

Metro Gold Line Eastside Extension  
Four Quadrant Gate Feasibility Study

September 2009



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## 1. Introduction

In October 2008, the Board of Directors approved a motion related to the operation of the Metro Gold Line Eastside Extension to direct staff to:

- (a) Report back the necessary steps to seek approval to install four quadrant gates along all at-grade intersection crossings along the alignment, including a report on the necessary steps for obtaining California Public Utilities Commission's (CPUC) approval along with the estimated timeline for such approval and an estimated cost;
- (b) Work with the Los Angeles County Department of Public Works to design and install red light photo enforcement cameras along all four approaches on all at grade intersections;
- (c) Deploy Rail Safety Ambassadors for an additional three months, for a total coverage of 6 months, to educate the public about rail safety.

In support of the October 2008 motion, the Board of Directors approved the following motion at the December 2008 Board Meeting to direct staff to:

- (a) Perform the initial analysis to determine feasibility of installing four quadrant gates along the Metro Gold Line Eastside Extension.

This report addresses the December 2008 motion to determine feasibility for the installation of four quadrant gates along the Metro Gold Line Eastside Extension.

## 2. Project Background

The Metro Gold Line East Side Extension (MGLEE) is a six mile light rail transit project which extends the Pasadena Gold Line from Downtown Los Angeles at Union Station to the Little Tokyo/Arts District through Boyle Heights to the terminus near the intersection of Atlantic Avenue and Pomona Boulevard. Four miles of the MGLEE alignment runs on the surface and two miles runs underground. A portion of the surface alignment crosses over the 101 Freeway and I-710 Freeway and the Los Angeles River at the 1<sup>st</sup> Street Viaduct. There are six at-grade stations and two underground.

The surface portion of the alignment is street running and operates in the center median of 1st Street and 3rd Street. The light rail trains that will operate in the center median are separated from adjacent vehicular traffic by a six (6) inch high curb. Where at-grade intersection crossings occur, the movement of trains, vehicles and pedestrians are controlled by traffic signals, train signals, striping and signage. This type of light rail system on the surface is classified as "semi-exclusive - within street right-of-way" by the California Public Utilities Commission (CPUC). CPUC regulations limit speed on these systems to the legal speed of parallel traffic but not to exceed to 35 miles per hour. CPUC does not require that this type of light rail transit system have four quadrant gates or full closure crossing gates to control traffic, but instead relies on traffic signals.

There are a total of 24 signalized at-grade vehicle crossings in the surface portion of the MGLEE alignment. The CPUC determined that the MGLEE grade crossing

designs met all CPUC requirements and the applications for all of the at-grade intersections were approved.

In February 2002 during the preliminary design phase of the MGL EE Project, a peer review was conducted by the American Public Transportation Association (APTA) (Appendix A). Four professionals from Sacramento Regional Transit Authority, Calgary Transit, Greater Cleveland Regional Transit Authority and 21<sup>st</sup> Century Rail Corporation, reviewed the design from a safety and operational perspective. The panel concluded that the project was progressing successfully and that a safe and productive transportation system would be provided upon completion.

In June 2009, another safety peer review was conducted (Appendix B) to evaluate the MGL EE Project and proposed safety enhancements including four quadrant gates. The panel consisted of three professionals with experience from San Diego Trolley, Sacramento Regional Transit, Portland Tri-met and FTA. The preliminary findings from this panel are that the MGL EE Project is safe with design features that are typical for street running and tunnel alignments, and that extraordinary mitigation measures are not required, such as four quadrant gates.

### 3. Study Analysis

The initial step of the Four Quadrant Gate Feasibility Study was to examine an existing grade crossing gating system at an intersection in South Pasadena from the Metro Pasadena Gold Line. This gating system was used to develop layouts that could be applied to all the at-grade crossings along the MGL EE alignment.

During the evaluation it was determined that multiple impacts would result at each intersection, including the need to acquire right-of-way from adjacent properties, modifications and relocation of utilities, reduction in traffic lanes, loss of street parking, reduction in sidewalk widths, and impedance on pedestrian circulation. Other environmental and businesses/community impacts will also need to be further evaluated.

Although a detailed cost estimate was not prepared, there is a direct correlation with the severity of the impacts and the costs associated to implement the gates. The costs will also need to factor in the additional engineering and length of time necessary for community outreach, City of Los Angeles, County of Los Angeles, CPUC and Federal Transit Administration (if necessary) approvals.

#### 3.1 Four Quadrant Gate Example – Mission and Meridian Avenues, South Pasadena, CA

Although it is a different alignment classification from CPUC, the Pasadena Gold Line has a section of right of way that includes four quadrant gates to control traffic. This portion of the alignment is classified as “Semi-Exclusive – Fenced Right-of-Way” and it includes four quadrant gates at the intersection of Mission and Meridian Avenues, as shown in Appendix C. Four quadrant gates on MGL EE would include similar equipment, which is comprised of the gates themselves, a train controller cabinet, an emergency pedestrian swing gate and traffic loops to detect vehicles. The gates and train controller cabinet at Mission and Meridian measures 10 ft long by 6 ft high by 3 ft deep and are shown in Appendix D.

### 3.2 Verification of Layout

To minimize traffic impacts, the at-grade intersection crossings were evaluated with the assumption that the existing number of travel lanes, existing on-street parking and the existing widths of the sidewalks needed to be maintained.

With respect to the specific location to place the four quadrant gates at the at-grade crossings, thought was first given to placing the gates immediately adjacent to the center median and parallel to the track, blocking both the entrance approach and exit from the crossing. Four gates are used, one in each quadrant to deter vehicles from driving around a downed gate. This configuration utilized at many intersections on the Gold Line is the most traditional and effective at deterring motorists from illegally proceeding through the crossings. When this type of gate layout was applied to a representative intersection of the MGL EE alignment (Appendix E), it became apparent that the road would need to be realigned, resulting in a large amount of additional required right of way (Appendix F). In addition, there were difficulties in storing pedestrians who would be crossing the street when the gates came down. Therefore, other gate layouts were evaluated. Ultimately the layout chosen for the MGL EE intersections was the layout with the least impacts.

The most feasible arrangement for placing the four quad gates includes placing gates at all four corners of the intersection, similar to the arrangement at Mission and Meridian Avenues on the Pasadena Gold Line (Appendix G).

To insure that the exit gates fail in the up position, vehicle detection loops will also need to be installed at every intersection. An example layout of vehicle detection loops is located in Appendix H. The installation of these loops may require the relocation of existing traffic loops.

### 3.3 Adjacent Property Impacts

All 24 at-grade intersection crossings that were evaluated for the implementation of four quadrant gates had an impact on adjacent property. Since gates are proposed at all four corners of the intersection, and traffic lanes and sidewalk widths are to be maintained, impacts resulted at each corner. It was determined that an additional width of seven (7) feet is required to place and operate a gate. In addition train controller cabinets are required to operate the gates, which results in further impacts to adjacent property. The severity of impact varied from minor landscaping impacts, to off-street parking impacts, to the need for full building acquisitions. Appendix I provides a plan view of the gate layout and its impact to adjacent properties.

There were also impacts to some of the adjacent housing facilities along the alignment, these include the following locations and relocation costs are to be considered

- 1<sup>st</sup> and Hewitt – Artist Loft housing
- 1<sup>st</sup> and Vignes Street – Artist Loft housing
- 3<sup>rd</sup> & Arizona – Casa Telacu (Senior Housing)
- 5172-007-902 – LA City Housing

### 3.4 Utility Impacts

Overhead and underground utilities will have some conflict with the installment of four quadrant gates. Overhead utilities will need to be relocated, to prevent the gate arm from interfering with them. The underground utilities will also need to be relocated, based on the depth and size of the utility, for the placement of the foundations of the pole support the gates. Additionally, existing traffic signal and other lighting posts will have to be relocated for the installation of the gates.

### 3.5 Traffic Impacts

While the traffic lanes were maintained, the introduction of gates will cause significant impacts to the efficiency of the intersections. CPUC requires that the gates be down 20 seconds prior to the train entering the intersection, as well as an advanced signal preemption at all crossing locations to allow sufficient time for vehicles and pedestrians to completely clear the track areas prior to gate activation and train arrival. This requires much longer signal cycles, and the automobile queues may not clear the intersection before the next train approaches, especially during peak travel times when the trains have 5 to 7 minute headways. As a result of the close proximity of the intersections, these traffic queues have the potential to accumulate a large number of cars which will spill back into downstream intersections. Four quadrant gates at each intersection will also have an impact to the response time for emergency vehicles. Overall, the travel time for automobiles along the corridor will significantly increase.

### 3.6 Pedestrian Impacts

The longer signal cycle lengths will also have an impact on pedestrians, since the signal timing needs to provide pedestrians enough time to complete movement across crosswalk, as well as complete movement across track area prior to activation of gates. This would be a complicated issue at crossings such as Alameda & Temple, and Alameda & 1<sup>st</sup> Street, where pedestrians must travel through the crosswalk prior to reaching a pedestrian gate between them and the tracks. In order to provide the needed storage space, additional right of way will be required. CPUC may recommend the removal of crosswalks at crossings where one currently exists immediately adjacent to tracks in order to avoid pedestrians obstructing vehicles trying to clear the tracks during traffic signal preemption. This issue may be mitigated by installing pedestrian gates for that crosswalk. Either option will have a significant impact to pedestrian access at these locations.

### 3.7 Other Impacts

There are several areas with significant issues which will need to be addressed further, they are the following:

- Impacts to adjacent cemeteries
- Impact to Ramona High School and East Los Angeles High School
- Impact to the MGLEE Traction Power Substation
- Impact to the VA Hospital at Alameda and Temple
- Impacts to the Buddhist Temple

- Impacts to businesses which would require full and partial takes

Four properties appear to be eligible for listing in the National Register of Historic Properties. Crossing gates proposed at these sites will require consultation with the State Historic Preservation Officer (SHPO). These properties are:

- 3<sup>rd</sup> and Rowan - 3772 3<sup>rd</sup>, Our Lady of Lourdes church
- 3<sup>rd</sup> and Downey - 4201 Whittier, New Calvary Cemetery
- 3<sup>rd</sup> and Eastern – 260 S. Eastern Avenue, St. Sava Serbian Eastern Orthodox Church and Cemetery
- 1<sup>st</sup> and Lorena – Evergreen Cemetery

An impact to Our Lady of Lourdes is not adverse, although modifications to the landscaping and stairs will need to be performed according to the Secretary of the Interior's standards, and consultation with SHPO. There are adverse impacts to New Calvary Cemetery, Evergreen Cemetery, St. Sava Serbian Eastern Orthodox and the Serbian Cemetery are adverse since there is a very high potential for uncovering human remains, or unmarked graves within the Cemetery.

Additionally, it is possible that in the time between studies, new properties could become eligible for local historic recognition, or included in the National Register of Historic Places. Therefore, before proceeding with the next level of study, a reassessment of the affected properties will be needed.

There are also numerous impacts to community facilities. These facilities include,

- Alameda St and Temple St - VA Outpatient building
- 1<sup>st</sup> and Vignes – Buddhist temple, Medical Facility (behind Little Pedros)
- 1<sup>st</sup> and Utah – East Los Angeles High School
- 1<sup>st</sup> and Clarence – Aliso/Pico Pre-school/Day Care
- 1<sup>st</sup> and Pecan – Pecan Park Recreation Center
- 3<sup>rd</sup> and Indiana – Ramona High School
- 3<sup>rd</sup> and Mednik – David Wark Griffith Middle School, Edward Roybal Comprehensive Medical Center, Sala Evangelica Church
- 3<sup>rd</sup> and Civic Center – E. LA Library, Church
- 5019 E. 3<sup>rd</sup> Street – LA County Sheriff's site
- Pomona and Telford – Kaiser Medical building

Impact to the VA Outpatient clinic is adverse due to the configuration of the clinic. Impacts to Ramona High School are adverse because there is a potential to lose or replace classroom space, in addition to a disruption to students. Discussions with these facilities will need to occur to determine how best to proceed.

Impacts to Buddhist Temple, medical facility at 1<sup>st</sup> and Vignes, Aliso/Pico Pre-school are adverse, but potentially mitigatable, depending on the outcome of discussions with the property owners. It will depend on the ability to come up with a reasonable solution for impacts.

Impacts to visual resources would not be adverse, with the major impacts being installation of utility cabinets at each intersection. It is advisable to add a decorative element (landscaping, art, a house structure over them, etc.) to mitigate impacts.

Any parcel or portion of a parcel with demolition will require testing for asbestos containing materials and lead based paint. There may be other electrical equipment to consider at some of the businesses locations. It appears that a parcel at Eastern Ave. may have an underground storage tank.

If the four quadrant gates are desired, then an addendum to the Supplemental Environmental Impact Report will need to be prepared and adopted by the Board. Concurrently, an Environmental Assessment (EA) will need to be performed under the National Environmental Policy Act (NEPA). Both documents may require a limited traffic study, limited noise analysis and adoption by the Board. The EA would require a public meeting.

### 3.8 Costs

There are a range of costs associated with the design and installation of four quadrant gates. These costs include, but are not limited to,

- Right-of-Way Acquisition
- Utility Relocation
- Equipment Costs
- Signal and Control Circuitry Costs
- Construction Costs
- Engineering Costs
- Maintenance Costs

The total costs to implement four quadrant gates at the 24 at-grade intersection crossings are significant.

### 3.9 Necessary Steps for Implementation

The Implementation Phase would take approximately 4 years to complete. The schedule for this step is shown in Appendix J. The components for the completion of implementation are:

- Determine Funding Source
- Board Authorization to Fund the Four Quadrant Gate Plan
- Environmental Analysis
- CPUC Hazard Analysis Study
- Preliminary Engineering
- Environmental Approval
- Final Design
- Caltrans, Los Angeles City and Los Angeles County Approvals
- CPUC Crossing Application Approval
- Procurement Process
- Grade Crossing Equipment Installation and Testing
- CPUC Approval to Operate

With respect to obtaining CPUC approval it is noted that the implementation of four quadrant gates at the intersection crossings is a departure from their standards for "Semi-Exclusive – Street Median" Alignments,



#### 4. Other Safety Enhancements

The Board direction to have staff determine the necessary steps and study the feasibility for four quadrant gates, resulted in an increased focus on safety for the MGLLE Project. Although not a part of this study, other additional safety enhancements that are either being implemented or evaluated are listed below.

##### 4.1 Red Light Photo Enforcement

The design and installation of Photo Enforcement for 14 intersections, to enforce left-turn violations only, along MGLLE was initiated by Metro Corporate Safety more than a year before the October 2008 motion. The Photo Enforcement equipment will be installed in coordination with the Los Angeles County Street Improvement Contractor and will be completed by the end of 2009 at the following intersections:

|                       |                               |
|-----------------------|-------------------------------|
| 1st Street & Mission  | 3rd Street & Eastern          |
| 1st Street & Anderson | 3rd Street & Ford             |
| 1st Street & Utah     | 3rd Street & McDonnell        |
| 1st Street & Clarence | 3rd Street & Arizona          |
| 1st Street & Lorena   | 3rd Street & Mednik           |
| 3rd Street & Gage     | 3rd Street & Civic Center Way |
| 3rd Street & Downey   | 3rd Street & La Verne         |

Based on historical violation and accident data on other rail lines, Metro staff has determined that enforcing dedicated Left Turn Lanes would provide the maximum benefit and warning since most violations and accidents occur due to illegal Left Turns. The same type of enforcement will also be implemented on the Exposition Line.

The addition of red light photo enforcement cameras on all approaches at all at-grade intersections will require individual analysis by the local agency to determine if an intersection meets the local agency's established warrants for installing red light photo cameras, per California Vehicle Code 21455.5, since these cameras will enforce red light violations. Metro enforces violations under California Vehicle Code 22451(a), which addresses grade crossing violations.

Existing Metro lines provide evidence that there are not a significant number of through movement violations to warrant all approach photo enforcement. In lieu of photo enforcement, additional enhancements are available, such as active warning LED "TRAIN" signs, pavement markings and other warning signs to provide motorist with ample warning time.

##### 4.2 Rail Safety Ambassadors

To assist in educating the public about operations along the alignment, 12 Rail Safety Ambassadors have been deployed at 8 MGLLE locations since March 2009 and will continue their efforts for 90 days after revenue service begins on the line. During the months prior to revenue service, these ambassadors are documenting

their observations of how pedestrians and vehicles behave around the alignment during the testing phase.

As a result of this information, additional safety features are being added or evaluated to make the system safer. These features include:

- Removal and relocation of stripping at certain intersections.
- The addition of signage at numerous locations stating “Look Both Ways,” “No Trespassing” and other warning signs
- Taking steps to close the pedestrian crossing at 3rd Street and Marianna Avenue
- Extending existing curb or adding delineators at a couple of intersections to deter vehicles from making U-Turns
- Additional “Train Coming” LED signs

#### 4.3 2009 Peer Review Panel Recommendations

As a result of the recently completed safety peer review by an industry expert panel, the project team is evaluating and implementing many of the recommendations made by the panel to enhance the safety of the line. Some of these enhancements are listed below:

- Evaluating the amount of signs along the alignment to reduce confusion for motorists.
- Place bollards or other devices to protect the catenary poles and guy wires from being accidentally struck and damaged by an errant motor vehicle.
- Consider using raised button and/or reflective pavement markers, in lieu of reflective paddles, to outline the trainway
- Enhance the stop bar to make it more evident where motor vehicles are to stop.
- Continue the Ambassador program for several weeks beyond the start of revenue service.

## 5. Conclusions

The Board direction to conduct the Four Quadrant Gates Feasibility Study and implement safety measures including photo enforcement and rail safety ambassadors reaffirms Metro's commitment to safety and reinforces the importance of conducting safety awareness for the Metro Gold Line Eastside Extension Project. Rail Safety Ambassadors observations have been documented and evaluated to determine if additional safety enhancements should be implemented.

This Four Quadrant Gates Feasibility study has analyzed all at-grade crossings along the alignment and has determined that the installation of gates will create multiple significant impacts including: right of way acquisition from adjacent properties, relocation of utilities, vehicular and pedestrian traffic impacts, disruption to businesses and institutional facilities and other environmental and community impacts. Furthermore, engineering designs and approvals by the regulatory agencies need to occur before installment can commence. The costs which are estimated to also be significant will require Board approval and it is estimated that all of the necessary steps will take a minimum of four years to implement.

Prior to the Board direction, the February 2002 APTA Peer Review and the CPUC determined that the Metro Gold Line Eastside Extension Project is safe. In addition, a recent Safety Peer Review conducted in June 2009 concluded that the Metro Gold Line Eastside Extension alignment is safe and does not require extraordinary mitigation measures, such as implementing four quadrant gates. Any such measures are above the standard of practice for this type of light rail system. However, the Board direction has resulted in additional safety awareness and education within the community and safety measures that are currently being implemented or evaluated to enhance the safety along the Metro Gold Line Eastside Extension.

