations 3, 5, B, 8, 9, 10, 12, 14, 15, 16, and 17.

The predicted Future Build noise levels are very similar to the Future No-Build noise levels except at locations 11 and C where a new angled road is proposed. The noise level is significantly lower than the existing and no build along New Magee Road because much of the traffic is expected to be diverted along the angled road. The Future Build noise levels exceed the Pima County noise limits at the same locations listed above for the No-Build condition.

The receivers that are impacted, according to the Pima County definition, are shown in Figures 5, 6 and 7.

Table 3 Noise Prediction Results

Receiver Location	Existing Noise Level (dBA)	Future No-Build Noise Level (dBA)	Future Build Noise Level (dBA)	Noise Criteria (dBA)
1 – 8366 Washakie Way	62	64	64	66
A – Calle de Manzanillo	61	63	63	66
2 - 3361 Broward Trail	63	65	65	66
3 - 3220 Moondance Way	64	**66**	**66**	66
4 – 3205 Cortaro Farms #103	62	64	64	66
5 – 2980 Trevi Plaza	64	65	65	66
B – W Fairway View Circle	65	**67**	**67**	66
6 – 2830 Medallion	63	65	65	66
7 – 7801 N Tuscany Drive	63	65	65	66
8 – 770 Via Piccolina	65	**67**	**67**	66
9 – W Via di Silivaio	64	**66**	**66**	66
10 – Sonora Terrace Apartments	**67**	**69**	**68**	66
11 – W Paseo Maserrat	58	60	64	66
C – W Paseo Maserrat	56	58	61	66
D – Tierra Vida Condo	60	62	58	66
12 – 17415 Magee Road	64	**67**	**66**	66
13 – 8021 N Totavi Trail	61	64	63	66
14 – St Marks Methodist Church	65	**67**	**67**	66
15 – 7955 Leonardo da Vinci	65	**67**	**66**	66
16 – 1040 Magee Road	65	**67**	**67**	66
E – W Comobabi Drive	63	64	64	66
17 – 8001 Plaza Feliz	65	**67**	**67**	66

8 Mitigation Measures

Mitigation measures must be considered when either: 1) the projected noise levels at noise sensitive receivers are 66 dBA or more; or, 2) the projected noise levels are 15 dBA or more above the existing noise levels. Substantial increases in noise levels over existing levels were not found in this analysis.

The FHWA guideline states that when noise abatement measures are being considered, every reasonable effort shall be made to obtain substantial noise reduction. Pima County sets a maximum cost of noise abatement per benefited developed property at $35,000. Benefited residential developed properties include all single-family dwellings (apartments, manufactured homes, condominiums, detached homes) whether occupied by the owner or a renter that receive a 5 dBA noise reduction from proposed mitigation. Pima County states that a barrier construction cost of $25 per square foot shall be used and that noise barrier construction shall not be constructed unless two or more adjacent receivers are benefited.

Mitigation considerations for traffic noise exceeding the NAC and the ADOT Policy criteria due to highway improvements includes shifting the horizontal alignment, depressing the roadway, acquiring real property, managing traffic, and constructing noise barriers.

As stated earlier Pima County allows a 3 dBA noise reduction for the use of RAC; however, since ADOT and FHWA do not permit this noise reduction. No noise reduction for the use of RAC was taken in this analysis. A 3 dBA noise reduction would reduce the predicted future noise levels to below the noise limits at all locations.

Table 4 shows the required barrier size, benefited receivers (receiving a 5 dBA noise reduction or more) and the cost per benefited receiver for each area with impacted receivers.

Recommended barriers are shown in Figures 5, 6 and 7. As shown in Table 4, barriers that meet the Pima County requirements are a, b, d, f, g, h, and j.

