## Technical Memorandum

**To:** Kathy Arnold  
**From:** Seri Park  
**Company:** Rosemont Copper Company  
**Date:** June 4, 2009  
**Re:** Rosemont “T” Intersection Analysis – Stop Sign and Speed Reduction  
**Doc #:** 101/09-320842-5.3  
**CC:** Jamie Sturgess (Rosemont)  
David Krizek and Jamie Joggerst (Tt)

### 1.0 Introduction

This Technical Memorandum was prepared by Tetra Tech and presents design alternatives for the proposed Primary Access Road associated with the Rosemont Copper Project (Rosemont). The Primary Access Road intersection is proposed to consist of a basic “T” intersection that allows access from the mine property to State Route 83 (AZ-83). As shown on Figure 1, the location of the Primary Access Road “T” intersection occurs at Milepost (MP) 46.9 along AZ-83. The current topography conditions at the “T” intersection consist of an undeveloped area. Adding a “T” intersection at this location will require the area to be upgraded per Arizona Department of Transportation (ADOT) and American Association of State Highways and Transportation Officials (AASHTO) roadway design guidelines.

The “T” intersection design presented in the Mine Plan of Operation (MPO) (WestLand, 2007) consisted of the Primary Access Road being “stop” controlled with traffic along AZ-83 being uncontrolled (i.e., no stop sign). The intersection design also included a 500-foot long center lane to the south of the intersection. This center lane would allow northbound traffic to make a left turn onto the Primary Access Road. A 220-foot long deceleration and right turn lane was also proposed along the western edge of AZ-83, north of the intersection. The lane would also continue to the south of the intersection for 500 feet and serve as an accelerating lane for traffic going south on AZ-83. Figure 2 illustrates the “T” intersection configuration and corresponding typical section taken from the MPO.

Tetra Tech completed an in-depth analysis of the “T” intersection in order to assess potential traffic flow issues and to recommend designs that will allow traffic to safely merge from the Primary Access Road onto AZ-83. A total of four (4) alternatives to the MPO design were evaluated for this “T” intersection. These four (4) alternatives include:
A three-way stop sign;

A speed limit reduction;

An acceleration lane with both 55 and 35 miles per hour (MPH) speed limits; and

A bypass lane.

In all of the above listed alternatives, gravel was added along the west side of AZ-83, at the “T” intersection location, allowing for a temporary pull-off area for trucks. This Technical Memorandum presents details and discusses the advantages and disadvantages for the three-way stop sign and the speed limit reduction design alternatives. The remaining design alternatives are presented in other Technical Memorandums prepared by Tetra Tech.

2.0 Design Vehicle

In order to assess the various intersection design alternatives for the “T” intersection, the design vehicle must first be established. Based on Table 407.2 in the ADOT Roadway Design Guidelines, a WB-62 type, Interstate Semi Trailer is recommended as the design vehicle for intersections along a State Route. In AASHTO’s Geometric Design of Highways and Streets, a WB-65 type is recommended as the minimum sized design vehicle for intersections on state highways that carry high volumes of traffic and/or provide local access for large trucks. Therefore, in this Technical Memorandum, a WB-65 type was chosen as design vehicle since a safe truck turning with a WB-65 type will also satisfy a safe truck turning for a WB-62 type.

3.0 Three-Way Stop Design Alternative Criteria

Adding a “STOP” sign along AZ-83 will make the “T” intersection a three-way stop intersection. All the vehicles arriving at the intersection will be required to make a full stop regardless of the opposite or entering traffic. The layout of this proposed alternative is provided on Figure 3. The selection of sign locations followed the guideline in the Manual on Uniform Traffic Control Devices (MUTCD) from the Federal Highway Administration (FHA). In Attachment A, a before and after photo comparison is provided to illustrate the visual changes with regards to the three-way stop intersection.

Geometric Design Elements:

With the newly installed “STOP” sign (R1-1) along AZ-83, additional striping, a white strip starting from the roadway centerline to the shoulder, is required per MUTCD.