## Appendix A -2002 APTA Peer Review Conclusion

**REPORT  
OF THE  
AMERICAN PUBLIC TRANSPORTATION ASSOCIATION  
FOR  
LOS ANGELES COUNTY METROPOLITAN  
TRANSPORTATION AUTHORITY  
LOS ANGELES, CA**

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**A Service of the  
APTA Safety Management Program**

**May 2002**



**William W. Millar, President**

**REPORT OF THE  
AMERICAN PUBLIC TRANSPORTATION ASSOCIATION  
PEER REVIEW PANEL  
ON THE  
EASTSIDE CORRIDOR LRT ALIGNMENT  
OF THE  
LOS ANGELES COUNTY  
METROPOLITAN TRANSPORTATION  
AUTHORITY**

**MAY 2002**

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## I. INTRODUCTION

The purpose of this panel convening is to review the current design of the East Los Angeles Light Rail Line from a system safety and operational safety perspective. The review was conducted February 11-14, 2002. The review panel consisted of:

William P. Grizard, Chair  
Manager of System Safety  
Sacramento Regional Transit Authority  
Sacramento, CA

William Thompson  
Manager of Operations  
Calgary Transit  
Calgary, Alberta, Canada

Pamela McCombe  
Director of Safety  
Greater Cleveland Regional Transit Authority  
Cleveland, OH

Al Fazio  
Vice President, Operations  
21<sup>st</sup> Century Rail Corporation  
Hudson-Bergen Light Rail Transit Project  
Jersey City, NJ

Based on reviews of drawings, site visits, and interviews the panel concluded that the project is progressing successfully and that a safe and productive transportation system will be provided. The panel observed a number of excellent practices by Los Angeles County Metropolitan Transportation Authority (LACMTA) staff, not notably in the public awareness, and the integration of design within the community. Also noteworthy was the remarkable improvement achieved in customer and pedestrian safety on the Long Beach "Blue Line." Although this observation is not a part of this review, the panel noted that the methods employed to accomplish this have already been implemented on the East Line. The staff of LACMTA is commended for this action.



Exemplary efforts were also noted in areas including:

- Integration with the Community
- Good mix of urban design and cultural sensitivity
- Blue Line safety efforts
- Lessons learned, transferred from Blue Line
- Urban rail environment
- Clean and well lit

### **Methodology**

Special considerations for this review included:

- A major portion of this line will be deployed through a design/build process.
- The line will be connected to the Pasadena Gold Line (PGL) at Union Station; through operation of some or all trains is anticipated.
- The Rail Operations Center will be re-fitted to accept control of PGL and the East Line under a separate project.
- The operating philosophy of the at-grade portions of the East Line will significantly differ from the Long Beach Line; i.e., while at grade, the line will operate as a medial strip at speeds of 35 m.p.h. or less. It will be more representative of a streetcar or urbantran, rather than a high speed, light rail transit line.

In order to evaluate the impact of these special considerations, particularly on operational safety, the peer review panel's investigation was appropriately broadened. Following is a summary of the methodology employed for this review.

1. Preliminary introductions to staff and summary brief by LACMTA on the project.
2. Interviews with LACMTA technical and operational staff and review of selected drawings.
3. In depth discussions with Design Consultant.
4. Ride on Long Beach Line, visit to ROC, and discussions and interviews with Los Angeles County Sheriff.
5. Tour project site.
6. Additional interviews with staff and Consultants, as requested by the panel.
7. De-briefing of LACMTA staff and subsequent discussion.

The entire team, including staff, design consultants and security, were extremely cooperative and open in their presentation and made all requested information readily available.

## II. GENERAL COMMENTS ON TECHNICAL SECTION / RAIL SYSTEMS

This section will include the following major topics, each of which could impact the safety/security of the final operation.

1. Union Station interlocking configuration
2. Alignment of the bridge at Union Station
3. Rail Operations Control Center
4. The Tunnel
5. LRV integration/safe braking model/vehicle compatibility and integration

Each of the topics is discussed further.

### Union Station Interlocking

The East Line will be connected to the Pasadena "Gold Line." Under this arrangement, the ideal operation would be through-operation of all trains from Pasadena to East Los Angeles. This would be the safest and most efficient operation. However, demand forecasts indicate that the two lines will be "imbalanced," with heavier ridership on the Pasadena section. The LACMTA scheduling group indicated to the panel that they plan to turn every other train from Pasadena at Union Station. Although two diamond interlockings are provided (one on either side of the Station platform), this turnback operation would work better with some configuration adjustments, namely the sacrificing of the East diamond for a pocket track. This track would preferably be double-ended; but if that is not possible, single-ended facing Pasadena. In addition, the proximity of this high ridership area to the yard lead tracks could create congestion during peak hours with "yard moves." A number of recommendations should be considered for implementation between Union Station and the Little Tokyo segment of the line. These are:

- Installation of the pocket track so that the "end of line" schedule "pad" for short turn Pasadena trains will not have to be consumed while these trains are standing on the main line. This will also permit the storage of a gap/rescue train in the pocket during off-peak hours or the staging of trains when unusually large flows of customers are anticipated at Union Station. This "gap" train could fill a slot on either the Pasadena segment or the East Line.

- The access to the yard must be capable of feeding the line in both the East and the Pasadena directions; however, with the proper arrangement of crossovers on the main line and between the two lead tracks, the junction may not need to be configured as one-half of a “grand union.” A further review might be warranted for the bi-directional operation yard trains down the ramp to the yard. Both ramp tracks need to be bi-directional for purposes of operating flexibility; however, caution must be exercised for conflicts with pedestrians and vehicular traffic. This protection should include static and dynamic signage.
- The headway design for the segment between Chinatown and the end of signaled territory in Little Tokyo should be specified at two-minute theoretical and three-minute practical. This headway capability will be extremely important to avoid major line delays in the process of operating Pasadena trains, and dealing with yard movements. Importantly, if the line is delayed in the street, territory trains may “queue up” at very close intervals. A short headway capability through this signal leg segment will greatly aid in restoring the line to its proper schedule. The ability to move trains at short headways through Union Station will aid in crowd management, particularly during the evening rush hour.

#### Alignment of Bridge Over the 101 Freeway Alignment

- As presently configured, the line crosses the 101 Freeway at an approximate 90° angle then curves sharply to parallel the Freeway as it heads to East Los Angeles. The peer review panel expressed concern with the radius of curvature and recognizes that although this curve is within the operating capability of Light Rail, it is an undesirable configuration from both safety and operating perspectives. A potential mitigation of this curvature could be achieved by having the bridge alignment modified to cross the 101 Freeway on a skew. The panel recommends this be considered, although it may be more costly due to increased length of the structure. The following recommendations are offered on this alignment.
  - A curve radius of 135 feet in “signaled” territory on a viaduct should have the following engineering subsystem designed in as a means of “hazard mitigation - full guarding of the track through the curve to reduce wheel set angles of attack and subsequent possibility of derailment due to wheel climb of the high rail. This guarding is at times referred to as a check rail or “restraining rail.”
  - A 10 M.P.H. cab speed, which will conform to the posted speed due to the civil alignment (curvature).
  - A lubrication device to apply a friction modifier to the high rail. This is for noise mitigation as well as for reduction in wheel and rail wear.
  - Special testing of the vehicles to ensure proper curving.

- Control of access to the bridge, as this structure will provide a shortcut for trespassers crossing the freeway.
- Careful review of site lines and appropriate signage or signal placing to minimize poor signal preview.

### Rail Operations Control (ROC)

The ROC is located at the crossing of the Blue and Green lines and serves as the facility for control of all Metro rail operations. Each existing line (Red, Green, Blue) has a separate but co-located control console and associated controllers. An adjacent area contains video monitors with full time attendants. The panel toured the ROC and found the operation to be efficient and well managed, and also noted the close coordination at ROC with the Los Angeles County Sheriff's office. We understand that a revision to the ROC is planned that will add the Pasadena Line and East Line, and the scope of the East Line project is to provide so called "dry contacts" to the ROC contractor. The panel feels that supervisory control of the PGL/East Line in a manner similar to the Green and Red lines will be quite suitable.

The panel recommends that a method be implemented whereby (approximate) train locations in street railway (i.e., non-circuited track) be reported to Supervisory Control. A number of technologies exist that will provide approximate (i.e., not for train separation) location. This can be useful for routine train management, as well as for safety and security.

### The Tunnel

The design appears to conform to current industry and LACMTA practice, with respect to underground transit systems. This includes the design of stations, track, clearances, and tunnel systems. At the time of the review, certain design aspects appear not to be finalized. These items need to be "locked in" before a construction contract is solicited. An important aspect of the design is the fire/life safety ventilation and its integration with the station and train control design. Although time did not allow the panel to probe this subject in depth, it appears that the ventilation "zones" are adequately designed for a fire/smoke emergency. These zones might be modified; however, to improve the minimal theoretical headway for trains operating through the tunnel, under normal operations. Both stations are in the same ventilation zone and therefore a train must make a station stop, travel to the next station, complete its second station stop, and leave that zone before the following train can be given a signal to enter the zone. A calculation of this minimum headway, and potential modifications to the vent zones, should be considered. Following are some specific suggestions with regard to the tunnel.

- Move the East Side crossovers as close as possible to the portal of the tunnel and "interlock" these crossovers. They should be designed as a full interlocking (not a pair of TWC operated crossovers), even if the territory between the interlock and the portal is not signaled. This interlocking (as is LACMTA practice) should be capable of local as well as supervisory (from OCC) control. This will add to safety as well as make their use convenient and efficient.

- Provide gates (i.e., railroad style protection) between the west portal interlocking and the tunnel portal. This will expedite the normal and reverse movement of trains and will mitigate hazards to traffic associated with trains operating in and out of the portal. Importantly, it will expedite the operation of “rescue” trains in the event of a fire/life safety emergency.
- Evaluate the throughput (headway capability) of the tunnel as the headway is constrained by the ventilation zones. We recommend that a minimal headway of three minutes be achievable. We were not able to verify this headway during our time on site. This minimal, operable, and practical headway should be computed by the Design Consultant as a “systems integration” item.
- Develop a written narrative describing preferred and alternate methods for train and/or passenger rescue, at a number of selected locations within the tunnel. For example, these locations could be in a station or in the tunnel between stations, or at either end with other trains already in the tunnel. (Multiple scenarios need to be evaluated.) The narrative needs the approval of the System Safety Director and the Chief Operating Officer, and essentially becomes an Operating Requirements Document (along with headways under normal operations) for this design. The design should then be reviewed for its ability to support these proposed rescue operations.

#### Vehicle Compatibility / Integration

The peer review panel recognizes that Los Angeles currently has a number of different types LRVs available for service on this line, and also is considering the purchase of a relatively large number of additional LRVs. The panel would recommend that a special task force be established to clearly delineate integration criteria, which are required between vehicle and fixed plant systems. The most important of these interface criteria pertain to signaling design and alignment (grades and curvature). The particular areas that will be of interest for the East Line deployment are:

- Clearly define a safe braking model for use by the signal contractor in designing the block layout. This, of course, will be a major element in the safety certification of the line. Such a definition is particularly important on lines where different vehicles will be operated.
- Evaluate the performance of the LRV on long grades. This includes acceleration, maintenance, and service and emergency braking.
- The end of the car and mid-car offsets on horizontal curvatures should be verified. This will be a major issue for a LRV line operating in mixed traffic.



### **III. FINDINGS AND RECOMMENDATIONS ON ISSUE AREAS AS IDENTIFIED BY LACMTA FOR REVIEW BY THE PANEL**

#### **ISSUE #1 – PEDESTRIAN MANAGEMENT**

##### **Findings:**

- Excellent Public Outreach
  - Security is an integral part of safety effort
  - Funding has been allocated
  - Innovative techniques applied
  - Efforts go beyond other properties
- Blue Line Remediation Efforts
  - Fiber optics
  - Channelization
  - Community input
- Riverstone
- Pedestrian Channeling
- Community Involvement
- Education / Outreach
- Commitment to Mitigate Ped/Train Conflicts

##### **Recommendations:**

- Public Outreach
  - Place Safety information on web page
  - Target East Side communities and ethnic communities
  - Start campaign now and continue throughout construction
- Intrusion Detection
  - Viaduct
  - Tunnel
- Continue to include community during design / build phases
- Continue to channel pedestrians, such as:
  - Z curves, bedstead barriers, pedestrian gates

## ISSUE #2 – PEDESTRIAN MANAGEMENT AND TRAFFIC INTERFACE

### Findings:

- Extensive funding and work has been accomplished and continues regarding Community Linkages and Passive Safety Design for the Eastside Metro Rail Project.
- The improvements are beyond traffic, safety, and designed systems being constructed as part of the approved project.
- The improvements are expected to result in slowing automobile traffic in the vicinity of tracks, and the area within one-third mile around stations.
- The improvements include “channeling” and directing the paths and placement of pedestrians in the areas adjacent to the tracks.
- Improvements are being made to reduce the potential for auto and train conflicts, train and pedestrian conflicts, and auto and pedestrian conflicts.
- The review of the existing design has already included a review of passive safety improvements that will be included in the system construction.

### Passive systems include:

- Use of rougher materials in right turn lanes to increase the level and type of noise to alert pedestrians that are watching the trains that an automobile is approaching.
- Use of colored and textured surface materials near tracks and stations to advise motorists and pedestrians that there is something different about the area.
- Reduced radius curbs near tracks to reduce the speed of vehicles turning.
- Choking curb extensions in areas of potential auto-train conflicts.
- Asymmetrical improvements at intersections that emphasize the direction of travel so motorists and pedestrians are aware of the different circumstances surrounding train operations.
- Channeling of pedestrian movements to safer, less conflicted areas.
- Increasing or modifying pedestrian queuing areas to encourage appropriate pedestrian movement.
- Use of physical barriers in areas to reduce the invitation of crossing streets, intersections, and tracks with high probability of conflict.
- Orientation of station entrances and exits that force users to look in the direction of vehicular and train traffic.
- There is significant evidence of Community involvement in safety considerations and a strong commitment to continue this through the design, build and operations phases.
- There is significant evidence of educational and Community outreach programs in place.

## ISSUE #2 – PEDESTRIAN MANAGEMENT AND TRAFFIC INTERFACE (cont.)

### Recommendations:

- Consider the installation of intrusion alarms for unauthorized entry to tunnels and elevated surfaces. This would include procedures for Operator advance warning to unauthorized persons (e.g. strobe lights or radio notifications and associated operating protocols).
- Continue to seek active Community participation in all design, build and operations activities.
- Explore the possibility of train preemption or phasing techniques, such as left turn given the lead signal to clear left turning bays prior to giving the green signal for straight through movement, or holding all vehicle traffic signals to red until the train has gained the intersection for the 1<sup>st</sup> and 3<sup>rd</sup> Street crossings.
- Explore the possibility of gate protection for the Lorena Street crossing in consideration of the revised station location.

## ISSUE #3 – TRAFFIC MANAGEMENT

### Findings:

- T-Intersection
- Photo enforcement
- Rumble strips used
- Traffic calming
- Fiber optics
- Train tracking

### Recommendations:

- 1<sup>st</sup> and 3<sup>rd</sup> Street crossing
- Signal priority / preemption / phasing
- Explore gate protection for Lorena Street
- Left turns given the leading signals



## **ISSUE #4 – SECURITY**

### **Findings:**

- Excellent presentation and design criteria for the Project
- CPTED principles
- Excellent enforcement
  - Bike patrol
  - Motorcycle patrol
- Excellent visibility
- High commitment to safety and education

### **Recommendations:**

- Digital CCTV monitoring – pan, zoom and tilt
- Ensure that communication system is adequate, particularly in the tunnel segment
- Security department must be included in the design review

## **ISSUE #5 – FIRST STREET BRIDGE**

### **Findings:**

- Vertical curve
- Operator visibility
- Stopping distances
- Heavy vehicle traffic
- Design considerations

### **Recommendations:**

- Develop a two track exclusive lane
- Eliminate tail-end and sideswipe collisions
- Avoidance of emergency braking
- Establish a free fare zone

## ISSUE #6 – ALIGNMENT

### Findings:

- Operational Safety
  - Operator visibility
  - Train handling
- Vehicle Capabilities
  - Operation over grades
  - Braking and propulsion safety margins
  - Dynamic envelope of trains and on-track equipment

### Recommendations:

- Evaluate vehicle performance specifications for the various LRVs and maintenance equipment
- Evaluate track-train dynamics for braking downgrade, acceleration on ascending grades, and abnormal train handling over curves in tunnel and elevated structures.

## ISSUE #7 – TECHNICAL ELEMENTS

### Viaduct

#### Findings:

- Percentage of curvature
- Horizontal and vertical

#### Recommendations:

- Excellent method for being evaluated
  - Mitigate degree of horizontal curvature
- Guard and restraining rail
- Rail lubrication
- Full CTC from ROC
- Center walkways
- Fencing
- Adequate lighting

## ISSUE #7 – TECHNICAL ELEMENTS (cont.)

### Tunnel

#### **Findings:**

- Train block / ventilation issues
- Interlocking West and cross over East
- Cross passages
- Wayside signals

#### **Recommendations:**

- East crossover moved closer to tunnel and should be interlocked.
- West crossover protected by crossing gates.
- Wayside becomes the Home Signal.
- Verification of full CTC available from ROC.
- Break up ventilation blocks by adding intermediate home signals.
- Headway analysis needed.

### Train Control

#### **Findings:**

- Bumping block
- Reverse signals
- Central control

#### **Recommendations:**

- Headway analysis needed at tunnel and Union Station.
- Employ train control methods at the Terminal Station and Tail Track.

### Traction Power

#### **Findings:**

- Low resistance design
- Transfer trips
- Surge arresters

#### **Recommendations:**

- Continue with same design principles
- Catenary weights guarded in residential areas
- Down guides guarded
- Review OCS sectionalizing in tunnel

## Appendix B -2009 Safety Peer Review Conclusion

**Los Angeles County Metropolitan Transportation Authority**



**Panel Review of the Gold Line Eastside Extension**

**June 29, 2009 – July 2, 2009**

## I. INTRODUCTION

The Los Angeles County Metropolitan Transportation Authority (Metro) is the regional public transportation provider for the county of Los Angeles. Metro operates approximately 2,000 buses, two surface running light rail lines, one grade-separated light rail line, and two heavy rail subway lines. The present Gold Line, one of two of the surface running light rail lines, is approximately 13.6 miles in length running between Downtown Los Angeles and Pasadena, through Highland Park and South Pasadena. The Gold Line operates both in an exclusive and semi-exclusive right-of-way alignment with at-grade crossings. The Gold Line Eastside Extension Project will extend Gold Line rail transit service 5.8 miles from the current terminus, Union Station, to Atlantic Avenue.