Table 4 Cost of Barriers per Benefited Receiver

Barrier ID and Location	Existing Wall[1]	Potential Wall Length	Potential Wall Height[2]	Benefited Receivers[3]	Cost per Benefited Receiver[4]	Recommended
a – between Locations 2 and 3, south side of Cortaro Farm Road, west of Midnight Way	4’	270’	7’	4	$11,813	**Yes**
b – between Locations 2 and 3, south side of Cortaro Farm Road, between Midnight Way and Wheatfield Dr	4’	690’	7’	17	$7,103	**Yes**
c –Location 5, south side of Magee Road, corner of Magee Road	None	300’	>10’	2	>$37,500	No[6]
d – Location B, north side of Magee Road, east of Shannon Road	4’	375’	7’	4	$16,406	**Yes**
e – Location 8, north side of Magee Road, west of Via Piccolina – adjacent impacted residences[5]	None	363’	>10’	2	>$45,375	No[6]
f – Location 9, south side of Magee Road, east of Shannon Road	3.5’	866’	7’	10	$15,155	**Yes**
g – Location 10, west side of La Cholla Blvd, Sonora Terrace Apartments	3’	1288’	10’	15	$21,467	**Yes**
h – Location 12, south side of Magee Road, west of Camino de Maximilian – frontage road	None	1400’	6’	6	$35,000	**Yes**
i – between Locations 12 and 14, south side of Magee Road, east of Camino de Maximilian	None	-	-	-	-	No[5]
j – near Location 13, northwest corner of Magee Road and La Cananda Drive	None	1600’	7’[1]	9	$31,111	**Yes**
k – Location 14, southwest corner of Magee Road and La Cananda Drive	None	-	-	-	-	No[5]
l –near Location 15, north side of Magee Road, east of La Cananda Drive	None	-	-	-	-	No[5]
m – near Location 15, south side of Magee Road, east of Shannon Road	6’	-	-	-	-	No[5]
n – near Location 16, north side of Magee Road, west of Cool Drive	None	-	-	-	-	No[5]
o – Location 16, north side of Magee Rd, east of Cool Dr	None	420’	10’	2	$52,500	No[6]
p – near Location 16, south side of Magee Road, west of Vamori Drive	None	-	-	-	-	No[5]
q – near Location 16, north side of Magee Road, west of La Oesta Avenue	None	-	-	-	-	No[5]
r – Location E, south side of Magee Road, east of Vamori Drive – adjacent impacted residences[5]	None	400’	9’	2	$45,000	No[6]
s – across from Location E, north side of Magee Road, east of La Oesta Avenue	None	-	-	-	-	No[5,7]
t – across from Location 17, south side of Magee Road, east of Paseo del Norte – adjacent impacted residences	None	600’	8’	2	$60,000	No[6]
u –Location 17, north side of Magee Road, Plaza Feliz	None	315’	9’	1	$70,875	No[5,6,7]
v –Location 17, north side of Magee Road, Plaza Feliz	None	-	-	-	-	No[5]

1 Barrier height relative to the ground at the barrier
2 Barrier height relative to future road elevation
3 Noise reduction of 5-7 dBA
4 Based on Pima County cost assumption of $25/ft^2
5 Only one impacted receiver benefits from a wall
6 The cost per benefited receiver exceeds $35,000
7 Breaks in the wall prevent a 5 dBA reduction

9 Construction Noise

Properties in the vicinity of the project area would be exposed to noise from construction activities.

The Pima County Noise Code (Chapter 9.30.070) limits construction activities to between 5 AM and 7 PM, April 15 to October 15 and between 6 AM and 7 PM, October 16 to April 14. A noise variance will be required if nighttime construction is necessary.

Construction noise differs from traffic noise in several ways:

- Construction noise lasts only for the duration of the construction contract, with most construction activities in noise-sensitive areas being conducted during hours that are least disturbing to adjacent and nearby residents.
- Construction activities generally are of a short-term nature, and depend on the nature of construction operations.
- Construction noise also is intermittent and depends on the type of operation, location, and function of the equipment, and the equipment usage cycle. Traffic noise, on the other hand, is present in a more continuous fashion after construction activities are completed.

Adjacent properties in the project area would be exposed to noise from construction activity.

The following noise mitigation measures are recommended to reduce impacts from construction noise; however, not all measures cited would be feasible for the Magee project:

- Construct noise barriers, such as temporary walls or piles of excavated material, between noisy activities and noise sensitive receivers.
- Re-route truck traffic away from residential streets, if possible. Select streets with fewest homes, if no alternatives are available.
- Locate equipment on the construction lot as far away from noise sensitive receivers as possible.
- Construct walled enclosures around especially noisy activities, or clusters of noisy equipment. For example, shields can be used around pavement breakers, loaded vinyl curtains can be draped under elevated structures.
- Combine noisy operations to occur in the same time period. The total noise will not increase significantly and the duration of the noise impact will be less.
- Avoid nighttime activities. Sensitivity to noise increases during the nighttime hours at residential receivers.
- Use specially quieted equipment when possible, such as quieted and enclosed air compressors, residential or critical grade mufflers on all engines.
- Stationary equipment will be located as far away from sensitive receptors as possible. Loud, disrupting construction activities in noise sensitive areas will be conducted during hours that are least disturbing to adjacent and nearby residents.