Sign Installation:

If a “STOP” sign (R1-1) is placed at each leg of the “T” intersection, advanced warning signs are required to alert the upcoming traffic of the stop sign. Advance warning signs, such as “STOP SIGN AHEAD” (W3-1), should be placed per the MUTCD Table 2C-4 (Attachment B) in the Guidelines for Advance Placement of Warning Signs. Based on this table, a W3-1 warning sign
along the Primary Access Road (road speed of 35 MPH) should be placed approximately 125 feet ahead of the “STOP” sign. A W3-1 warning sign along AZ-83 (road speed of 55 MPH) should also be placed approximately 325 feet ahead of the “STOP” sign for each direction of traffic (i.e., north bound and south bound lanes). Sign installation should follow ADOT’s Roadway Design Guidelines, Section 303.2, which states:

“Roadside obstacles, non-traversable hazards and fixed objects, should be removed, made ‘breakaway’, relocated or shielded by a barrier if they are within the minimum recovery area width”

Therefore, all new signs will need to be “breakaway” and any existing signs will need to be evaluated in order to ensure they meet the breakaway criteria. In addition, roadside clearing of large trees will need to be coordinated with ADOT in order to maintain a safe clear recovery area beyond the pavement limits. Clearing and Grubbing will conform to the guidelines specified in Landscape and Irrigation Design Guidelines for Arizona Department of Transportation Encroachment Permit Applications as presented in Attachment C.

3.1 Three-Way Stop Alternative Advantage and Disadvantage

Advantages:

- Safer merging movement for trucks leaving the Project site and entering AZ-83.

- The additional cost beyond basic intersection widening is minimal and would include: 1) adding the various “STOP” and advanced warning signs and 2) adding stripping at each “STOP” sign.

- No intersection sight distance criteria is applicable (per ADOT Roadway Design Guidelines Section 400-26, AASHTO Case E Intersection Control)

Disadvantages:

- Adding a “STOP” sign to AZ-83 will increase traffic delays and reduce roadway capacity.

- Potential safety issues arise since a “STOP” sign on AZ-83 will increase speed variance along AZ-83 and require drivers to come to a complete stop from a traveling speed of 55 MPH.

4.0 Speed Limit Reduction Alternative Design Criteria

Prior to developing a speed limit reduction design, a determination of what the new speed limit should be must first be analyzed. The current AZ-83 roadway layout has a posted speed limit of 55 MPH north of MP 47, near the proposed Primary Access Road “T” intersection. From MP 47 to MP 43.6, the speed limit varies between 35 and 45 MPH. Since the design vehicle is a WB-62 type Interstate Semi Trailer, it is recommended that the speed limit be reduced to 35 MPH in
order to achieve a safe turning speed for all traffic entering and exiting the Project site. Reducing the speed limit to 35 MPH along AZ-83 allows traffic to continue to flow while also creating a safer condition for truck traffic turning onto AZ-83. Figure 4 describes the proposed speed limit reduction alternative. Similar to the previous alternative, a before and after photo comparison is provided in Attachment D in order to illustrate the visual changes with regards to this speed limit reduction design alternative.

**Geometric Design Elements:**

No additional modification to the “T” intersection configuration presented in the MPO is required.

**Sign Installation:**

In MUTCD Section 2B.18, the following statement is presented regarding the placement and location of the Speed Limit (R2-1) signs:

“Speed Limit (R2-1) signs, indicating speed limits for which posting is required by law, shall be located at the points of change from one speed limit to another. At the end of the section to which a speed limit applies, a Speed Limit sign showing the next speed limit shall be installed. Additional Speed Limit signs shall be installed beyond major intersections and at other locations where it is necessary to remind road users of the speed limit that is applicable. ”

Since the speed limit north of the “T” intersection is 55 MPH, this design alternative will require a speed reduction to 45 MPH at approximately 2,000 feet north of the “T” intersection and a speed reduction to 35 MPH approximately 1,000 feet north of the “T” intersection in order to avoid a sudden speed limit change. Since the speed limit south of the “T” intersection is 45 MPH, this design alternative will require a speed reduction to 35 MPH at approximately 1,000 feet south of the intersection. Furthermore, any existing signs that conflict with this speed change will be removed.

At a minimum, an advanced warning sign stating “SPEED REDUCED AHEAD” (W3-4) will need to be installed following the MUTCD Table 2C-4 in the Guidelines for Advance Placement of Warning Signs. The MUTCD table suggests adding a warning sign 950 feet in advance of the speed reduction for a beginning speed of 55 MPH. However, Tetra Tech recommends a distance of 1,000 feet in order to allow more reaction time for the drivers. Similar to the previous alternative, all new signs will need to be “breakaway” and any existing signs that remain will need to be evaluated to ensure they meet the breakaway criteria.

### 4.1 Speed Limit Reduction Alternative Advantage and Disadvantage

**Advantages:**

- Safer merging movement for trucks leaving the Project site and entering AZ-83.
- The only additional cost beyond basic intersection widening is for adding the various speed limit and advanced warning signs. No additional geometric design elements or striping is needed.
- No intersection sight distance criteria is applicable (per ADOT Roadway Design Guidelines Section 400-26, AASHTO Case E Intersection Control)

Disadvantages:

- Speed reductions may increase traffic delay along AZ-83 considering through vehicles and merging traffic will require acceleration time.