Metro requested a panel review of the new extension prior to the start of revenue to determine its operational readiness, with particular emphasis be placed on:

- Fire/Life Safety
- Grade Crossing Design
  - General Perspective
  - Temple Street/Alameda Avenue
  - 1<sup>st</sup> Street/Alameda Avenues
  - 1<sup>st</sup> Street/Indiana Avenues
  - 3<sup>rd</sup> Street/Indiana Avenues
  - Gless Avenue
- Alignment Characteristics – gated vs. non-gated crossings
- Operating Practices, Facilities, and Systems

## II. METRO GOLD LINE EXTENSION DESCRIPTION

The Gold Line Eastside Extension is a 5.8 miles double track extension of the Pasadena Gold Line. As in the current Gold Line, a 750-volt DC overhead catenary system will provide propulsion power to 90-foot light rail vehicles. The predominant operating environment is street running in a center median, with a 1.7 mile underground segment and a short elevated segment. Six of the new passenger stations are at-grade and two are located underground. The top operating speed in the street running segment is 35 mph, 10 mph on the 101 Freeway Bridge, and 55 mph in the tunnel segment. Operating speeds will be regulated through a cab signal system. Train separation will be maintained by a train control system in the tunnel segment. In-street operation will be controlled in accordance with traffic signals for motorists and “bar” signals for trains. Service frequency is planned for 7 to 8 minutes during the weekday peak hours and 12 to 20 minutes during the non-peak hours, depending on time of day and day of the week.

Starting at Union Station, the Gold Line extends southerly onto a new elevated structure, over the 101 Freeway Bridge and Commercial Street, to Temple Street and Alameda Avenue, where it touches ground. After crossing Temple and Alameda at-grade, the alignment continues south in a short exclusive right-of-way segment. At 1<sup>st</sup> Street, the

alignment turns easterly. The alignment then moves along 1<sup>st</sup> Street for approximately 0.8 miles in a center median, which is for the exclusive use of light rail vehicles. At 1<sup>st</sup> Street and Gless Avenue, the alignment descends into a 1.7-mile tunnel, emerging at 1<sup>st</sup> Street and Lorena Avenue, the east portal. Continuing along 1<sup>st</sup> Street to Indiana, the alignment then turns south onto Indiana and then west onto 3<sup>rd</sup> Street. The alignment at this point continues in a generally westerly direction until the terminus at Atlantic Avenue.

### **III. Review Panel**

The review panel consisted of three members with extensive rail transit operations, safety, and security experience. The panel included:

Cameron Beach  
Beach Consulting  
San Francisco, California

Harry Saporta  
Good Harbor Consulting, LLC  
Arlington, Virginia

Peter Tereschuck, Retired Transit Executive  
San Diego, California

### **IV. METHODOLOGY**

The panel review occurred from June 29, 2009 to July 2, 2009 at the headquarters of Metro. During this time period, the panel members met with Metro project staff, a representative of the Los Angeles City Fire Department, and others related to the Gold Line Eastside Extension Project, including representatives from Mayor Antonio Villaraigosa's office. Several site visits were also made along the alignment during daylight and evening hours to better understand the operating conditions during these times of the day. Additionally, a number of project documents were reviewed. A list of these documents is found in Appendix B.

It should be kept in mind that it was not possible to conduct a comprehensive, in-depth review of the safety and operational aspects of the Gold Line extension during the review time period. The review was high level; it provides a snapshot in time by the panel members over a three-day period.

### **V. OBSERVATIONS AND RECOMMENDATIONS**

#### **A. Alignment Characteristics**

The alignment of the present Pasadena Gold Line and that of the Eastside Extension are vastly different and should not be compared.

### **Pasadena Gold Line**

The Pasadena Gold Line alignment is mostly that of a former Santa Fe Railroad freight line. The 13.6 mile line operates in a semi-exclusive and exclusive right-of-way that is protected by barrier walls, grades, fencing, and/or dense vegetation. There is also a short tunnel segment, approximately 1262 feet in length. Because of warning devices installed at the grade crossings, operating speeds range between 45 mph to 55 mph in many segments of the rail line. Train speeds are controlled by cab signals. Train separation is provided through a train control system. There are 17 at-grade vehicular-pedestrian crossings that have four-quadrant gates, and most locations also have pedestrian gates. There are 13 rail stations; 6 that are at-grade, 3 that are elevated (Union Station, Chinatown Station, and Lincoln Heights/Cypress Park Station) one underground station (Memorial Park Station), and 3 stations that are in the median of the 210 freeway

Light rail operations where speeds are greater than 35 mph warrant the use of crossing gates in accordance with State regulations, the Manual of Uniform Traffic Devices (MUTCD) and industry practice. Also, the likelihood of serious injury or loss of life is 20 times more at crossings where speeds are greater than 35 mph. The practice in North America is to provide 2-quadrant crossing gates at these crossings. Where an additional level of protection is desired due to sightline obstructions or other factors, some transit agencies have installed 4-quadrant gates. It should be noted; however, that 4-quadrant gates do not totally resolve grade crossing violations by motorists or pedestrians, as evidenced by accident data for the Pasadena line and by data from the Federal Railroad Administration.

### **Eastside Extension**

The Gold Line Eastside Extension is approximately 5.8 miles in length with a mixed operating environment. The line is predominately street running, with a top operating speed of 35 mph. At no time is the operating speed greater than the posted speed limit for vehicular traffic. The grade crossings are wide offering for the most part excellent sightlines. As mentioned earlier, this type of alignment, combined with the operating characteristics, does not justify or require the installation of crossing gates. Other segments of line include a 1.7-mile tunnel with a maximum operating speed of 55 mph, and a short aerial structure with an operating speed of 10 mph. The low operating speed on the aerial structure is due to the curvature of the bridge and steep grade.

The street running segment is characterized by operation within a light rail transit (LRT) strip in the middle of the street. A 6-inch mountable curb and stamped colored concrete delineates the median trainway. There are a total of 31 at-grade vehicle or pedestrian crossings protected by traffic signals or warning signals.

The street running segment is typical of many light rail operating systems in North America that operate without any crossing gates. Examples of similar street running segments are:

- Portland, Oregon – Burnside Street, Interstate Avenue
- San Diego, California – Mission Valley East (through La Mesa), Commercial Street
- Sacramento, California – 7<sup>th</sup> and 8<sup>th</sup> Street, 12<sup>th</sup> and O Streets, AMTRAK Extension
- San Jose, California – 1<sup>st</sup> Street, San Carlos



- Seattle, Washington - Rainer
- Phoenix, Arizona

The panel found no unusual characteristics or features that warrant extraordinary measures and determined the design of the project to be consistent with industry practices in North America. The panel, however, recommend several safety features to enhance the safety measures that have been implemented.

Signage



Signs have been placed within the 1<sup>st</sup> Street and 3<sup>rd</sup> Street trainways to warn pedestrians of trespass and motorists that vehicles are not permitted on the tracks. These signs are appropriate. However, the No Trespass sign size and lettering appear to be too small. The team was not able to easily read the sign until they were in the trainway itself, defeating the purpose of the sign. On the other hand the “No Vehicle on Tracks” sign and “No Vehicles” symbol sign, appear to be appropriately sized. See Figure 1

Figure 1 – No Trespass and No Vehicle Signs

There are several areas along 3<sup>rd</sup> Street where there are numerous “No Vehicle” signs in close proximity to one another. In other locations, such as Gless Avenue, the purpose of some of the signs is not clear and the number of signs confusing. Although the signs are meant to convey a clear message the frequency and clustering of the signs may add to driver distraction and confusion.

Recommendation 1 – No Trespass Signs

*Evaluate the size of, and the lettering on, the “No Trespass” signs for readability and effectiveness. The signs should be able to be read before entering the trainway.*

Recommendation 2 – Sign Clutter

*Evaluate the purpose and number of signs throughout the extension. The signs should be clear as to the desired action, easily read, non confusing by eliminating multiple signs that are clustered together. This will also enhance the esthetics of the line.*

Trainway Delineation

Trainways should be delineated to clearly indicate that it is not a roadway for motor



vehicle traffic and to define the dynamic envelope of the train. The latter is particularly important for those segments where trains mix with vehicular traffic, such as in roadway intersections. Typical means to delineate the trainway are by striping, curbs (including mountable curbs), raised buttons or other tactile treatment. Along 1<sup>st</sup> Street and 3<sup>rd</sup> Street, the trainway is delineated by a 6-inch mountable curb, colored stamped concrete, and in some

locations reflective paddles atop the curbs. The panel found the stamped concrete to be noticeable during daylight hours. During hours

of darkness, the color contrast of the stamped concrete area with the roadway was much less discernable. This is a concern as a motorist negotiating a turn may mistake the trainway for the roadway, and as a consequence, enter the trainway. Additional treatment is needed to more clearly indicate that the trainway is not a roadway and that motorists are not to enter it. See Figure 2.



At several locations, catenary poles and catenary guy wires are located at the intrusion entry point of the trainway. The poles and guy wires need to be protected from errant vehicles. An option is to protect the poles and guys with bollards striped with retro-reflective tape. See Figure 3.

Figure 3 – Unprotected Guy Wire



The reflective paddles along 3<sup>rd</sup> Street visibly outline the trainway. However, the paddles are likely to become a maintenance issue as they are easily damaged. Several damaged paddles were seen during site visits. There are several other treatments that can achieve the same effect. One option is to place yellow raised buttons on the curbs with reflective pavement markers place every third one or so. Another option is to simply place reflective pavement markers on the curb. If on the other hand paddles are to be retained, they should be placed at approximately 15-foot intervals.

Figure 4 – Reflective Paddle Delineators

**Recommendation 3 – Catenary Pole/Guy Wire Protection**

*Place bollards or other devices to protect the catenary poles and guy wires from being accidentally struck and damaged by an errant motor vehicle.*

**Recommendation 4 – Trainway Delineation**

*At those locations where motor vehicles may mistakenly enter the trainway, as in Figure 2, place large raised buttons or rumble strips to tactilely indicate that the trainway is not a roadway. Additionally place reflective pavement markers along entry point to further highlight the area.*

**Recommendation 5 – Trainway Delineators**

*Consider using raised button and/or reflective pavement markers, in lieu of reflective paddles, to outline the trainway.*

## **B. Pedestrian and Grade Crossings**

At-grade light rail crossings with median running trains can be challenging. The vast majority of collisions at these intersections are due to motorists and pedestrians disobeying traffic control devices, signs, and pavement markings. Also, collisions in street running light rail operations where train and motor vehicle speeds are less than 35 mph usually result in injuries that are less severe than those where speeds are greater than 35 mph, such as on the Pasadena Gold Line.

An important concept in developing strategies to control at-grade collisions is driver and pedestrian expectancies. The grade crossings along 1<sup>st</sup> Street and 3<sup>rd</sup> Street take this concept into account.

### **Motor Vehicle Intersections**

There are 31 four-way intersections on the Eastside Extension operating environment where automobiles or pedestrians can cross the tracks. In addition, there are 19 T-intersections where the roadways do not continue across the tracks. As light rail traffic does not interact with motor vehicle traffic at T-intersections, traffic control devices are not necessary; consequently, none are present. Signage and a pipe rail have been placed at the end of, and perpendicular to, these T-roadways to indicate that the roadway ends.

The four-way intersections are controlled by traffic signals for motorists and train signals for trains. The Metro has also used a number of strategies to control the likelihood of a mishap. Advance warning signs and railroad pavement markings are used to warn motorists that they are about to enter a train crossing. Active signs, such as “No Right Turn” and “No Turn On Red” are used to prohibit movement when trains are present. “Train Coming Signs” warn motorists of an approach of a train. Passive signs; pavement markings, such as “Keep Clear” and “Stop Here” markings; and traffic light directional arrows are used to contribute to the safe movement of trains and motor vehicles through an intersection. In addition, train operators are provided with bar signals to advise them when there are conflicting or no conflicting motor vehicle movements present. All of these techniques, when used in combination as it is being done in the Eastside Extension, enhance the safety of light rail-motor vehicle crossings. To further the safety of intersections, the Metro will be implementing its photo enforcement program at 14 intersections on the Eastside Extension. The Metro program has proven itself to be successful in reducing light rail vehicle-motor vehicle collisions on its other light rail lines.

A safety design feature that has been successfully used at other light rail systems is the use of lagging left-turn phase at intersections. This permits the trains to proceed before giving the motorists a left-turn green phase. Thus, the left turn phase “lags” the train “proceed” phase. Its use; however, is dependent on traffic conditions. The City and County of Los Angeles evaluated the use of lagging left-turn phases and implemented them where feasible.

### **Light Rail Pedestrian Crossings**

Pedestrian crossings are provided at intersections and at stations. Pedestrian crossings are not permitted mid-block. However, it is not uncommon for pedestrians to cross mid-block (jaywalk) at certain locations when it has been relatively easy and permitted to occur in the past. To discourage trespassing onto the light rail right-of-way and jaywalking, picket fences, pipe rail, bollard and cable, and bollard, chain fences, and other treatments have been successfully used to discourage pedestrians from crossing

mid-block and trespassing into a light rail right-of-way. The use of a fencing system should continue, but targeted at those locations where frequent trespass has been observed. The “No Trespass” and “No Pedestrian” symbol signs should also continue to be used. These locations should also be targeted for aggressive enforcement of the trespass/jaywalking laws.

*Recommendation 6 – Mid-Block Fences*

*Continue the use of fencing, but target those areas where frequent jaywalking is observed.*

*Recommendation 7 – Jaywalking Enforcement*

*Target locations with high trespass/jaywalking violations for enforcement of the laws.*

Pedestrian movements at intersections are controlled by traffic signals and pedestrian signals. These signals are used to control pedestrian movements across the roadways and light rail tracks. Additional treatment is usually not warranted, as these devices would be activated whenever there is a conflicting motor vehicle or light rail vehicle movement.

At light rail stations the concept of channelization is used to direct and control the movement of pedestrians. This concept is widely used by light rail operating systems. Channelization, as used in the Eastside Extension is very effective, as there is very little opportunity for a pedestrian trespass onto the trainway. This is particularly important at light rail stations, as train traffic is high. However, where the picket fences meet the pedestrian crossing, the height of the picket fence obstructs the visibility of pedestrians and of train operators. The picket fences in these areas should be lowered.

*Recommendation 8 – Station Picket Fences*

*Picket fences immediately adjacent to station pedestrian crossings should be lowered to approximately 4 feet in height.*

To further control pedestrian movements at stations, active pedestrian “Train Coming” signs are used at the end of station platforms and dual-active pedestrian warning signs or railroad style flashers are used at the crossings themselves. The type used is dependent on the most appropriate device for the location. In addition to the active signs, passive signs are used to notify and direct pedestrians. For added enforcement swing gates are used to encourage pedestrians to orient themselves in the direction of an approaching train and to discourage pedestrians from darting across the tracks. The combination of active and passive signs and swing gates as used on the Eastside Extension is considered a best practice.

At several locations; however, the direction of the swing did not properly orient the passenger toward the approach of a train. It is recommended that each gate be evaluated for proper orientation.

*Recommendation 9 – Swing Gates*

*Evaluate the direction of the station swing gates to ensure that they properly orient a passenger toward the direction of an approaching train.*

### **Temple Avenue and Alameda Avenue**

The Temple Street and Alameda Avenue crossing is located near a fire station and is one of the primary routes for Los Angeles City Fire Department responses to emergencies. Prior to entering the crossing, eastbound trains descend a 5% grade. Concerns were raised early on as to whether trains would be able to stop short of the intersection during a fire department response. Working in partnership, the Metro and fire department resolved this issue through a special traffic signal preemption system. Although the panel considers this issue to be satisfactorily resolved, it should be noted that the effectiveness of this feature will depend on the degree to which firefighters use it during initial dispatch from the station when responding to a call.

### **1<sup>st</sup> Street and Alameda Avenue**



Eastbound train moves from Little Tokyo Station through 1<sup>st</sup> Street and Alameda Avenue require operators to negotiate the move at 10 mph due to the sharp curve.



Trains moving through this crossing frequently encounter motor vehicles encroaching in the designated “Clear Zone”. The encroachment may be due to motorist confusion as to where to stop, as the “Wait Here” and “Keep Clear” zones appear to blend together. The encroachment creates two problems. First, it may impede train movements. Second, a train moving through the crossing may collide with the stopped vehicle, as it may not always be evident to the operator that there is insufficient clearance. The use of markers to define the dynamic envelope will assist the operator in knowing whether it is safe to proceed through the curve. Train clearance markers have an added benefit. They provide a visual queue to the operator where the end of the train is in relation to the curve and when it is safe to accelerate.

#### **Recommendation 10 – Enforcement**

*Work closely with the Los Angeles Police Department and Los Angeles County Sheriff’s Department to strongly enforce the “Stop Here” and “Keep Clear” requirements.*

#### **Recommendation 11 – Dynamic Envelope Delineation**

*Mark the dynamic envelope of the train through the curve. This may be accomplished with striping or other treatment.*

#### **Recommendation 12 – Stop Bar Enhancement**

*Enhance the stop bar to make it more evident where motor vehicles are to stop.*

#### **Recommendation 13 – “Keep Clear” Zone**

*Cross hatch the “Keep Clear” zone to make evident that motorists are not to enter the zone.*



### **1<sup>st</sup> Street and Indiana Avenue**

At this location, trains begin the transition from 1<sup>st</sup> Street to Indiana Avenue. The issues at 1<sup>st</sup> Street and Indiana Avenue are very similar to those of 1<sup>st</sup> Street and Alameda Avenue. However, there are multiple intersecting streets, limited sightlines, and special stopping requirements for motorists. This requires added operator attention in knowing whether it is safe to proceed. Consequently, this area will require added enforcement to ensure the intersection remains clear of vehicle encroachment. In addition to the recommendations for the 1<sup>st</sup> Street and Alameda crossing, consideration should be given to setting the stop bars farther back. The panel was encouraged to see active enforcement being conducted by members of the Los Angeles County Sheriff's Department Traffic Enforcement units.

#### **Recommendation 14 – Enforcement**

*Continue to work closely with the Los Angeles County Sheriff's Department to aggressively enforce the "Stop Here" and "Keep Clear" requirements.*

#### **Recommendation 15 – Dynamic Envelope Delineation**

*Delineate the dynamic envelope of the train through the curve. This may be accomplished with striping.*

#### **Recommendation 16 – Stop Bar Enhancement**

*Enhance the stop bar to make it more evident where motor vehicles are to stop.*

#### **Recommendation 17 – Stop Bar Set-back**

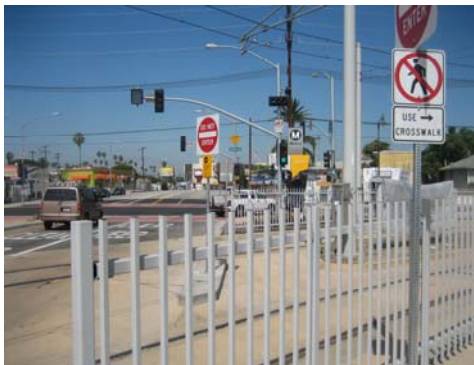
*Evaluate the current stop bar locations to determine whether they should be set back further.*

#### **Recommendation 18 – "Keep Clear" Zone**

*Cross hatch the "Keep Clear" zone to make evident that motorists are not to enter the zone.*

### **3<sup>rd</sup> Street and Indiana Avenue**

The motor vehicle safety issues at the 3<sup>rd</sup> Street and Indiana Avenue crossing are also similar to those of 1<sup>st</sup> Street and Alameda Avenue. There is; however, a pedestrian safety issue that requires attention.