10 Acoustic Terminology

Sound Pressure Level

Sound, or noise, is the term given to variations in air pressure that are capable of being detected by the human ear. Small fluctuations in atmospheric pressure (sound pressure) constitute the physical property measured with a sound pressure level meter. Because the human ear can detect variations in atmospheric pressure over such a large range of magnitudes, sound pressure is expressed on a logarithmic scale in units called decibels (dB). Noise is defined as "unwanted" sound.

Technically, sound pressure level (SPL) is defined as:

$$SPL = 20 \log (P/P_{ref}) \text{ dB}$$

where P is the sound pressure fluctuation (above or below atmospheric pressure) and P_{ref} is the reference pressure, 20 µPa, which is approximately the lowest sound pressure that can be detected by the human ear.

The sound pressure level that results from a combination of noise sources is not the arithmetic sum of the individual sound sources, but rather the logarithmic sum. For example, two sound levels of 50 dB produce a combined sound level of 53 dB, not 100 dB. Two sound levels of 40 and 50 dB produce a combined level of 50.4 dB.

Human sensitivity to changes in sound pressure level is highly individualized. Sensitivity to sound depends on frequency content, background noise, time of occurrence, duration, and psychological factors such as emotions and expectations. However, in general, a change of 1 or 2 dB in the level of sound is difficult for most people to detect. A 3 dB change is commonly taken as the smallest perceptible change and a 6 dB change corresponds to a noticeable change in loudness. A 10 dB increase or decrease in sound level corresponds to an approximate doubling or halving of loudness, respectively.

A-Weighted Sound Level

Studies have shown conclusively that at equal sound pressure levels, people are generally more sensitive to certain higher frequency sounds (such as made by speech, horns, and whistles) than most lower frequency sounds (such as made by motors and engines)[1] at the same level. To address this preferential response to frequency, the A-weighted scale was developed. The A-weighted scale adjusts the sound level in each frequency band in much the same manner that the human auditory system does. Thus the A-weighted sound level (read as "dBA") becomes a single number that defines the level of a sound and has some correlation with the sensitivity of the human ear to that sound. Different sounds with the same A-weighted sound level are perceived as being equally loud. The A-weighted noise level is commonly used today in environmental noise analysis and in noise regulations. Typical values of the A-weighted sound level of various noise sources are shown in Table 4.