- Trucks heading northbound do not have a dedicated acceleration lane.
REFERENCES


Arizona Department of Transportation (2007) Roadway Design Guidelines


Intersection Widening Designed Per:

Legend:
- ROW - Right of Way

Location:
Mile Post 46.9
Intersection of SR-83 and Primary Access Road
Intersection Widening Designed Per:

Legend:
- ROW - Right of Way

Location:
- Mile Post 46.9
- Intersection of SR-83 and Primary Access Road
Intersection Widening Designed Per:

Legend:
ROW - Right of Way

Location:
Mile Post 46.9
Intersection of SR-83 and Primary Access Road
ATTACHMENT A
PHOTOS FOR THE STOP SIGN “T” INTERSECTION
ALTERNATIVE
Existing Roadway Layout at the Primary Access Road (Milepost 46.9 – looking south)
Stop Sign “T” Intersection Alternative (looking south)
Table 2C-4. Guidelines for Advance Placement of Warning Signs

(English Units)

<table>
<thead>
<tr>
<th>Posted or 85th-Percentile Speed</th>
<th>Advance Placement Distance ¹</th>
<th>Condition A: Speed reduction and lane changing in heavy traffic²</th>
<th>Condition B: Deceleration to the listed advisory speed (mph) for the condition⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mph</td>
<td>225 ft</td>
<td>N/A³, N/A³</td>
<td>— —  — —  — —  — —  — —  — —</td>
</tr>
<tr>
<td>25 mph</td>
<td>325 ft</td>
<td>N/A³, N/A³</td>
<td>— —  — —  — —  — —  — —  — —</td>
</tr>
<tr>
<td>30 mph</td>
<td>450 ft</td>
<td>N/A³, N/A³</td>
<td>— —  — —  — —  — —  — —  — —</td>
</tr>
<tr>
<td>35 mph</td>
<td>550 ft</td>
<td>N/A³, N/A³</td>
<td>— —  — —  — —  — —  — —  — —</td>
</tr>
<tr>
<td>40 mph</td>
<td>650 ft</td>
<td>125 ft, N/A³</td>
<td>— —  — —  — —  — —  — —  — —</td>
</tr>
<tr>
<td>45 mph</td>
<td>750 ft</td>
<td>175 ft, 125 ft</td>
<td>N/A³  N/A³  N/A³  — —  — —  — —</td>
</tr>
<tr>
<td>50 mph</td>
<td>850 ft</td>
<td>250 ft, 200 ft, 150 ft, 100 ft</td>
<td>N/A³  — —  — —  — —  — —  — —</td>
</tr>
<tr>
<td>55 mph</td>
<td>950 ft</td>
<td>325 ft, 275 ft, 225 ft, 175 ft, 100 ft</td>
<td>N/A³  — —  — —  — —  — —  — —</td>
</tr>
<tr>
<td>60 mph</td>
<td>1100 ft</td>
<td>400 ft, 350 ft, 300 ft, 250 ft, 175 ft</td>
<td>N/A³  — —  — —  — —  — —  — —</td>
</tr>
<tr>
<td>65 mph</td>
<td>1200 ft</td>
<td>475 ft, 425 ft, 400 ft, 350 ft, 275 ft, 175 ft</td>
<td>N/A³  — —  — —  — —  — —  — —</td>
</tr>
<tr>
<td>70 mph</td>
<td>1250 ft</td>
<td>550 ft, 525 ft, 500 ft, 425 ft, 350 ft, 250 ft, 150 ft</td>
<td>— —  — —  — —  — —  — —  — —</td>
</tr>
<tr>
<td>75 mph</td>
<td>1350 ft</td>
<td>650 ft, 625 ft, 600 ft, 525 ft, 450 ft, 350 ft, 250 ft, 100 ft</td>
<td>— —  — —  — —  — —  — —  — —</td>
</tr>
</tbody>
</table>

Notes:

¹ The distances are adjusted for a sign legibility distance of 175 ft for Condition A. The distances for Condition B have been adjusted for a sign legibility distance of 250 ft, which is appropriate for an alignment warning symbol sign.

² Typical conditions are locations where the road user must use extra time to adjust speed and change lanes in heavy traffic because of a complex driving situation. Typical signs are Merge and Right Lane Ends. The distances are determined by providing the driver a PIEV time of 14.0 to 14.5 seconds for vehicle maneuvers (2001 AASHTO Policy, Exhibit 3-3, Decision Sight Distance, Avoidance Maneuver E) minus the legibility distance of 175 ft for the appropriate sign.