The photographs above show a view on 3<sup>rd</sup> street looking west at Indiana Avenue. The light rail station is just to the right in each photograph. Pedestrians approaching Indiana Avenue from the west (northwest quadrant of the intersection) are directed across

Indiana (toward the northeast quadrant) and onto what appears to be a pedestrian island. The area is not a pedestrian island, but in fact the northeast corner of the intersection. After reaching the corner, pedestrians are to proceed to the pedestrian crossing located on the south end of the 3<sup>rd</sup> and Indiana Station, if they wish to continue east along 3<sup>rd</sup> Street. Pedestrians are not to continue across the tracks as it places them into the roadway with no safe refuge, such as a sidewalk.

To discourage pedestrians from proceeding straight, there are picket fences on both the east and west sides of the trackway. However, the fencing on the east does not fully extend to the curb line, not making it fully clear that pedestrians are not to proceed straight across. Pedestrians ignore the fencing. The panel witnessed this several times during the site visit. Additional means are needed to direct pedestrians to the station crossing and to discourage them from proceeding straight. This is not an issue from the east approach to Indiana Avenue, as a pipe rail fence (right photograph) effectively directs pedestrians to the station crossing. Consideration should be given to extending the fence on the island to further discourage pedestrians from continuing on their original path.

**Recommendation 19 – Enforcement**

*Work closely with the Los Angeles County Sheriff's Department to strongly enforce the "Stop Here" and "Keep Clear" requirements.*

**Recommendation 20 – Dynamic Envelope Delineation**

*Delineate the dynamic envelope of the train through the curve. This may be accomplished with striping.*

**Recommendation 21 – Stop Bar Enhancement**

*Enhance the stop bar to make it more evident where motor vehicles are to stop.*

**Recommendation 22 – "Keep Clear" Zone**

*Cross hatch the "Keep Clear" zone to make evident that motorists are not to enter the zone.*

**Recommendation 23 – Pedestrian Island**

*Consideration should be given to extending the picket fence on the island to discourage pedestrians from continuing straight across the light rail tracks. A sign stating that pedestrian are prohibited from crossing the tracks at this location should be placed on the fence, as well.*

**1<sup>st</sup> Street and Gless Avenue**



1<sup>st</sup> Street and Gless Avenue is the locality of the west end of the tunnel. Prior to the construction of the tunnel portal, vehicular traffic was permitted to cross 1<sup>st</sup> Street at this location. Now, high curbs with large reflective paddles on top have been put in place as a crossing barrier. A number of active and passive signs were also in place, informing motorists that they must not turn and proceed straight ahead. Although no damage to the barrier was found, the signage at this location

was cluttered and may be confusing. There were “No U Turn” and “No Left Turn” signs on Gless Street (only right turns are permitted). Signage at this location should be evaluated.

**Recommendation 24 – Reevaluate Signage**

*Reevaluate the signage on Gless Avenue, as many of the signs are no longer applicable.*



A significant safety issue was identified at the west portal (above photographs). The pickets on the perimeter of the portal walls are spaced far enough apart to permit objects from being pushed through and landing on the trainway, making contact with the catenary, or being dropped in front of an approaching train. Additionally, there is a large opening (see photograph on the right) that allows a person to climb on to the pipe spanning the tracks. Tight wire mesh or other tightly woven fabric should be placed on the pickets to prevent objects from being pushed through. Additionally, the large openings on each side of the pipe span should be closed.

**Recommendation 25 – Picket Fence**

*Place tight woven fabric or mesh on the inside of the picket fence to prevent objects from being pushed through.*

**Recommendation 26 – Picket Fence Opening**

*Close the large opening on each side of the pipe span to prevent individuals from climbing onto the pipe.*

**C. Fire/Life Safety – Tunnel**

Review of the preliminary hazard analysis, safety certification plan, Fire/Life Safety Committee minutes and other documents appear to indicate that the requirements of NFPA 130 are being met. In some cases, such as the emergency walkway and deluge system, they exceed the requirements of NFPA 130. However, there are two critical issues that must be corrected before revenue service may commence. During the testing of the emergency ventilation system, the sequencing of the fans and dampers it was found that they needed to be modified in order to meet the smoke and heat ventilation requirements of NFPA 130. A solution to the problem had been identified and the system control software is being revised. Another issue is the Emergency



Management Panels (EMP's). They have not been completed and tested. The EMP's and control software are required for revenue service.

A related issue is the SCADA system. The SCADA installation has not been completed and fully tested. Consequently, the emergency ventilation fans and dampers cannot be controlled remotely from the Rail Operations Center (ROC). Until such time that the SCADA system has been fully tested and operational, personnel should be posted at the EMP's to initiate an emergency ventilation system should a smoke or fire condition occur. Also, the gas detection system cannot be fully monitored and operated without the SCADA system. Revenue service must not commence until gas system indications can be monitored either from the EMP or the ROC.

**Recommendation 27 – Emergency Management Panel**

*Test and confirm the functionality of the Emergency Management Panels*

**Recommendation 28 – Emergency Ventilation Control Software**

*Closely monitor and validate changes to the emergency ventilation control software*

**Recommendation 29 – Public Relations Tunnel Tours**

*Carefully evaluate conducting public relation tours through the tunnel until such time that the emergency ventilation system software has been validated and installed, and the gas detection system has been made fully operational and connected to the SCADA system.*

During one of the tunnel tours it was noted that the “No Clearance” sign was simply stenciled with black paint on the concrete tunnel wall. The sign was difficult to see. The color scheme should be revised with a yellow background or yellow and black striped background to make the sign more pronounced.

**Recommendation 30 – Tunnel “No Clearance” Sign**

*Change the background of the “No Clearance” sign so that the sign is more visible in the tunnel.*

**D. Security**

**Deputy Deployment**

The LACMATA has contracted with the Los Angeles County Sheriff's Department to provide transit policing, security, and fare inspection services throughout the Metro service area. At the start of revenue service, two additional transit police deputies will be assigned to patrol the Eastside Extension. The planned deputy deployments do not appear to be sufficient.

**Recommendation 31– Deputy Deployment**

*Evaluate current plans for deputy deployments. Consideration should be given to expanding police coverage by adding 6 or 8 additional personnel on trains, complemented by mobile units.*

### **Tunnel Intrusion Detection System**

A tunnel intrusion detection system has been installed to detect unauthorized persons and vehicles in the tunnel. Upon detection, an alert is sent to the ROC. A CCTV camera, mounted on the portal wall (see lower right photograph below) permits ROC personnel to view the intrusion. Additionally, a visual alert is displayed at the portal (see lower left photograph below) to notify train operators that an intruder is in the tunnel.

At each underground station there is an intrusion detection system that will be coupled to the platform end gates. Intruders entering the tunnel through the gate are immediately detected; sending an alarm to the ROC and are viewed through a CCTV system. Intrusions by stepping off the platform and into the trainway; however, would go undetected, as the detection device is only on the gate. Moreover, the platform detection system and the portal detection system are not integrated. Consequently, an intrusion from the portal would not automatically and immediately alert train operators already in the bores (the ROC Controller would have to notify these operators of the intrusion via radio communications). Conversely, trains entering the tunnel would not know of an intrusion from one of the stations unless notified by the Controller. Similarly, a train that has passed any one of the visual alerts would not know of an intrusion. For example, an eastbound train leaving the Boyle Heights Station would not know of an intrusion from the east portal. For safety and security reasons, it is vitally important that all trains be immediately informed of an intrusion. All of the detection systems should be fully integrated; sending visual alerts to all signs. Furthermore, an audible and visual alert should be annunciated locally to inform the intruder that they have been detected and they are to leave immediately.



### **Recommendation 32 – Detection System Integration**

*Integrate the platform and portal intrusion systems so that detection at any location will send an alert to all locations.*

### **Recommendation 33 – Local Alarms**

*When an intruder is detected, a local visual and audible alarm should annunciate, informing the intruder that he has been detected and that he should leave the area immediately.*

### Recommendation 34 – Supplemental Alerts

*Consider the installation of supplemental alert stations at locations between present detection points. The supplemental alerts would inform operators who have passed the current station and portal warning signs that an intrusion has occurred. One possible solution would be to install an amber light or strobe that would “wash” the bore when activated.*

## **E. Rail Activation and Operations**

Preparations are well underway for revenue service. A Rail Activation Plan has been developed and implemented as the roadmap to revenue service. Although many of the required activities are well underway, there are several issues that jeopardize revenue service. Although some of these issues may not be safety issues in themselves, they contribute to operator distraction and inattention to safe operations.

### **System Reliability**

During the panel site visits, several system reliability issues were experienced. These issues must be resolved prior to the start of simulated revenue service. Although some of these issues may not be safety issues in themselves, they are operator distractions and contribute to operator inattention.

### Radio Coverage

There is a serious void in radio coverage in the form of a “dead zone” from Atlantic Ave Interlocking to Maravilla Station. The radio is the primary means for reporting emergencies, car borne problems, and service issues.

### Cab Signals

The loss of cab signals was experienced at several locations. It is not clear to the panel if the loss was rail car or wayside related. Operating staff reported cab signal loss was a reoccurring problem experienced on most trips.

### Traction Electrification

During the tour of the tunnel, traction power was lost. Operating staff reported that the loss of power occurred on an intermittent basis.

### Train Bar and “Train Coming” Warning System

During an evening site tour, it was noted that the train bar aspect cleared a train for the move through the intersection of 3<sup>rd</sup> and Arizona, and that the “Train Coming” icon was activated. However, no train was present. Driver expectancy is for a train to be approaching when the warning sign is activated. Improper warning system operation lead drivers to believe that the train warning system is not operating properly and encouraging drivers disobeying traffic signals.

### SCADA

At this time, the SCADA system is not a reliability concern. The SCADA system; however, has not been completed and fully tested. The SCADA system is a critical component to monitoring and controlling safety critical systems, such as traction power gas detector indications, ventilation fan control systems, etc.

## **Operations**

The operations department must have the opportunity to train operators, test run times, conduct normal and abnormal operations (single tracking, etc), and other functions well in advance of revenue service. This all must be done without interruptions caused by system reliability issues and construction schedules. A minimum of 4 weeks of simulated revenue service must be permitted.

### **Recommendation 35 – Simulated Revenue Service**

*Provide a minimum of 4 weeks of simulated revenue service.*

As the new Eastside Extension is much different than the Pasadena Gold Line, schedule reliability may be an issue. There are numerous low speed curves and on-street operations that would impact schedule. Aside from the aforementioned distractions the ability to make the proposed schedule time of 23 minutes appears to be in question. If a 23 minute schedule must be maintained, the use of “drop back” trains may be necessary.

### **Recommendation 36 – Schedule Reliability**

*If it is determined that insufficient turn around time occurs at the end of the line, Metro should insert “drop back” trains, as necessary, to ensure schedule reliability. This may be necessary at both ends of the Gold Line.*

## **Service Start-Up**

At the time of the panel review, there was not a single individual responsible for ensuring that all of the required start-up activities – system testing, activation, construction, and operations activities were on-track and coordinated. It is essential that an individual be named as quickly as possible

### **Recommendation 37 – Start-Up Manager**

*As soon as possible, name a Start-Up Manager who would have the authority and responsibility to coordinate all functions to enable the start of revenue service.*

## **F. Safety Education**

A key aspect to any light rail transit safety program is a transit safety education and awareness program. These programs effectively reduce the number of mishaps by educating the public of the dangers of disobeying traffic signals and signs or acting inappropriately around rail tracks. The safety education and awareness program consists of a number of components. A unique program that has been implemented on the Eastside extension is the Ambassador program. Ambassadors actively promote safety awareness by interacting with the community at site-specific locations. The Ambassadors encourage safe behaviors through the distribution of safety materials, discussion with the community, and when necessary persuade correction of an observed unsafe behavior. The program is also used to identify potential safety and security operational issues at these locations prior to opening the Eastside Extension for revenue service. Other programs include:

- Public service announcements
- Written materials that are age appropriate
- School outreach program

- Mobile theater.
- Safety videos

The panel strongly endorses actively continuing the program throughout revenue operations. Additionally, consideration should be given to continuing the ambassador program for several weeks after opening day to identify safety issues. After the start of revenue service pedestrian and driver behaviors may change and require attention. The Ambassadors would be able to report those behaviors.

***Recommendation 38 – Ambassador Program***

*Continue the Ambassador program for several weeks beyond the start of revenue service.*

The panel considered the Metro safety outreach program to be outstanding and a model for the rail transit industry.

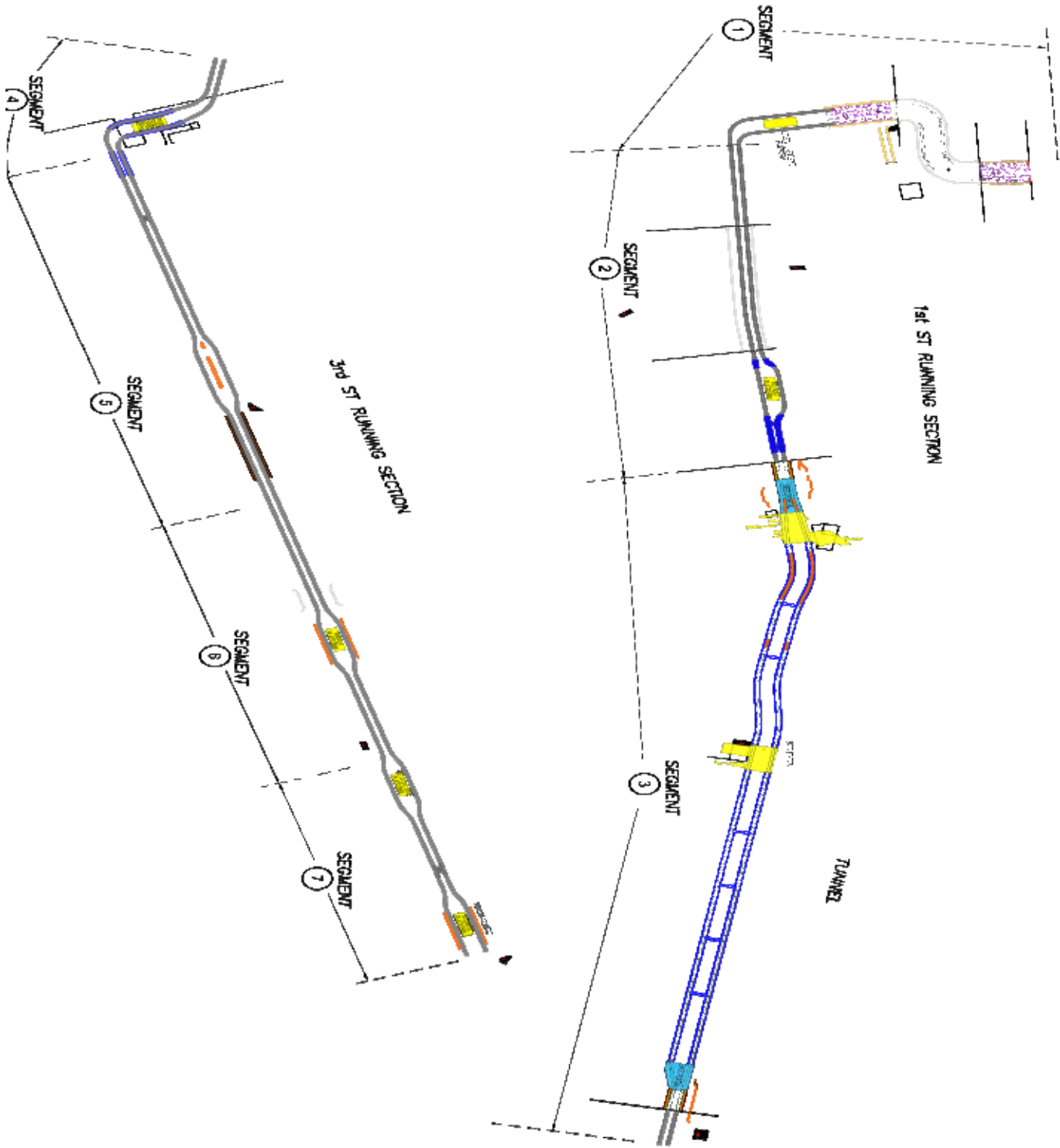
## **VI. CONCLUSION**

In conclusion, the operational characteristics of Eastside Extension are not unlike many other light rail operating environments in the United States. It has been designed to be a safe, efficient, and effective extension of the Pasadena Gold Line. The at-grade crossings have incorporated design features to promote the safe movement of trains and motor vehicles through these intersections. However, there are a number of safety enhancements that should be evaluated and considered prior to the start of revenue service. Additionally, system reliability issues must be resolved prior to the start of pre-revenue operations, and Operations must have sufficient time, a minimum of 4 weeks, to fully test the operations plan. Lastly, a start-up manager with strong and demonstrated interpersonal skills must be named immediately to assure that all critical safety, security, construction, and operational issues are resolved prior to carrying passengers in revenue service.

The entire Review Panel appreciates the opportunity to review the Eastside Gold Line Extension Project and offer observations and recommendations. The panelists received extraordinary cooperation, assistance and access to Metro personnel. Without such assistance and cooperation, this review would not have been possible.

# Appendix A

## Eastside Extension Alignment



## Appendix B

### Documents

- California Public Utilities Grade Crossing Approvals
- California Public Utilities Letter – Eastside Extension Pre-Revenue Operations, May 22, 2009
- Eastside Extension Presentations
  - Construction
  - Fire/Life Safety
  - Motorist Safety Features
  - Operations
  - Pedestrian Safety Features
  - Safety and Security Certification
  - Systems
  - Transit Safety Education Programs, Safety Outreach & Education
- Gold Line Eastside Extension Project Fire/Life Safety Committee Minutes and Action Items
  - Meeting #47 – January 2009
  - Meeting #48 – February 2009
  - Meeting #49 – March 2009
  - Meeting #50 – April 2009
  - Meeting #51 – May 2009
- Gold Line Eastside Extension Project System Integration, Test & Acceptance Plan – Final, February 5, 2008
- Gold Line Eastside Extension Project Preliminary Hazard Analysis
- Gold Line Eastside Extension Project Safety and Security Certification Plan – Rev 4, March 24, 2008
- Gold Line Eastside Extension Project Safety/Security Certification Checklist Sign Off Log – June 9, 2009
- Gold Line Eastside Extension Review Advisory Committee
  - Letter to California Public Utility Commission – Pedestrian Gate Request, May 7, 2009
  - California Public Utility Commission Response to Pedestrian Gate Request, June 11, 2009
- Metro Gold Line Eastside Extension – Fact Sheet
- Metro Gold Line Eastside Extension – Safety Training Plan
- Metro Rail Safety Tips Brochure

- Metro Rail East Los Angeles Light Rail Transit Metro Gold Line Rail Activation Plan – Revision 24, June 5, 2009
- Pasadena Gold Line Train-Auto and Train-Pedestrian Accident History – 2003 to 2009
- Rail Division Capacity Assessment Report
- Vehicle Comparison – Siemens P2000 vs. Breda P2550 Light Rail Vehicles
- Report of the American Public Transportation Association Peer Review Panel on the Eastside Corridor LRT Alignment of the Los Angeles County Metropolitan Transportation Authority – May 2002



## Appendix C

### Recommendation Summary

#### Alignment Characteristics

##### Recommendation 1 – No Trespass Signs

Evaluate the size of, and the lettering on, the “No Trespass” signs for readability and effectiveness. The signs should be able to be read before entering the trainway.