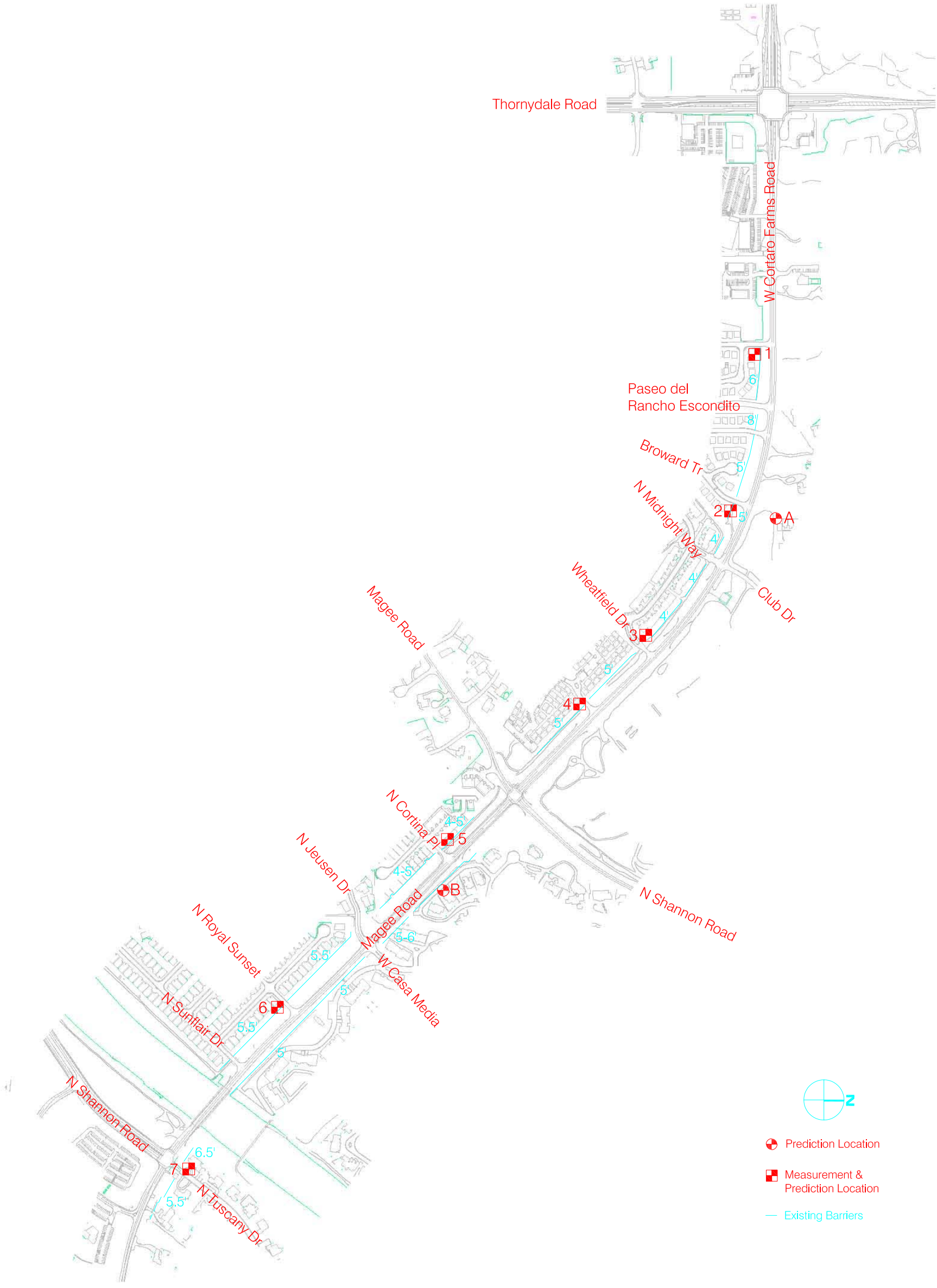
1 D.W. Robinson and R.S. Dadson, "A Re-Determination of the Equal-Loudness Relations for Pure Tones," *British Journal of Applied Physics*, vol. 7, pp. 166 - 181, 1956. (Adopted by the International Standards Organization as Recommendation R-226).

Table 4 Common Sound Levels in dBA

Common Outdoor Sounds	Sound Pressure Level (dBA)	Common Indoor Sounds	Subjective Evaluation
Auto horn at 10’ Jackhammer at 50’	**100**	Printing plant	Deafening
Gas lawn mower at 4’ Pneumatic drill at 50’	**90**	Auditorium during applause Food blender at 3’	Very Loud
Concrete mixer at 50’ Jet flyover at 5000’	**80**	Telephone ringing at 8’ Vacuum cleaner at 5’	
Large dog barking at 50’ Large transformer at 50’	**70**	Electric shaver at 1’	Loud
Automobile at 55 mph at 150’ Urban residential	**60**	Normal conversation at 3’	
 Small town residence	**50**	Office noise	 Moderate
	40	Soft stereo music in residence Library	
 Rustling leaves	**30**	Average bedroom at night Soft whisper at 3’	Faint
Quiet rural nighttime	**20**	Broadcast and recording studio	
	10	Human breathing	Very Faint
	0	Threshold of hearing (audibility)	

Equivalent Sound Level

The Equivalent Sound Level (L_{eq}) is a type of average which represents the steady level that, integrated over a time period, would produce the same energy as the actual signal. The actual *instantaneous* noise levels typically fluctuate above and below the measured L_{eq} during the measurement period. The A-weighted L_{eq} is a common index for measuring environmental noise.



Matchline "A"

Figure No.