³ Typical condition is the warning of a potential stop situation. Typical signs are Stop Ahead, Yield Ahead, Signal Ahead, and Intersection Warning signs. The distances are based on the 2001 AASHTO Policy, Stopping Sight Distance, Exhibit 3-1, providing a PIEV time of 2.5 seconds, a deceleration rate of 11.2 ft/second⁴, minus the sign legibility distance of 175 ft.

⁴ Typical conditions are locations where the road user must decrease speed to maneuver through the warned condition. Typical signs are Turn, Curve, Reverse Turn, or Reverse Curve. The distance is determined by providing a 2.5 second PIEV time, a vehicle deceleration rate of 10 ft/second⁵, minus the sign legibility distance of 250 ft.

⁵ No suggested distances are provided for these speeds, as the placement location is dependent on site conditions and other signing to provide an adequate advance warning for the driver.
ATTACHMENT C
LANDSCAPE AND IRRIGATION DESIGN
GUIDELINES FOR ARIZONA DEPARTMENT OF
TRANSPORTATION ENCROACHMENT PERMIT
APPLICATIONS
LANDSCAPE AND IRRIGATION
DESIGN GUIDELINES
ARIZONA DEPARTMENT OF TRANSPORTATION
ENCROACHMENT PERMIT APPLICATIONS

PREPARED BY:
ARIZONA DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION
ROADSIDE DEVELOPMENT SERVICES
INTRODUCTION

The Arizona Department of Transportation, Highways Division, encourages the landscaping of its rights of way through the cooperative efforts with local governments and adjacent property owners. Because the right of way is a public area, of prime importance with relation to landscaping is the protection of the public and its safe access to the facilities as well as the improvement of aesthetic considerations.

Landscaping, being composed of living plant material, is in a constant state of change and must consider the ultimate growth of plants. Additionally, other considerations are the use of low water requirement plant materials and any other local jurisdictional requirements, such as sidewalks, signing setbacks and other requirements in relation to each specific roadway. After all of these factors have been considered the completion of the landscaping can greatly enhance the beauty of the roadway and the community.
LANDSCAPING

I. GENERAL

An approved Encroachment Permit is required before any landscape improvements may be incorporated within the ADOT Highway right-of-way. This applies to work performed under nationwide programs such as Global Releaf as well as individual efforts. Landscaping by local governments may be constructed and maintained within the control of access on the crossroads of major highways under a fully executed Intergovernmental Landscape Maintenance Agreement prepared by the State and an approved Encroachment Permit.

The highway roadside is an integral unit of a total highway facility. The term "roadside" generally refers to the area between the outer edge of the roadway and the right-of-way boundary. These include all unpaved areas within the right-of-way.

Permit applicants are encouraged to employ competent design professionals such as Registered Landscape Architects, Architects or Engineers, and to direct their work toward securing a product that fully represents the owner's needs and desires and meets the Arizona Department of Transportation (ADOT) standards, before submitting such plans for review and approval. Permit applicants and design professionals are encouraged
to discuss landscape needs and proposals with District Permits Supervisors and Roadside Development Services Landscape Architects before commencing work on final construction plans.

All plans and specifications shall be sufficiently complete and detailed for easy analysis and compliance inspection. Plans shall be designed to select plant materials appropriate for the intended use and location, to arrange plants for optimum effect of color, texture, form and to ensure reasonable maintenance within the capability of the proposed permittee. Permit applications will be reviewed for consideration of the following factors which can affect the safe and efficient operation of the highway facility.

II. DRAWINGS

A. PLANS:

Drawings must be legible, accurate and drawn to scale. They shall include a north arrow, name of development, designer and design firm with appropriate phone numbers and location of project.

B. PLANT MATERIALS:

Plants proposed for use must be clearly located, showing mature sizes, and identified as to botanical name (genus species, variety), planting size, quantity and spacing used.
Areas within an Arizona Department of Water Resources Active Management Areas must adhere to the plant list provided for that area. (See attached Plant Lists.)

C. EXISTING FEATURES:

Existing features such as curbs, sidewalks, pipe culverts, drainage structures, retention basins, driveways, highway and non-highway signs, overhead lines, underground utilities, irrigation lines, manholes, service cabinets, etc, shall be shown. In addition, the posted speed limit for the highway shall be indicated. Existing trees and shrubs shall be incorporated into the design wherever feasible. Clearing of trees and shrubs will not be permitted unless approved through the permit process. When planters are cut out of existing sidewalk areas, sufficient space must remain for compliance with ARS statutes relating to accessibility by the physically handicapped. The use of steel tree grates is recommended to maximize usable sidewalk space and to maintain a safe walking surface.