##### Recommendation 2 – Sign Clutter

Evaluate the purpose and number of signs throughout the extension. The signs should be clear as to the desired action, easily read, non confusing by eliminating multiple signs that are clustered together. This will also enhance the esthetics of the line.

##### Recommendation 3 – Catenary Pole/Guy Wire Protection

Place bollards or other devices to protect the catenary poles and guy wires from being accidently struck and damaged by an errant motor vehicle.

##### Recommendation 4 – Trainway Delineation

At those locations where motor vehicles may mistakenly enter the trainway, as in Figure 2, place large raised buttons or rumble strips to tactilely indicate that the trainway is not a roadway. Additionally place reflective pavement markers along entry point to further highlight the area.

##### Recommendation 5 – Trainway Delineators

Consider using raised button and/or reflective pavement markers, in lieu of reflective paddles, to outline the trainway.

#### Pedestrian and Grade Crossings

##### Recommendation 6 – Mid-Block Fences

Continue the use of fencing, but target those areas where frequent jaywalking is observed.

##### Recommendation 7 – Jaywalking Enforcement

Target locations with high trespass/jaywalking violations for enforcement of the laws.

##### Recommendation 8 – Station Picket Fences

Picket fences immediately adjacent to station pedestrian crossings should be lowered to approximately 4 feet in height.

##### Recommendation 9 – Swing Gates

Evaluate the direction of the station swing gates to ensure that they properly orient a passenger toward the direction of an approaching train.

## **1<sup>st</sup> Street and Alameda Avenue**

### Recommendation 10 – Enforcement

Work closely with the Los Angeles Police Department and Los Angeles County Sheriff's Department to strongly enforce the "Stop Here" and "Keep Clear" requirements.

### Recommendation 11 – Dynamic Envelope Delineation

Mark the dynamic envelope of the train through the curve. This may be accomplished with striping or other treatment.

### Recommendation 12 – Stop Bar Enhancement

Enhance the stop bar to make it more evident where motor vehicles are to stop.

### Recommendation 13 – "Keep Clear" Zone

Cross hatch the "Keep Clear" zone to make evident that motorists are not to enter the zone

## **1<sup>st</sup> Street and Indiana Avenue**

### Recommendation 14 – Enforcement

Continue to work closely with the Los Angeles County Sheriff's Department to aggressively enforce the "Stop Here" and "Keep Clear" requirements.

### Recommendation 15 – Dynamic Envelope Delineation

Delineate the dynamic envelope of the train through the curve. This may be accomplished with striping.

### Recommendation 16 – Stop Bar Enhancement

Enhance the stop bar to make it more evident where motor vehicles are to stop.

### Recommendation 17 – Stop Bar Set-back

Evaluate the current stop bar locations to determine whether they should be set back further.

### Recommendation 18 – "Keep Clear" Zone

Cross hatch the "Keep Clear" zone to make evident that motorists are not to enter the zone.

## **3<sup>rd</sup> Street and Indiana Avenue**

### Recommendation 19 – Enforcement

Work closely with the Los Angeles County Sheriff's Department to strongly enforce the "Stop Here" and "Keep Clear" requirements.

### Recommendation 20 – Dynamic Envelope Delineation

Delineate the dynamic envelope of the train through the curve. This may be accomplished with striping.

### Recommendation 21 – Stop Bar Enhancement

Enhance the stop bar to make it more evident where motor vehicles are to stop.

Recommendation 22 – “Keep Clear” Zone

*Cross hatch the “Keep Clear” zone to make evident that motorists are not to enter the zone.*

Recommendation 23 – Pedestrian Island

*Consideration should be given to extending the picket fence on the island to discourage pedestrians from continuing straight across the light rail tracks. A sign stating that pedestrian are prohibited from crossing the tracks at this location should be placed on the fence, as well.*

**1<sup>st</sup> Street and Gless Avenue**

Recommendation 24 – Reevaluate Signage

*Reevaluate the signage on Gless Avenue, as many of the signs are no longer applicable.*

Recommendation 25 – Picket Fence

*Place tight woven fabric or mesh on the inside of the picket fence to prevent objects from being pushed through.*

Recommendation 26 – Picket Fence Opening

*Close the large opening on each side of the pipe span to prevent individuals from climbing onto the pipe.*

**Fire/Life Safety - Tunnel**

Recommendation 27 – Emergency Management Panel

*Test and confirm the functionality of the Emergency Management Panels*

Recommendation 28 – Emergency Ventilation Control Software

*Closely monitor and validate changes to the emergency ventilation control software*

Recommendation 29 – Public Relations Tunnel Tours

*Carefully evaluate conducting public relation tours through the tunnel until such time that the emergency ventilation system software has been validated and installed, and the gas detection system has been made fully operational and connected to the SCADA system.*

Recommendation 30 – Tunnel “No Clearance” Sign

*Change the background of the “No Clearance” sign so that the sign is more visible in the tunnel.*

**Security**

Recommendation 31– Deputy Deployment

*Evaluate current plans for deputy deployments. Consideration should be given to expanding police coverage by adding 6 or 8 additional personnel on trains, complemented by mobile units.*

Recommendation 32 – Detection System Integration

*Integrate the platform and portal intrusion systems so that detection at any location will send an alert to all locations.*

Recommendation 33 – Local Alarms

*When an intruder is detected, a local visual and audible alarm should announce, informing the intruder that he has been detected and that he should leave the area immediately.*

Recommendation 34 – Supplemental Alerts

*Consider the installation of supplemental alert stations at locations between present detection points. The supplemental alerts would inform operators who have passed the current station and portal warning signs that an intrusion has occurred. One possible solution would be to install an amber light or strobe that would “wash” the bore when activated.*

**Rail Activation and Operations**

Recommendation 35 – Simulated Revenue Service

*Provide a minimum of 4 weeks of simulated revenue service.*

Recommendation 36 – Schedule Reliability

*If it is determined that insufficient turn around time occurs at the end of the line, Metro should insert “drop back” trains, as necessary, to ensure schedule reliability. This may be necessary at both ends of the Gold Line.*

Recommendation 37 – Start-Up Manager

*As soon as possible, name a Start-Up Manager who would have the authority and responsibility to coordinate all functions to enable the start of revenue service.*

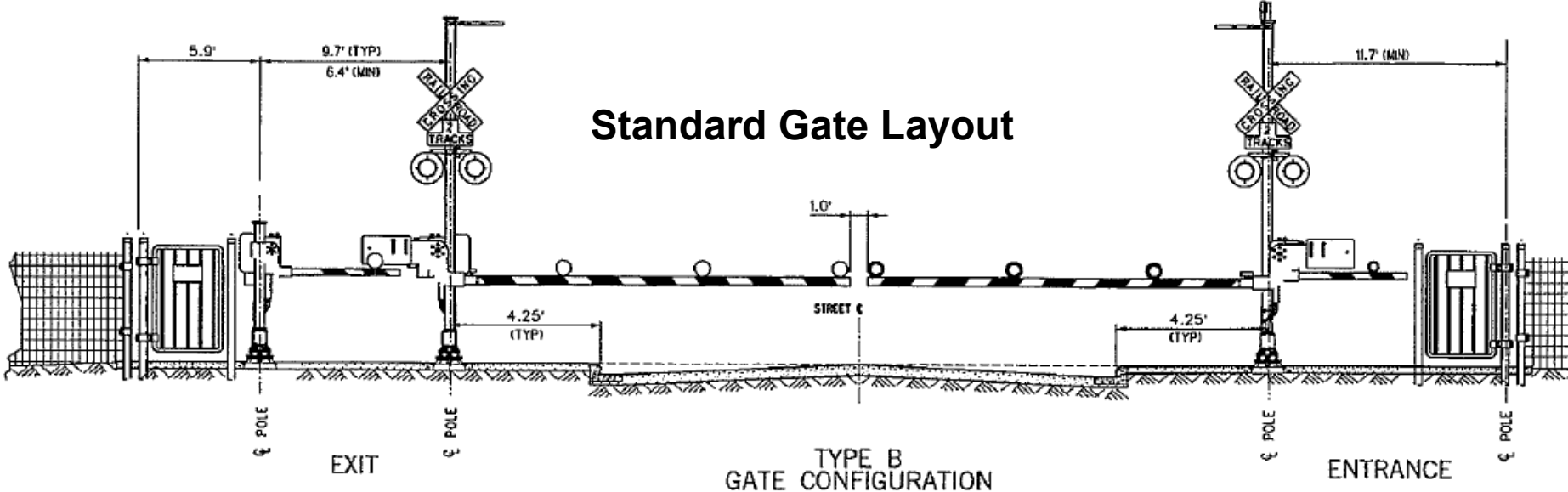
**Safety Education**

Recommendation 38 – Ambassador Program

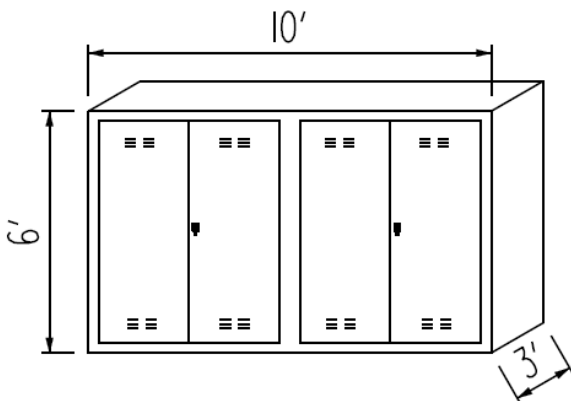
*Continue the Ambassador program for several weeks beyond the start of revenue service.*

## Appendix C – Equipment

# Standard Gate Layout

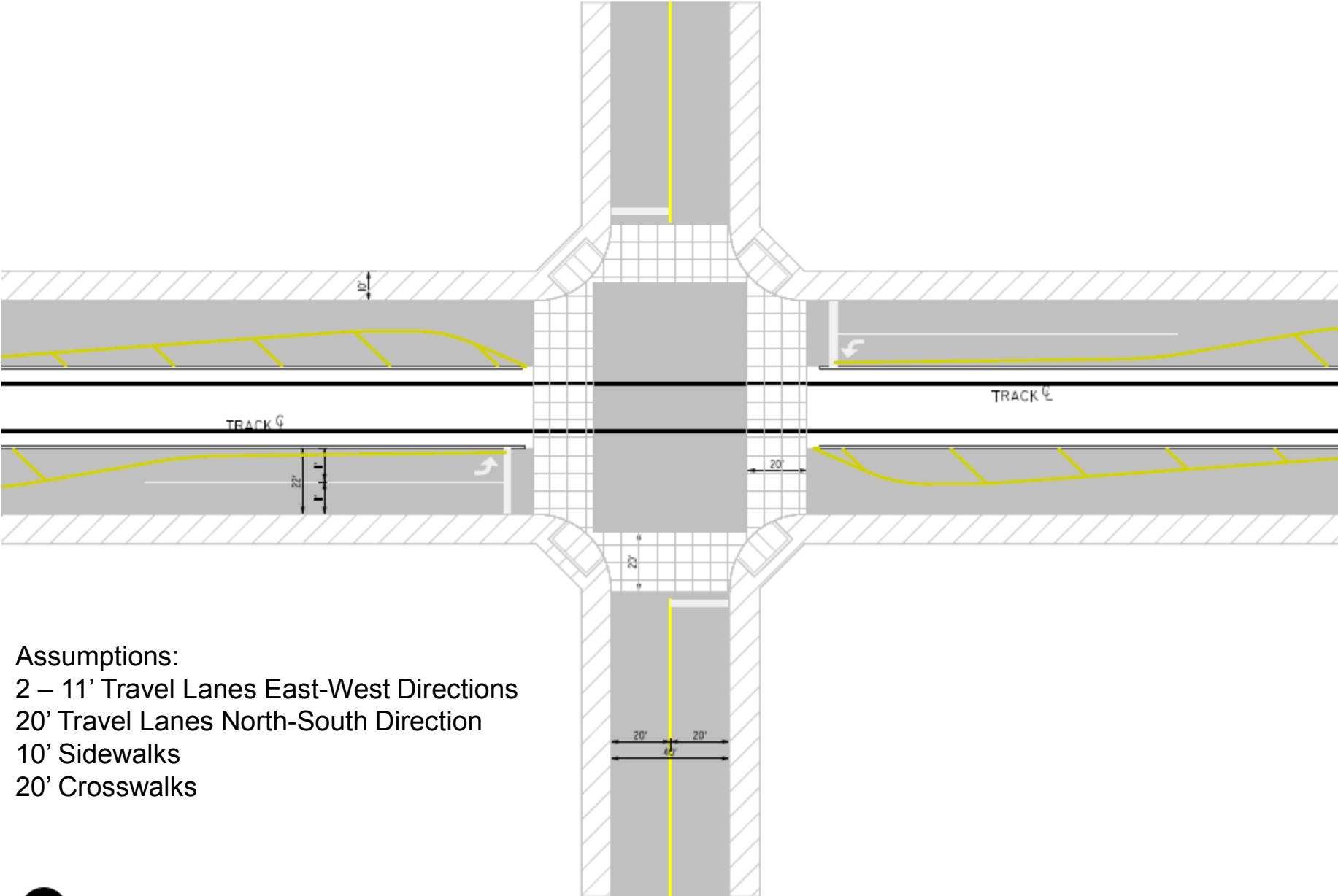


# Standard Cabinet – One per intersection



## Appendix D – Standard Intersection

# Standard Ideal Intersection

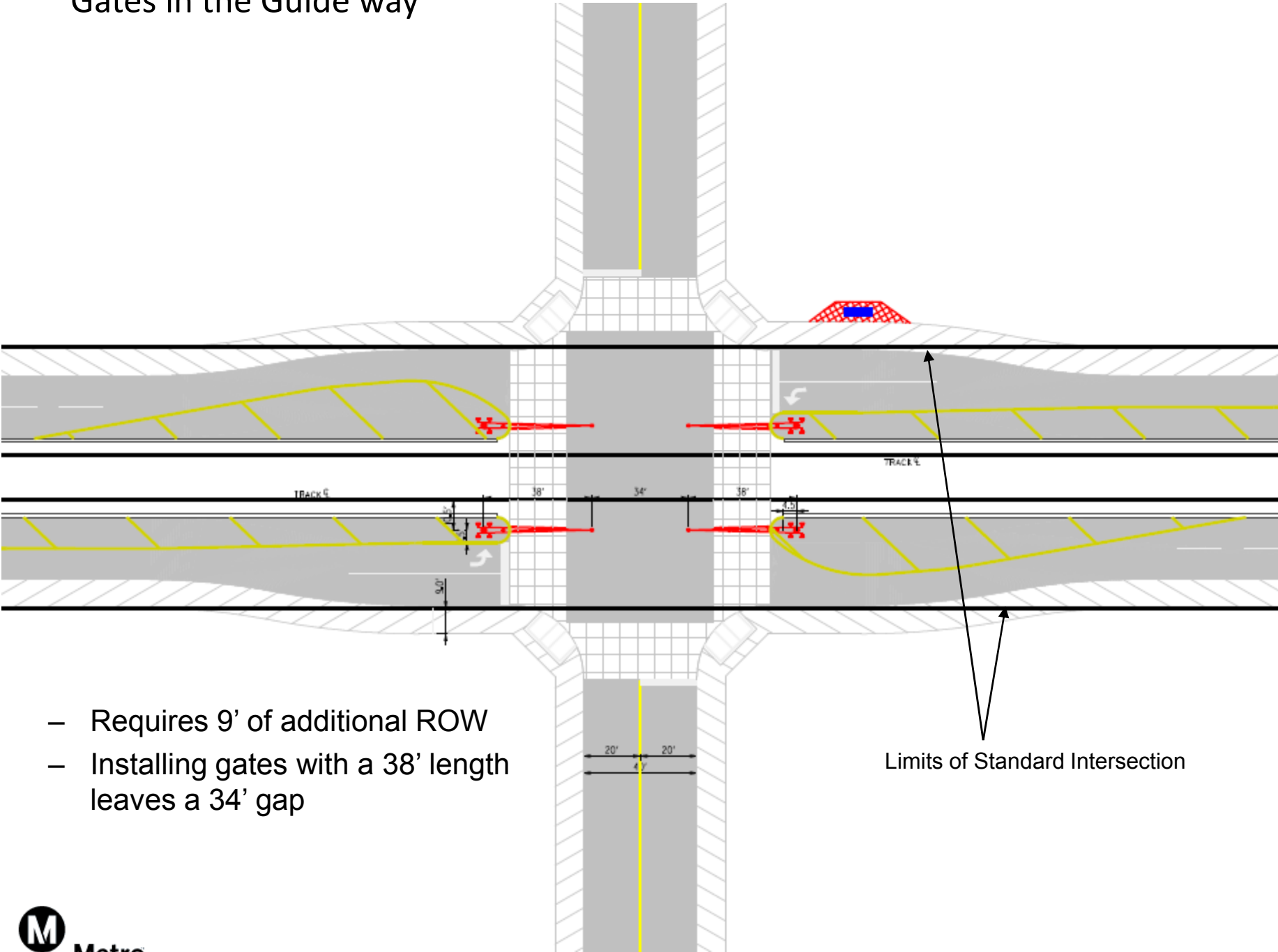


- Assumptions:
- 2 – 11' Travel Lanes East-West Directions
  - 20' Travel Lanes North-South Direction
  - 10' Sidewalks
  - 20' Crosswalks