2

PROJECT:

MAGEE RD—THORNYDALE TO ORACLE

Tucson, Arizona

PROJECT NO. 07109 DATE: March 3, 2009

DESCRIPTION: Existing with Prediction Locations - West

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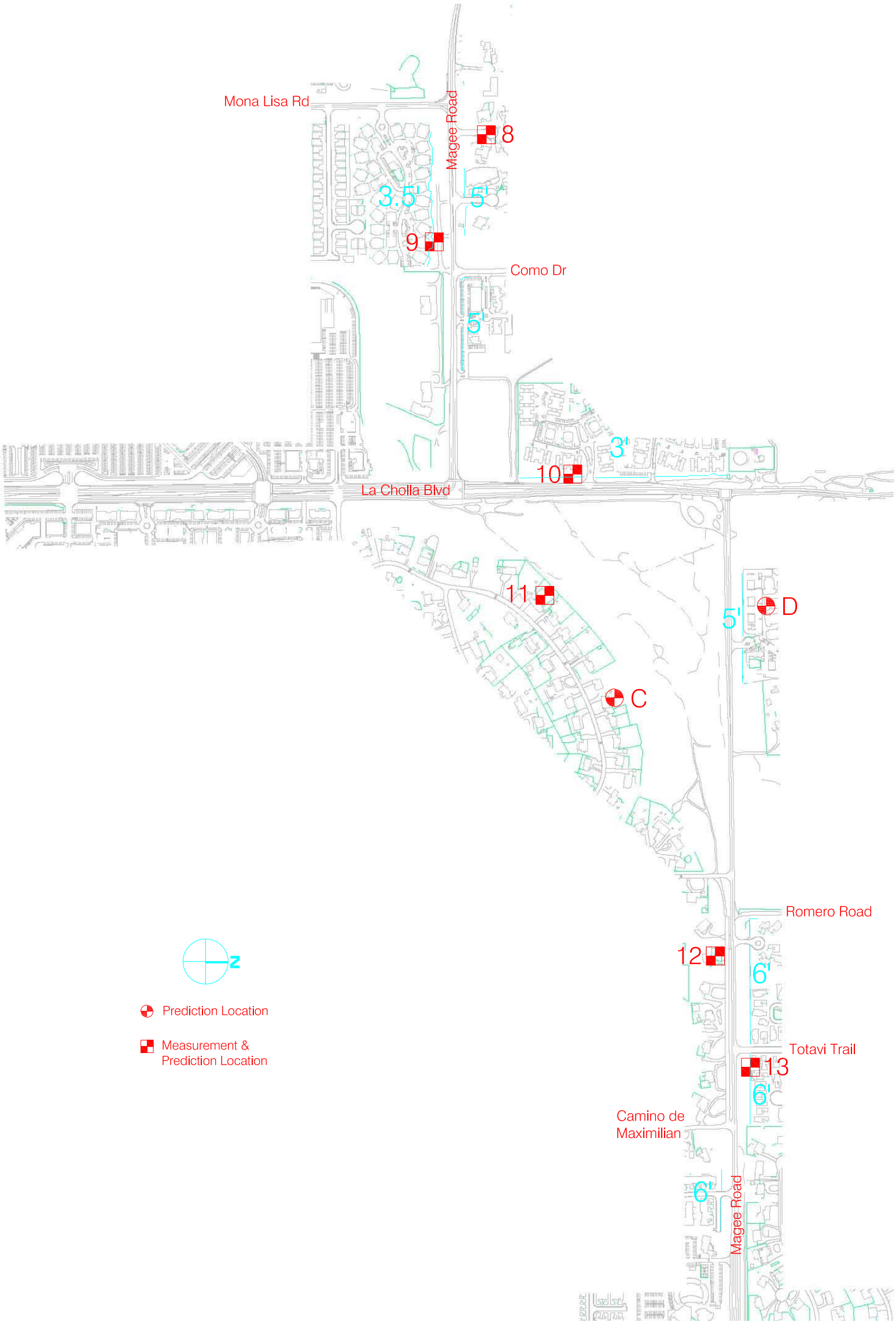
Matchline "A"



Matchline "B"

Figure No.