D. SLOPES:

Existing or proposed slopes shall be identified with respect to elevation differences between top and bottom and rate of slope between.
III. DESIGN

A. **EROSION CONTROL:**

Erosion control measures must be employed to prevent surface drainage from eroding soil surfaces and carrying the resultant silt into natural or man made drainage systems, highways or private properties.

B. **SAFETY SETBACKS FOR FIXED OBJECTS:**

Minimum setbacks from the travel way for newly planted trees with an ultimate trunk diameter of more than 4 inches or other hazardous fixed objects should be as follows:

1. **50 MPH or Greater Design Speed:**

   a. Minimum setback from the edge of the traffic lane should be 35 feet unless one of the following reasons will allow for a lesser distance.

      1) Cuts of 3 to 1 or steeper - obstacles are allowed 10 feet behind the point of vertical intersection (P.V.I.) at the toe of the slope. (See illustration 'A'.)

      2) Where concrete barriers, walls, abutments, or other rigid obstructions are used - fixed objects may be placed 4' behind the obstructions. (See illustration 'B')

- 4 -
3) Where flexible guardrail (box-beam, w-beam, or cable) is used - 6 to 20 feet behind the face of the guardrail, depending upon the type. (See illustration 'C'.)

4) Where there are barrier curbs (5" or more vertical face) near a traveled lane 6 feet behind the face of the curb (see illustration 'D'); adjacent to a parking lane - no definite setback distance.

b. Where limited right-of-way or the necessity for planting would result in less clearance, all factors in the particular problem area should be weighed to decide if a special exception is warranted.

2. 50 MPH or less design speed:

a. Minimum setback of a fixed object from the edge of the traffic lane may be 30 feet unless one of the reasons set forth under (1) will allow for a lesser distance.

b. On curves, adequate sight distance for the design speed of the highway must be maintained.

C. REQUIREMENTS FOR SIGHT DISTANCE:

A clear line of sight must be maintained at all highway intersections and entrances. Generally, shrubs, plantings or other obstructions in
this zone must be limited to an ultimate height of 18" or less to allow a clear line of sight down the highway in either direction for at least 400' from the front of the vehicle located 10' behind the edge of the highway to be entered. (See illustration 'E'.)

D. CULTURAL REQUIREMENTS FOR PLANTS:

Use plants that require minimal maintenance and are hardy to the area. Avoid plants that are messy, brittle, short lived or subject to infestations of insects or disease. Plants used in areas where sight distance must be maintained shall have a mature height of 18" or less.

E. VISIBILITY OF HIGHWAY FEATURES:

The visibility of highway signs, delineators, edges of sidewalks, curbs, roadway or guardrail must be maintained at all times. Therefore, provide sufficient plant setbacks and plants with mature sizes that will not outgrow spaces to avoid costly trimming as plants mature.

IV. DETAILS

A. Plans shall include, as appropriate, planting details for trees, shrubs, ground cover, vines, and cacti showing size of planting pit in relation to size of plant ball. (See planting details.)
B. Plans should include staking or guying details as required by the size and species of plant proposed. (See planting/staking details.)

C. Plans should identify problem soils and propose appropriate measures to overcome them.

D. If a mineral surface treatment is proposed, details should be included to indicate the depth, gradation, color and the vertical relationship to the roadway curb or sidewalk. A pre-emergent herbicide should be specified to preclude weeds in these areas. (See Granite and Rock Mulch details.)

E. Details for headers, signs, walls, sidewalks, planters, etc., should be included whenever proposed.

V. MAINTENANCE

A. Problems in maintenance shall be anticipated during the design phase. Changes in environmental conditions should be anticipated.

B. It shall be the responsibility of the permittee to assure that all landscaping and irrigation can be maintained to the satisfaction of ADOT.
ILLUSTRATION 'C'
ILLUSTRATION 'D'

TREE or OTHER FIXED OBJECT

ROADWAY

6' Min.

5''+ HIGH CURB
ATTACHMENT D
PHOTOS FOR THE SPEED LIMIT REDUCTION “T” INTERSECTION ALTERNATIVE
Existing Roadway Layout at Primary Access Road (Milepost 46.9 – looking south)
Speed Limit Reduction Alternative (looking south) (note: speed limit signs are outside of the photo extents)