## Appendix E – Option with gates in guide way

# Gates in the Guide way

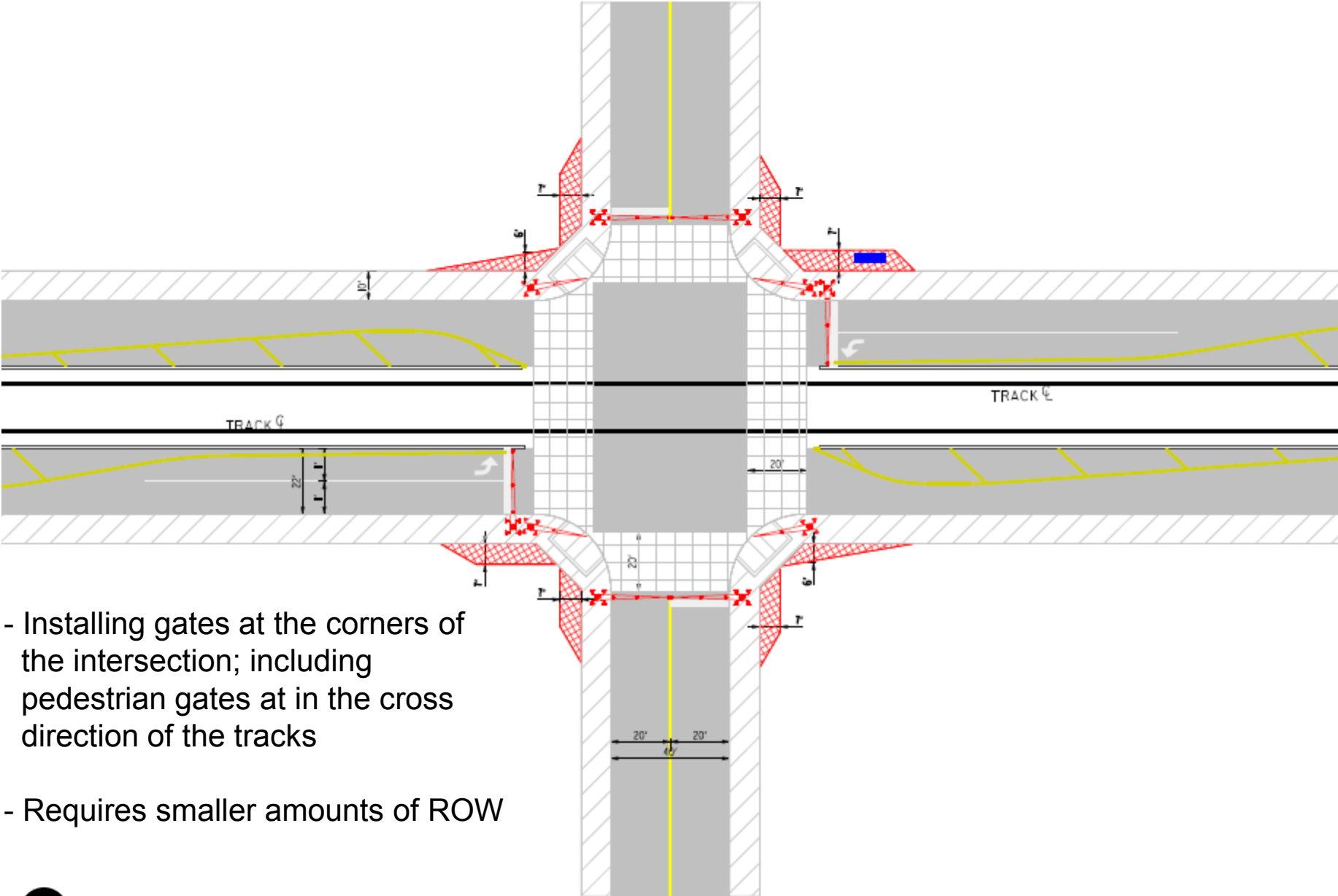


- Requires 9' of additional ROW
- Installing gates with a 38' length leaves a 34' gap

Limits of Standard Intersection

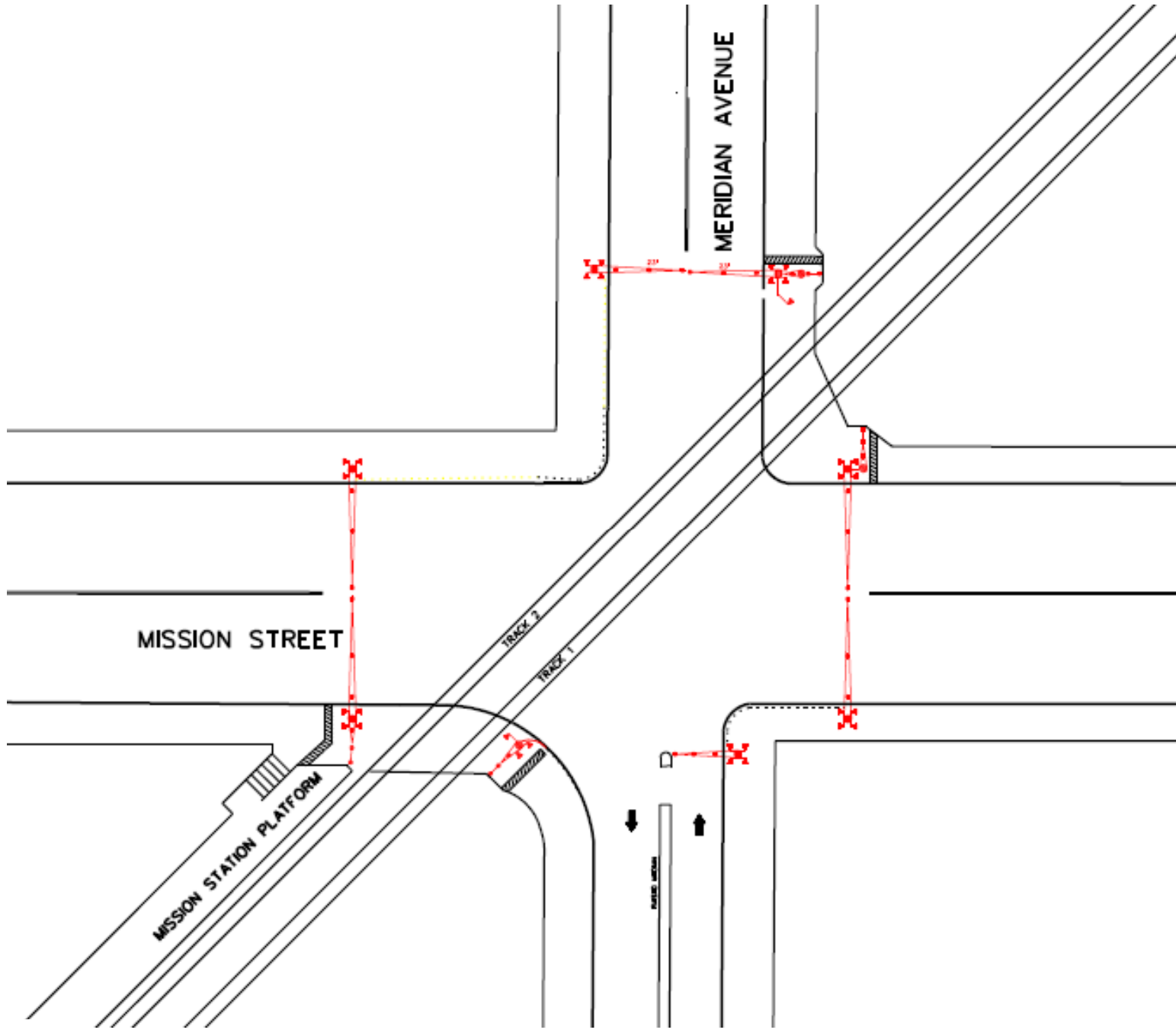
## Appendix F – Option for layout used

# Gates Closing the Intersection



- Installing gates at the corners of the intersection; including pedestrian gates at in the cross direction of the tracks
- Requires smaller amounts of ROW

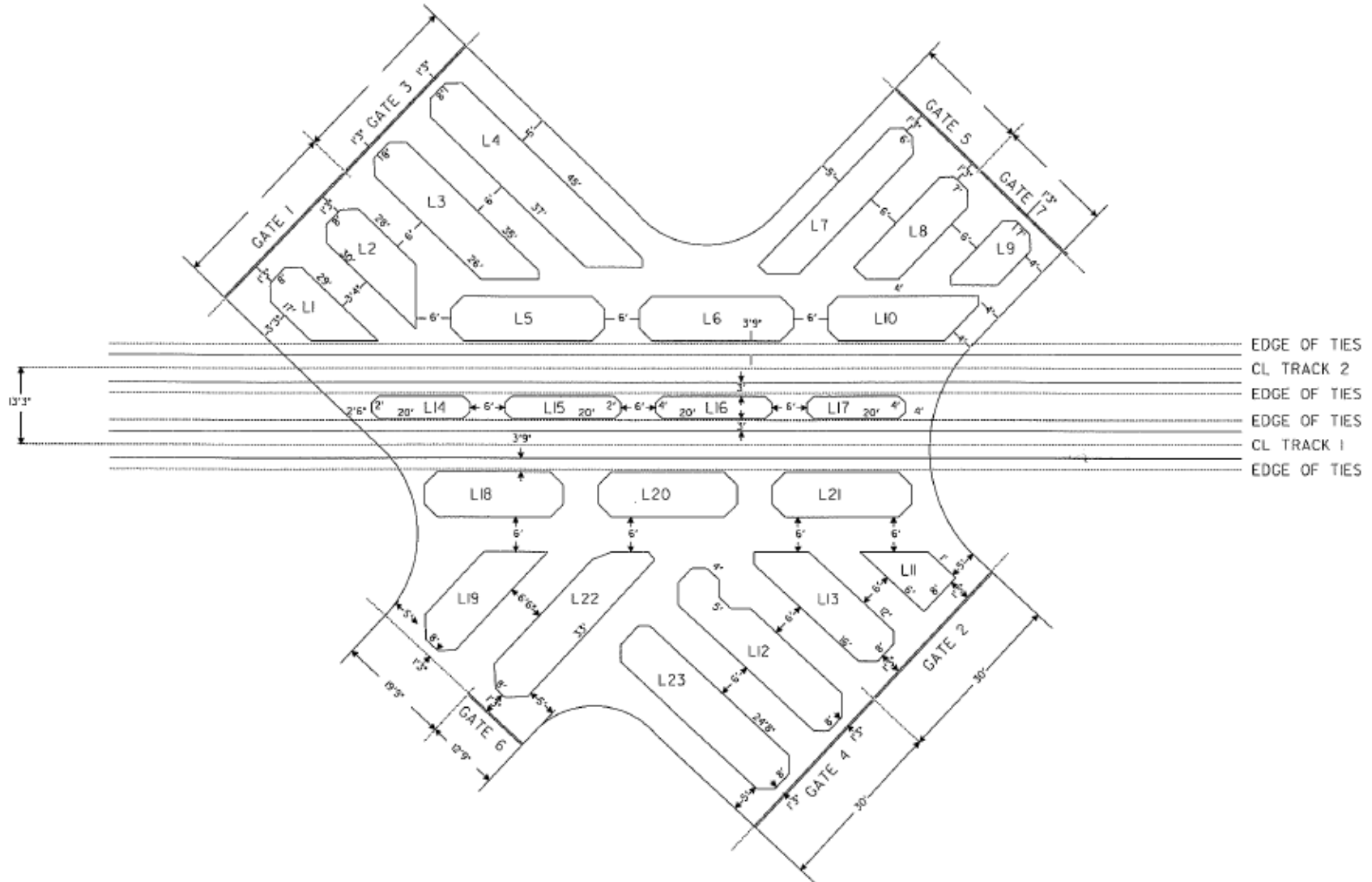
## Appendix G – Mission & Meridian



## Appendix H – Vehicle Detection Loop Layout



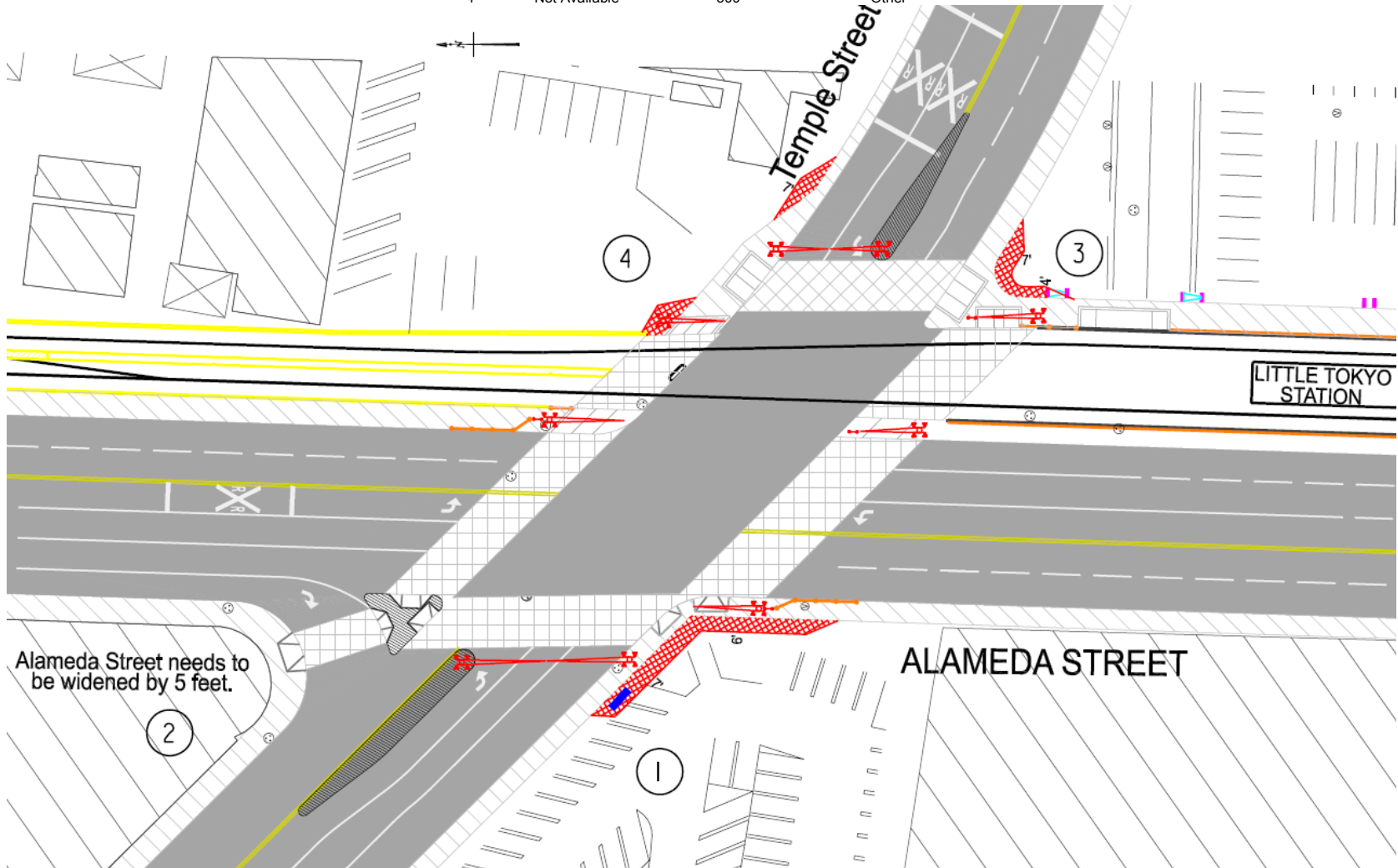
# Example Vehicle Detection Loop Layout



## Appendix I – Adjacent Property Impacts

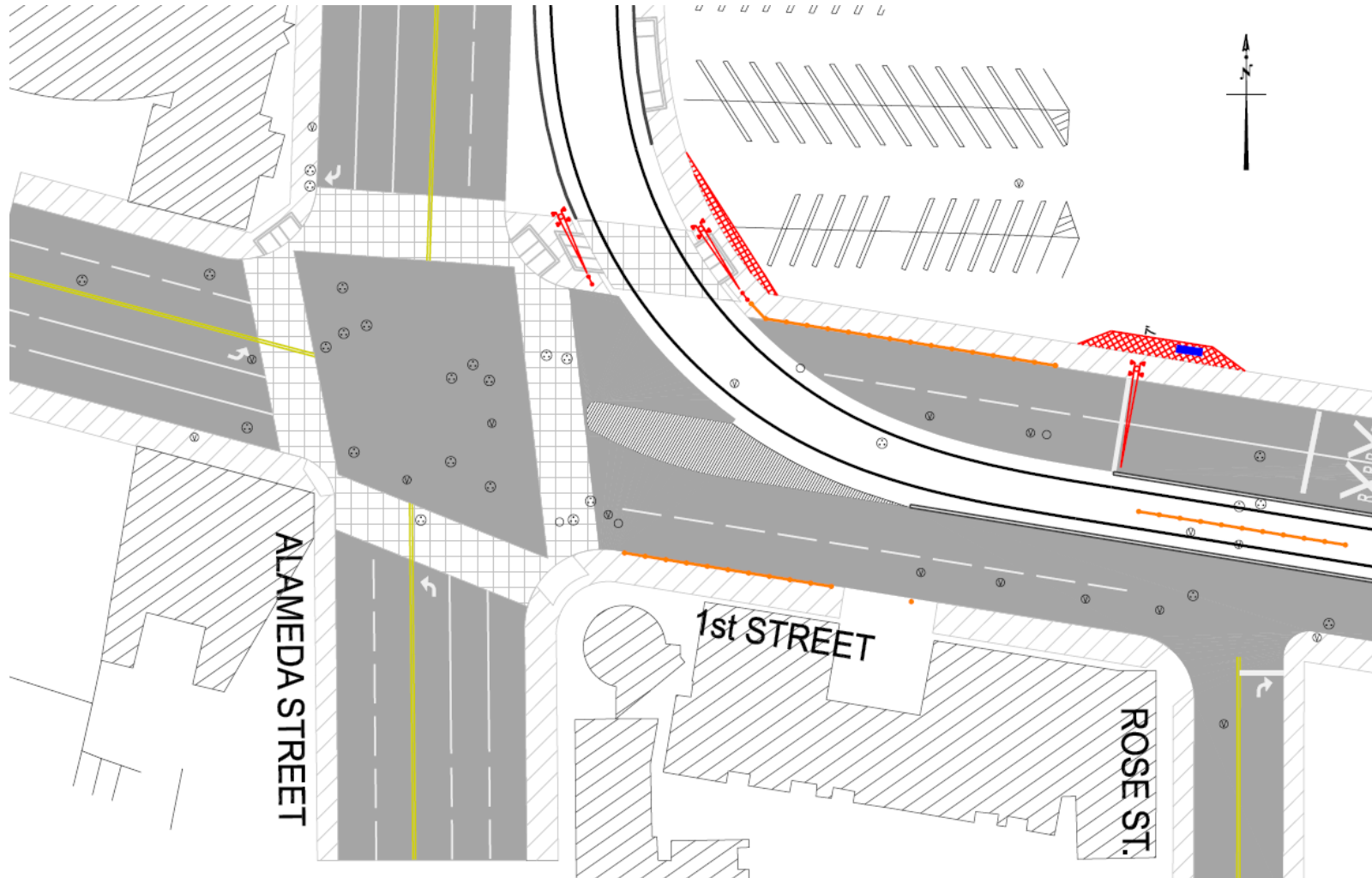
### Alameda & Temple

| Number | Address         | Square Footage                                 | Property Type |
|--------|-----------------|--|---------------|
| 1      | Not Available   | 500  | Other         |
| 2      | 351 E Temple St | 10' from Face of Building along Alameda Street | Other         |
| 3      | Not Available   | 250  | Other         |
| 4      | Not Available   | 300  | Other         |