3

PROJECT:

MAGEE RD—THORNYDALE TO ORACLE

Tucson, Arizona

PROJECT NO. 07109 DATE: March 3, 2009

DESCRIPTION: Existing with Prediction Loctions - Central

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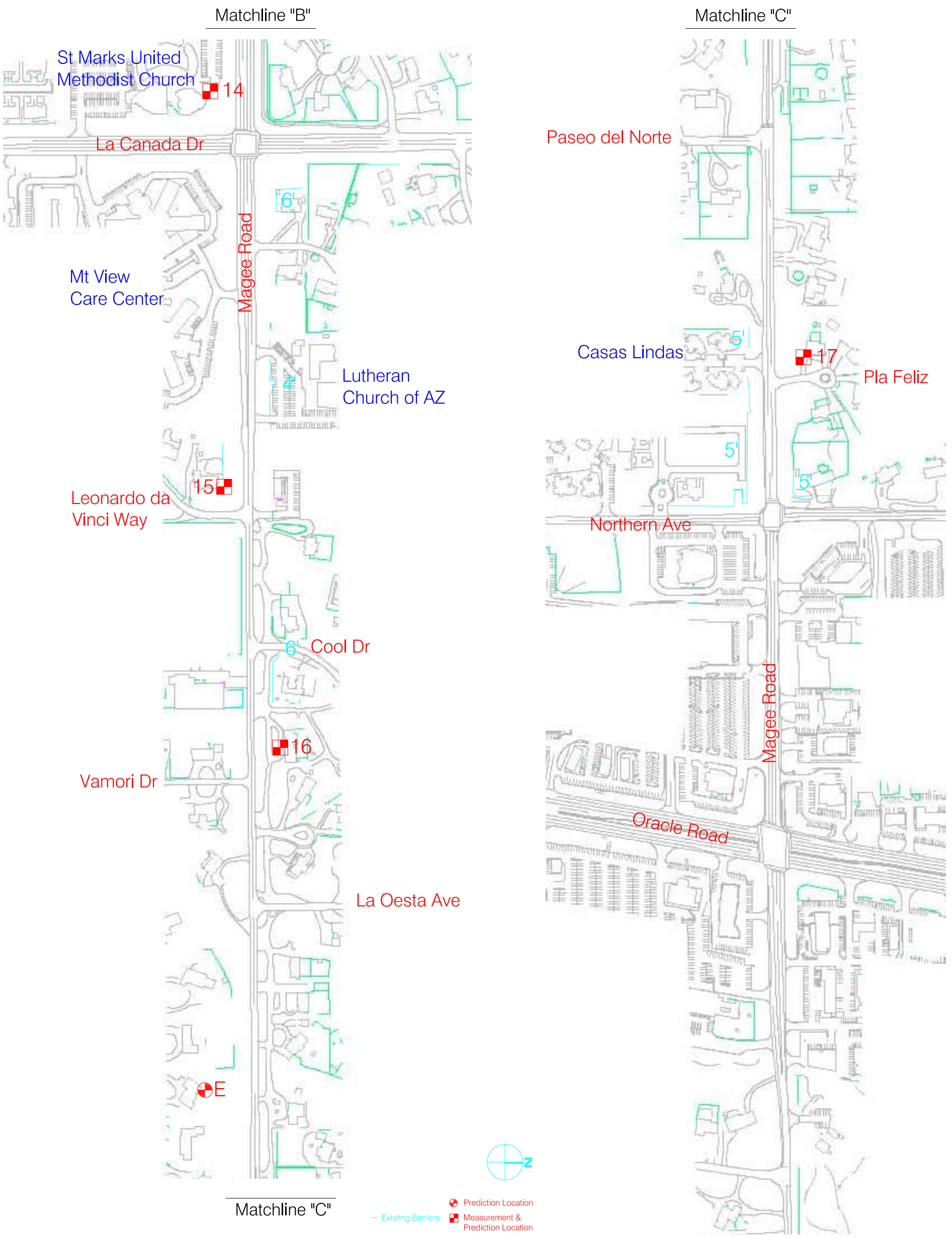

Figure No.

4

PROJECT:

MAGEE RD—THORNYDALE TO ORACLE

Tucson, Arizona

PROJECT NO. 07109 DATE: March 3, 2009

DESCRIPTION: Existing with Prediction Loctions - East

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Matchline "A"

Figure No.