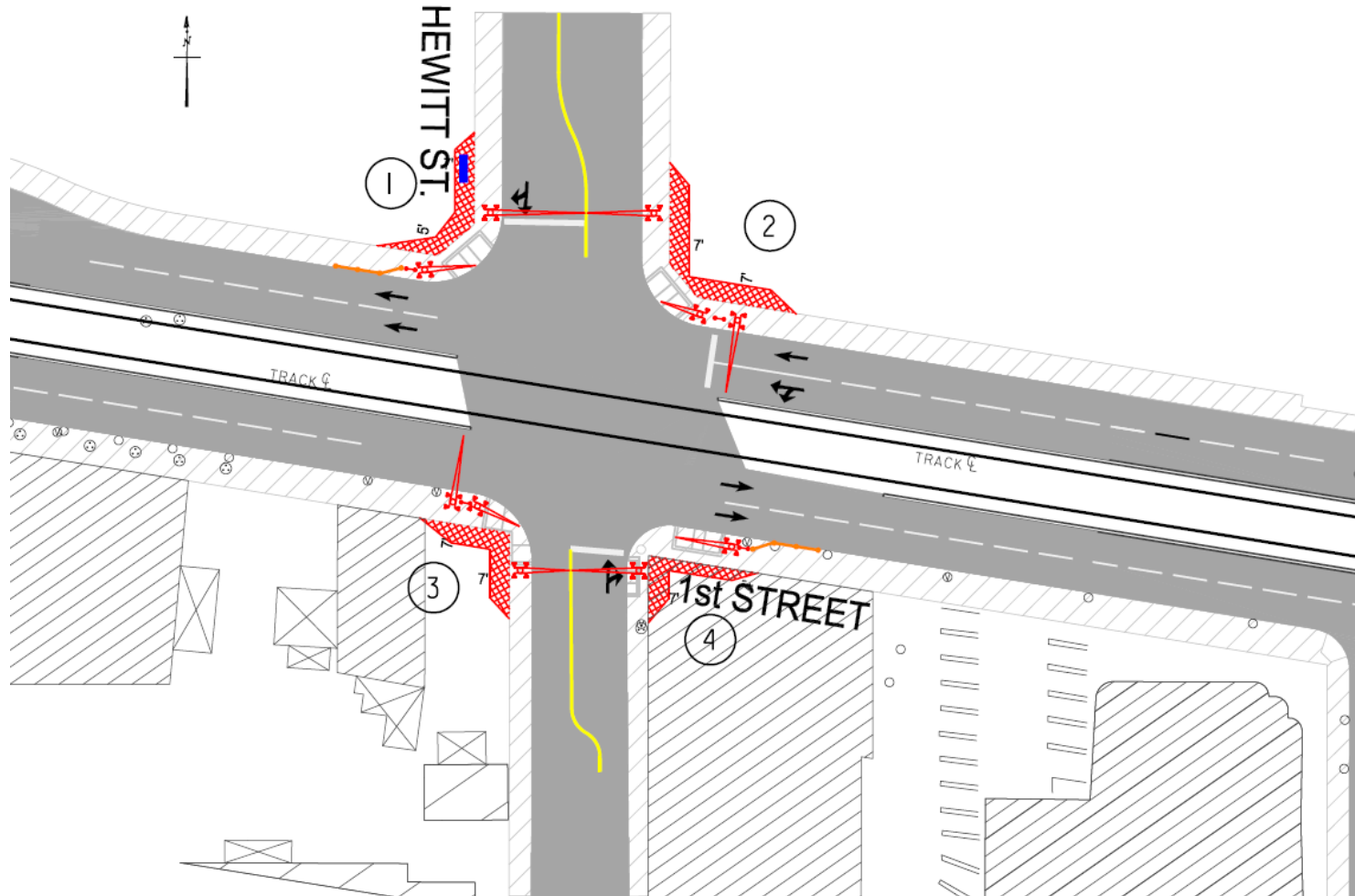
### 1<sup>st</sup> St & Alameda

| Number | Address       | Square Footage | Property Type         |
|--------|---------------|----------------|-----------------------|
| 1      | Not Available | 370            | Commercial/Industrial |



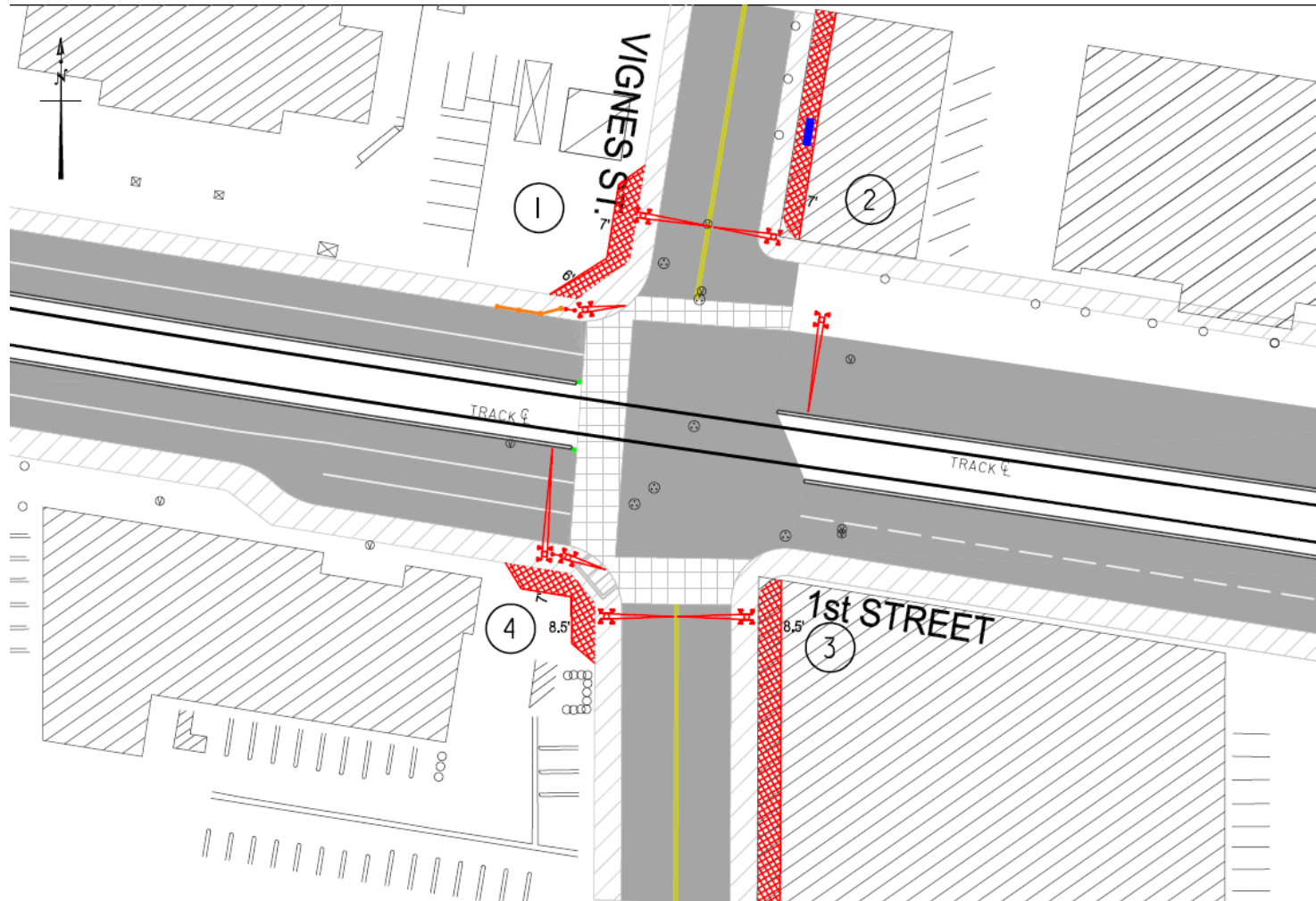
### 1<sup>st</sup> St. & Hewitt

| Number | Address          | Square Footage | Property Type         |
|--------|------------------|----------------|-----------------------|
| 1      | Not Available    | 360            | Vacant                |
| 2      | Not Available    | 500            | Vacant                |
| 3      | 622 E 1st Street | 330            | Commercial/Industrial |
| 4      | 700 E 1st Street | 245            | Commercial/Industrial |



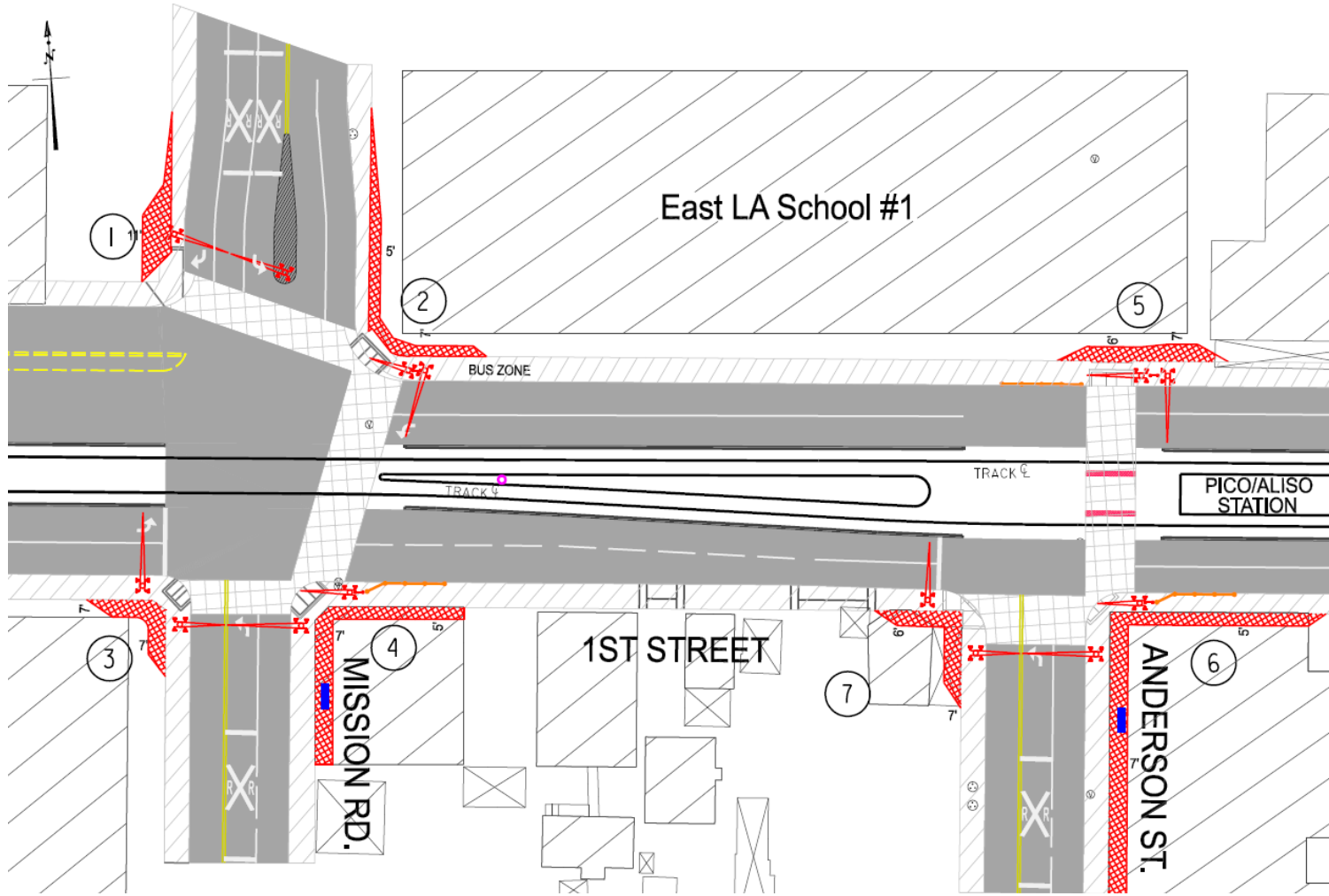
### 1<sup>st</sup> & Vignes

| Number | Address          | Square Footage | Property Type         |
|--------|------------------|----------------|-----------------------|
| 1      | 815 E 1st Street | 420            | Other                 |
| 2      | 901 E 1st Street | 575            | Commercial/Industrial |
| 3      | 900 E 1st Street | 1120           | Commercial/Industrial |
| 4      | 880 E 1st Street | 385            | Commercial/Industrial |



### 1st & Mission/1<sup>st</sup> & Anderson

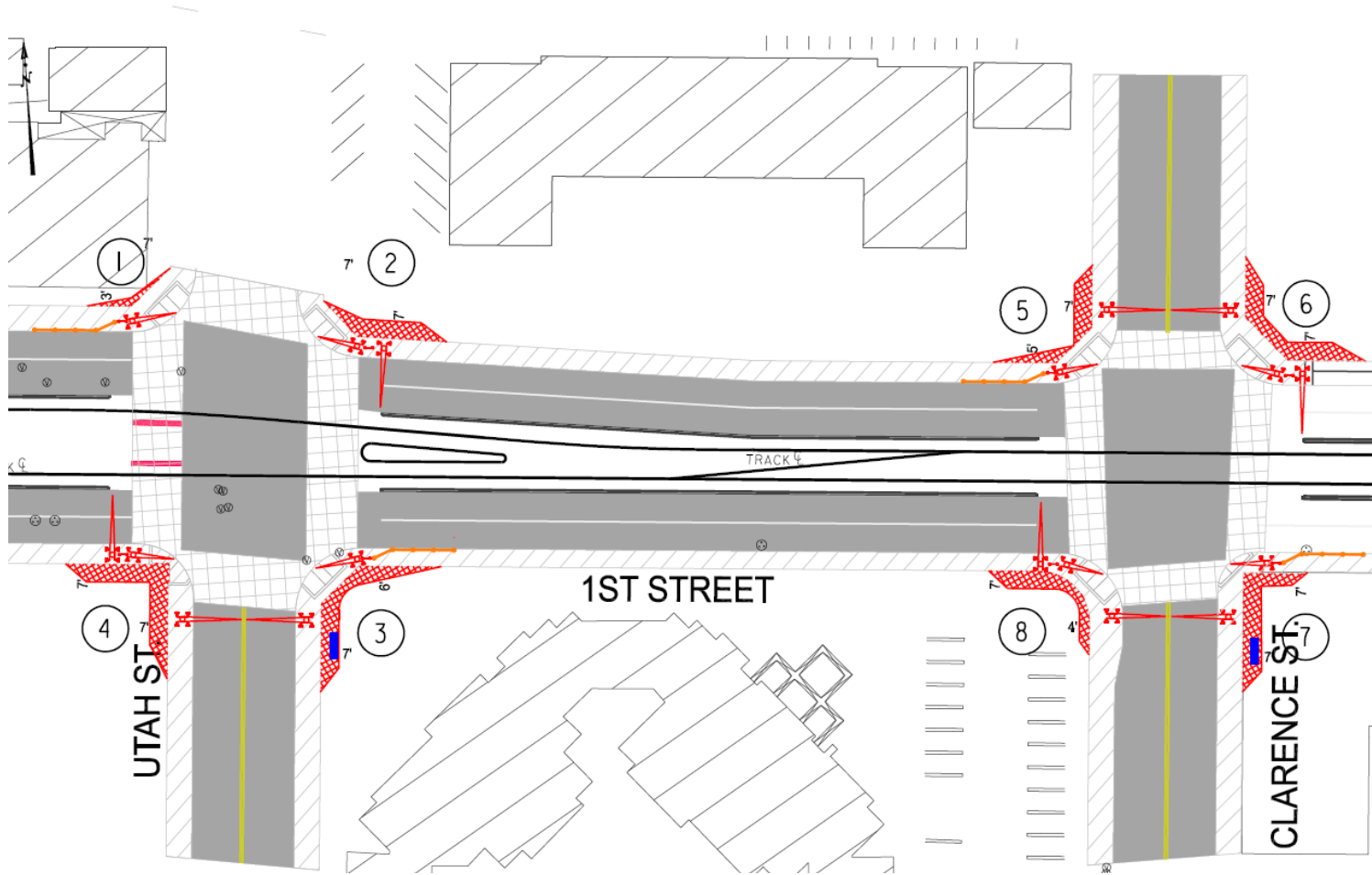
| Number | Address           | Square Footage | Property Type         |
|--------|-------------------|----------------|-----------------------|
| 1      | Not Available     | 190            | Vacant                |
| 2      | 1201 E 1st Street | 660            | Other                 |
| 3      | 1200 E 1st Street | 700            | Commercial/Industrial |
| 4      | 101 Mission Road  | 315            | Commercial/Industrial |
| 5      | 1225 E 1st Street | 365            | Commercial/Industrial |
| 6      | 1301 E 1st Street | 365            | Vacant                |
| 7      | 1219 E 1st Street | 1200           | Commercial/Industrial |
| 7      | 1220 E 1st Street | 380            | Commercial/Industrial |