5

PROJECT:

MAGEE RD—THORNYDALE TO ORACLE

Tucson, Arizona

PROJECT NO. 07109 DATE: March 3, 2009

DESCRIPTION: Proposed with Potential Barriers - West

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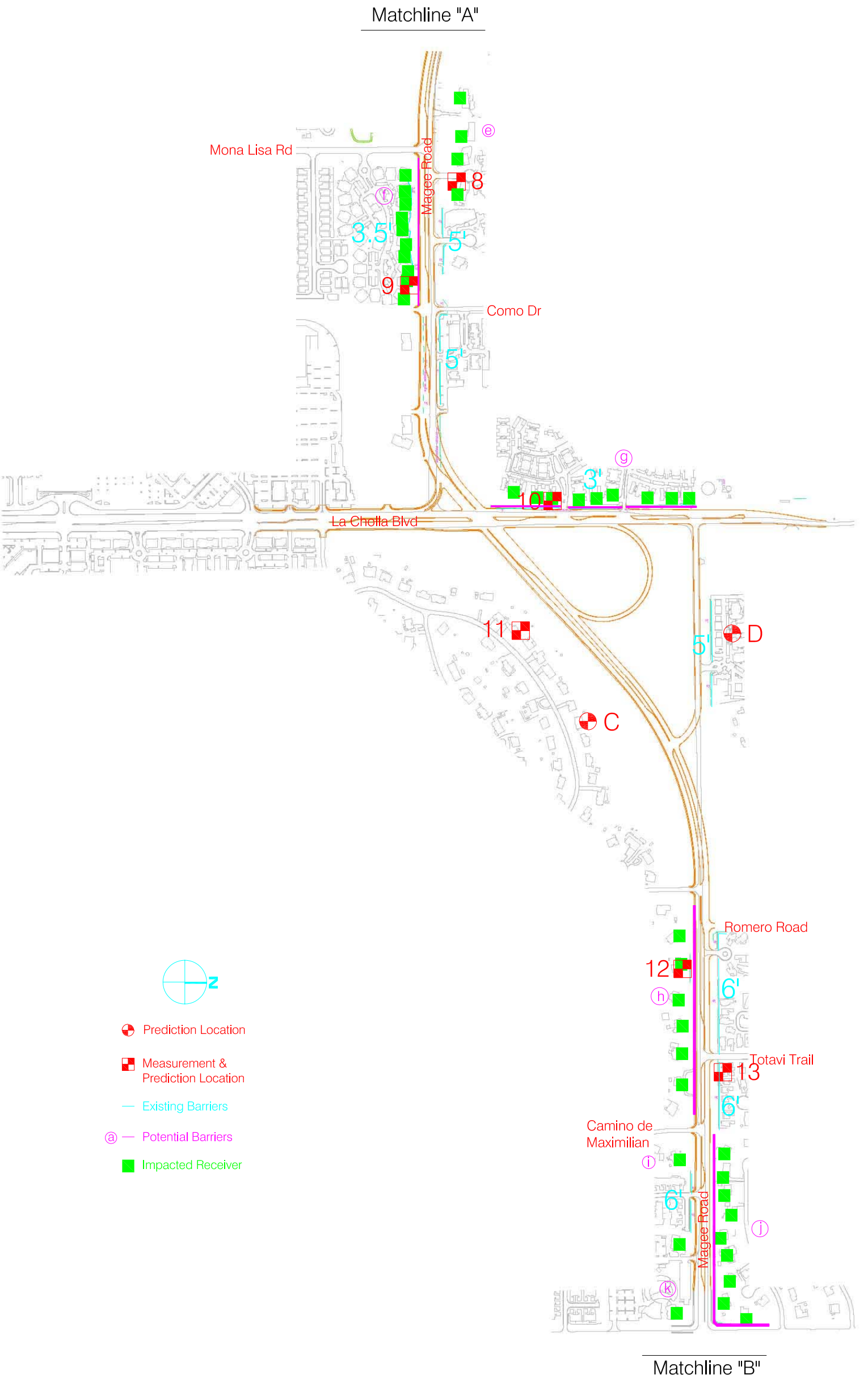

Figure No.

6

PROJECT:

MAGEE RD—THORNYDALE TO ORACLE

Tucson, Arizona

PROJECT NO. 07109 DATE: March 3, 2009

DESCRIPTION: Proposed with Potential Barriers - Central

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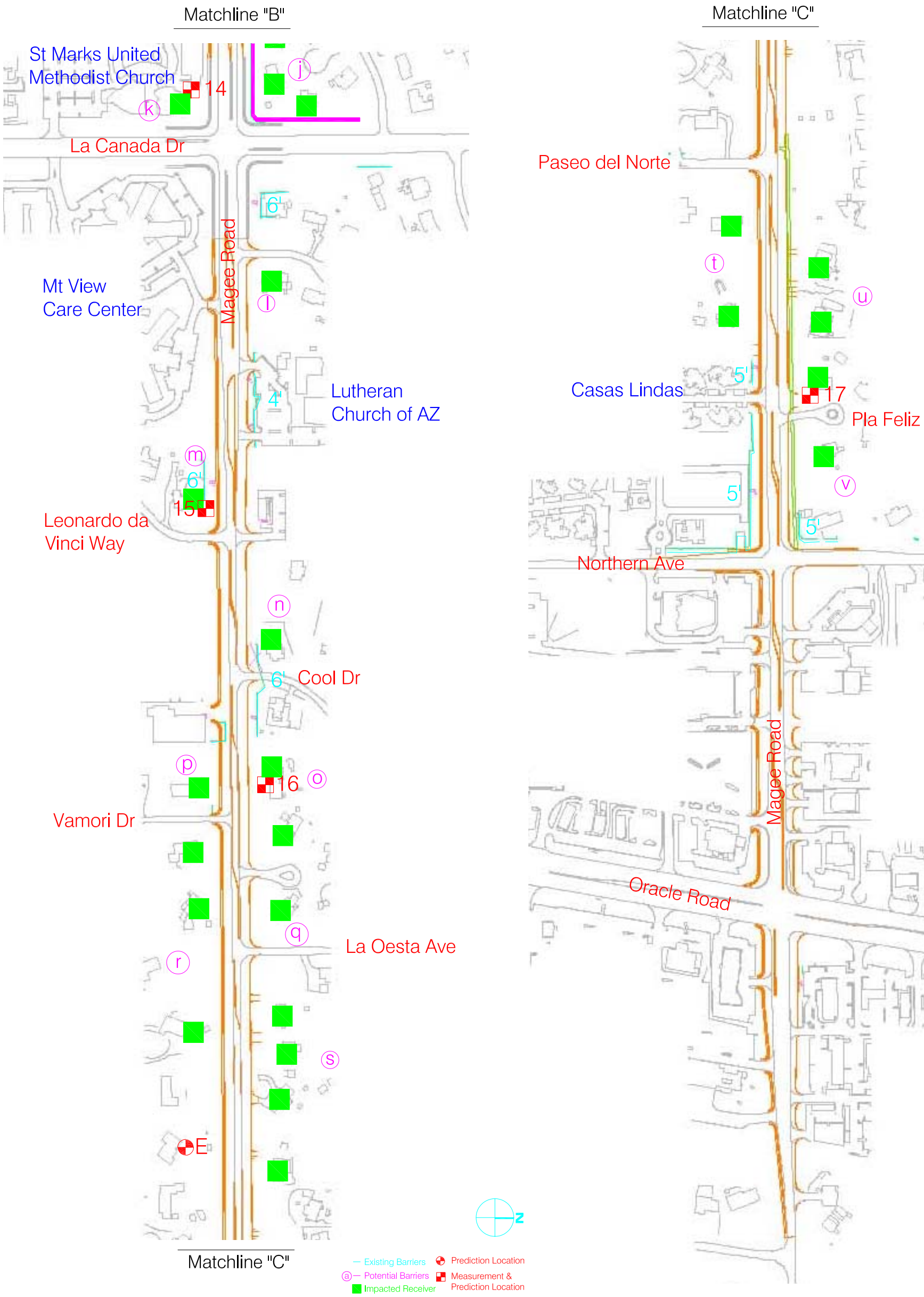

Figure No.

7

PROJECT:

MAGEE RD—THORNYDALE TO ORACLE

Tucson, Arizona

PROJECT NO. 07109 DATE: March 3, 2009

DESCRIPTION: Proposed with Potential Barriers - East

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