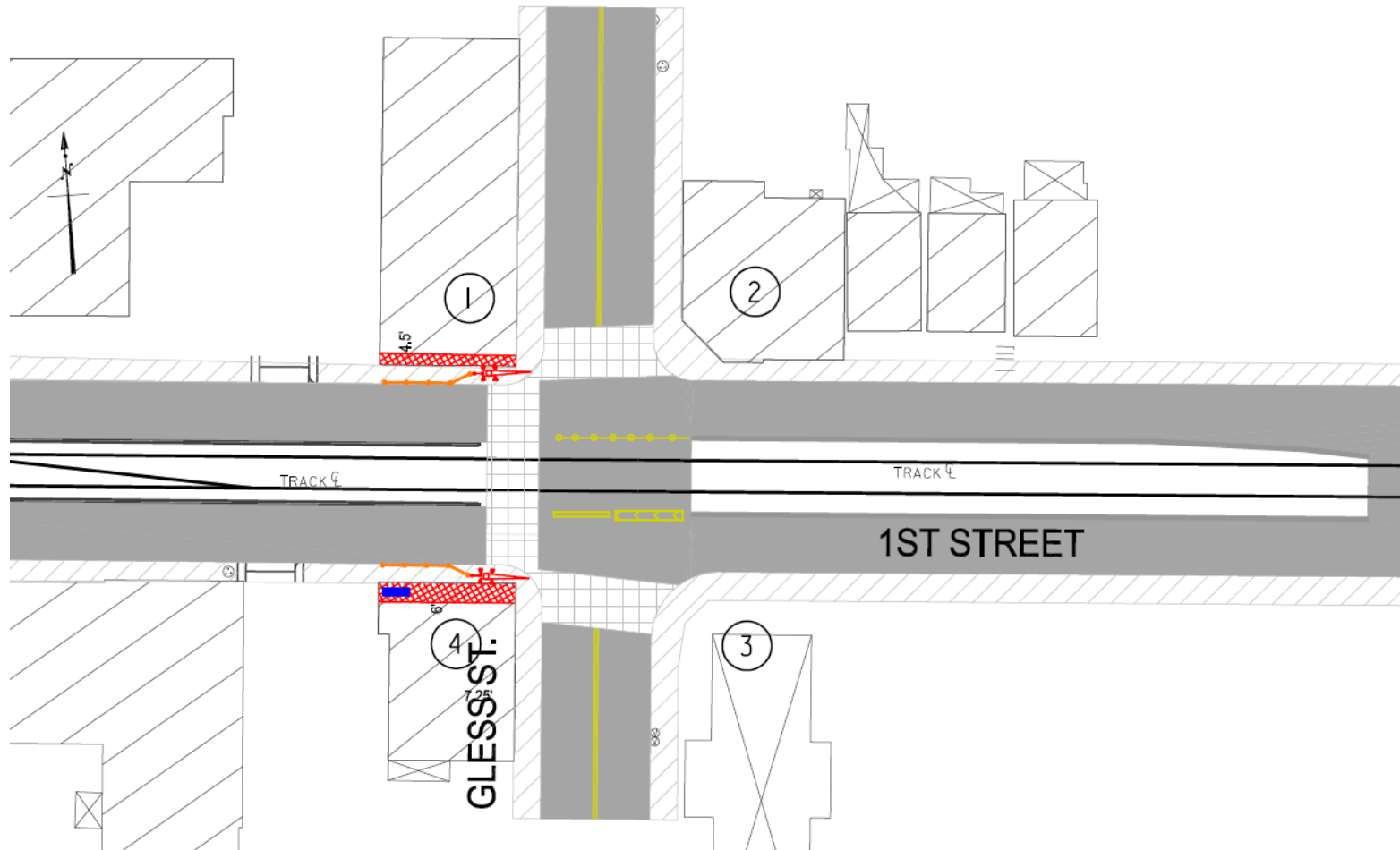
### 1<sup>st</sup> & Utah/1<sup>st</sup> & Clarence

| Number | Address           | Square Footage | Property Type         |
|--------|-------------------|----------------|-----------------------|
| 1      | 111 N Utah Street | 205            | Commercial/Industrial |
| 2      | Not Available     | 550            | Other                 |
| 3      | Not Available     | 340            | Other                 |
| 4      | 105 S Utah Street | 470            | Vacant                |
| 5      | Not Available     | 250            | Other                 |
| 6      | Not Available     | 400            | Other                 |
| 7      | 1500 E 1st Street | 300            | Commercial/Industrial |
| 8      | Not Available     | 275            | Other                 |



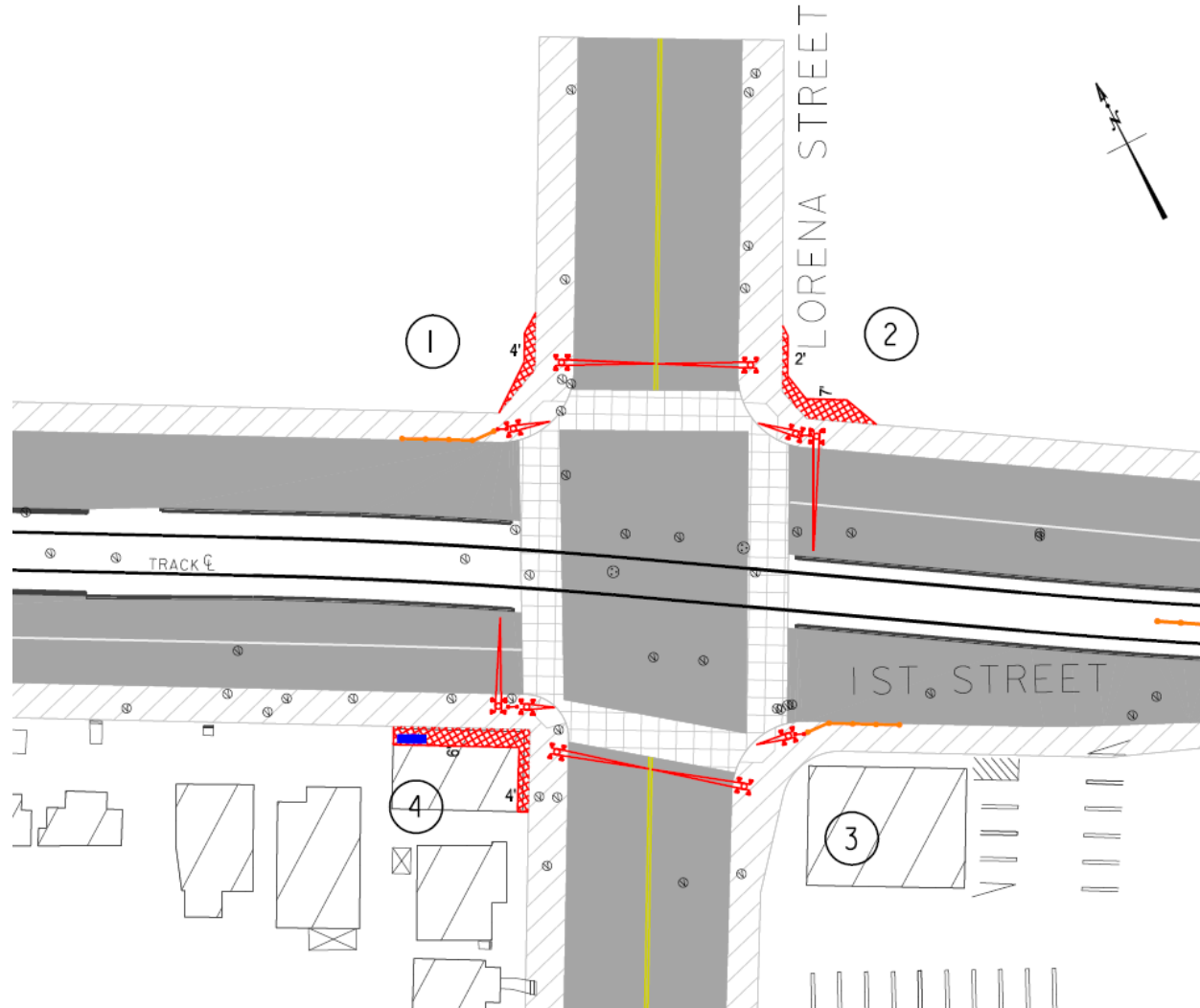
### 1<sup>st</sup> & Gless

| Number | Address            | Square Footage | Property Type            |
|--------|--------------------|----------------|--------------------------|
| 1      | 1529 E 1st Street  | 200            | Commercial/Industrial    |
| 2      | 1605 E 1st Street  | 0              | Commercial/Industrial    |
| 3      | 127 S Pecan Street | 0              | Other                    |
| 4      | 1526 E 1st Street  | 350            | Multi-Family Residential |



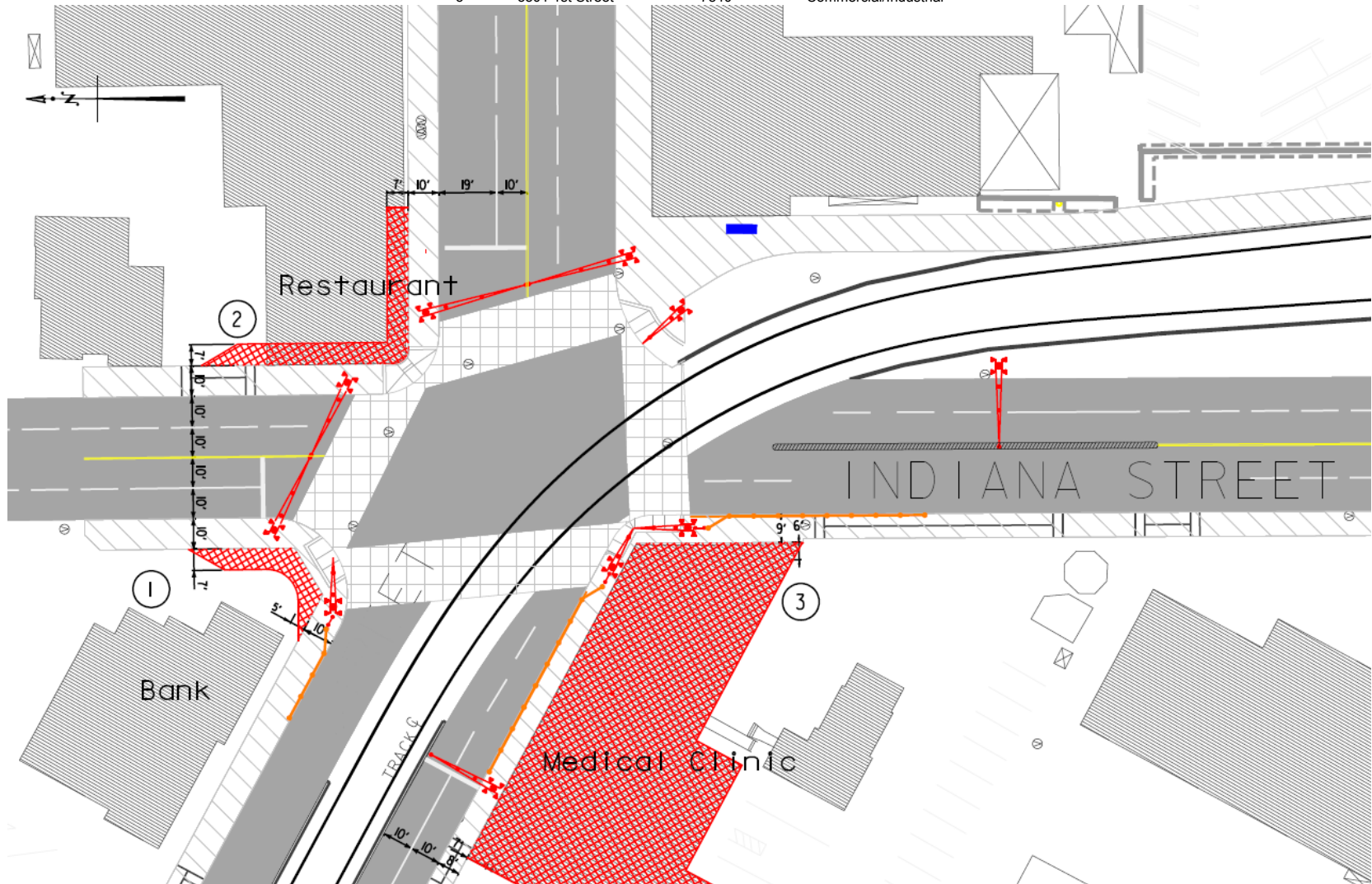
### 1<sup>st</sup> & Lorena

| Number | Address           | Square Footage | Property Type         |
|--------|-------------------|----------------|-----------------------|
| 1      | Not Available     | 100            | Other                 |
| 2      | 3401 E 1st Street | 220            | Vacant                |
| 3      | 3400 E 1st Street | 0              | Commercial/Industrial |
| 4      | 3344 E 1st Street | 375            | Commercial/Industrial |



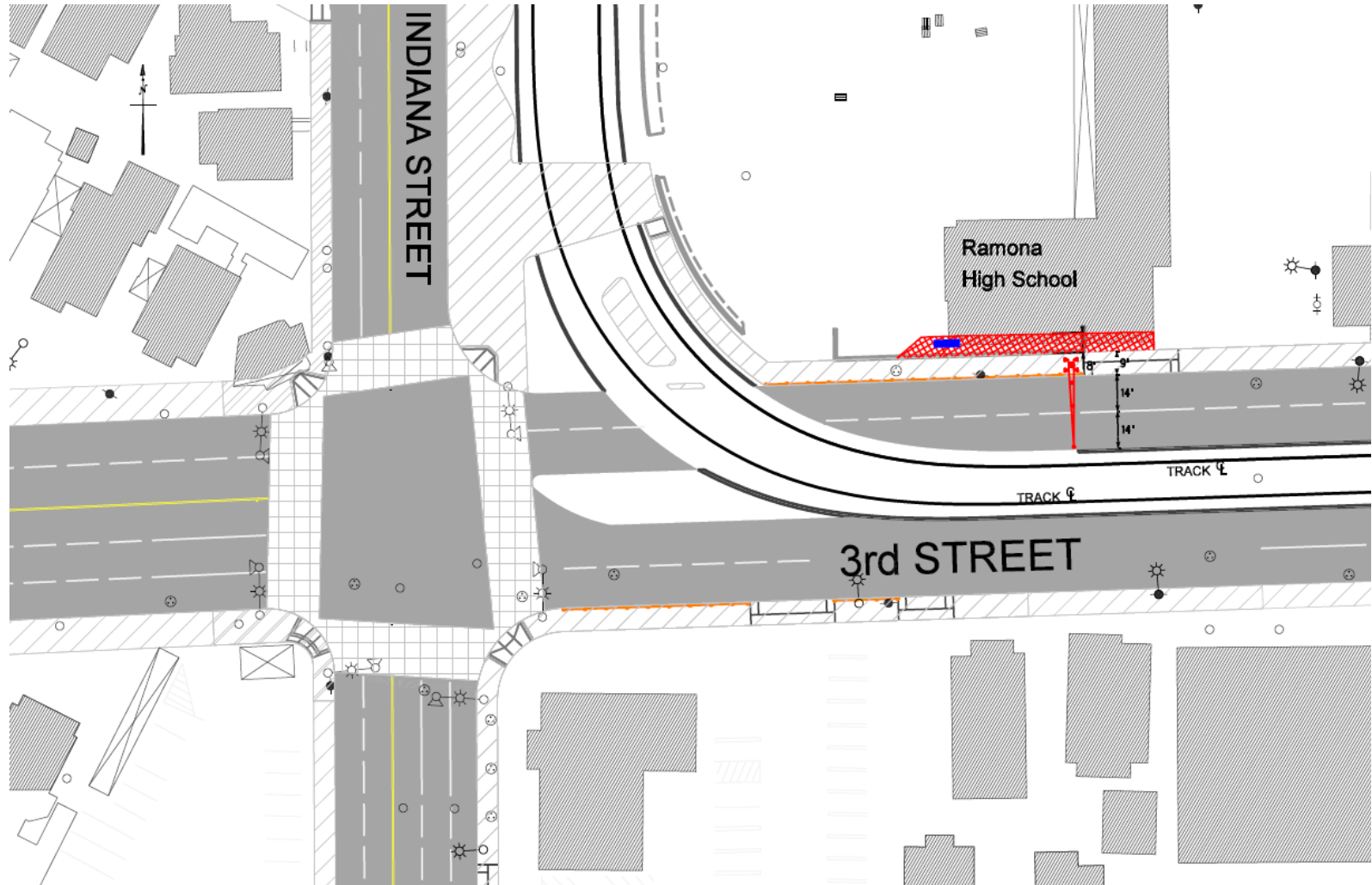
### 1<sup>st</sup> & Indiana

| Number | Address            | Square Footage | Property Type         |
|--------|--------------------|----------------|-----------------------|
| 1      | 3479 1st Street    | 350            | Commercial/Industrial |
| 2      | 105 Indiana Street | 740            | Commercial/Industrial |
| 3      | 3501 1st Street    | 7840           | Commercial/Industrial |



### 3<sup>rd</sup> & Indiana

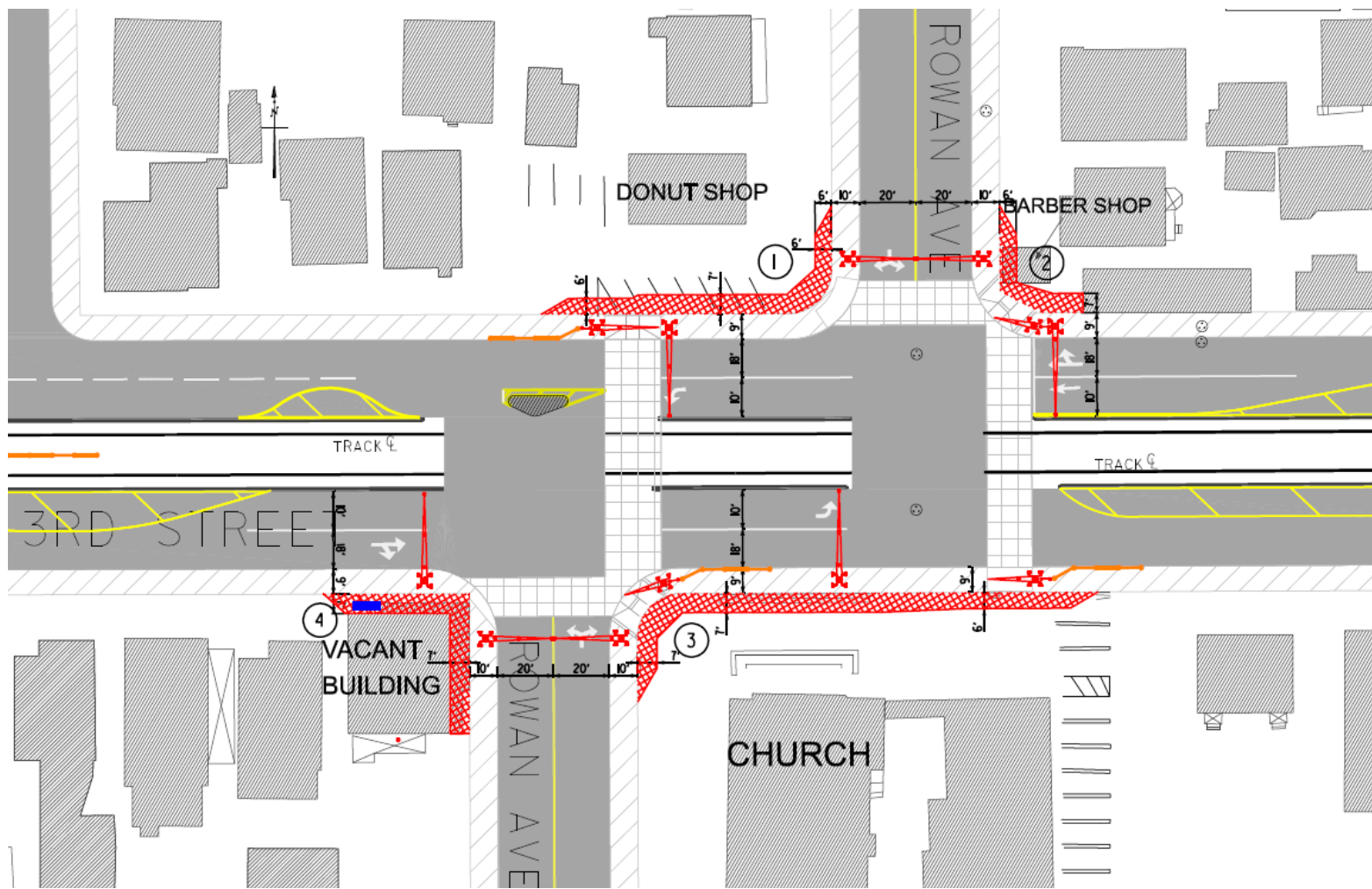
| Number | Address            | Square Footage | Property Type |
|--------|--------------------|----------------|---------------|
| 1      | Ramona High School | 740            |               |





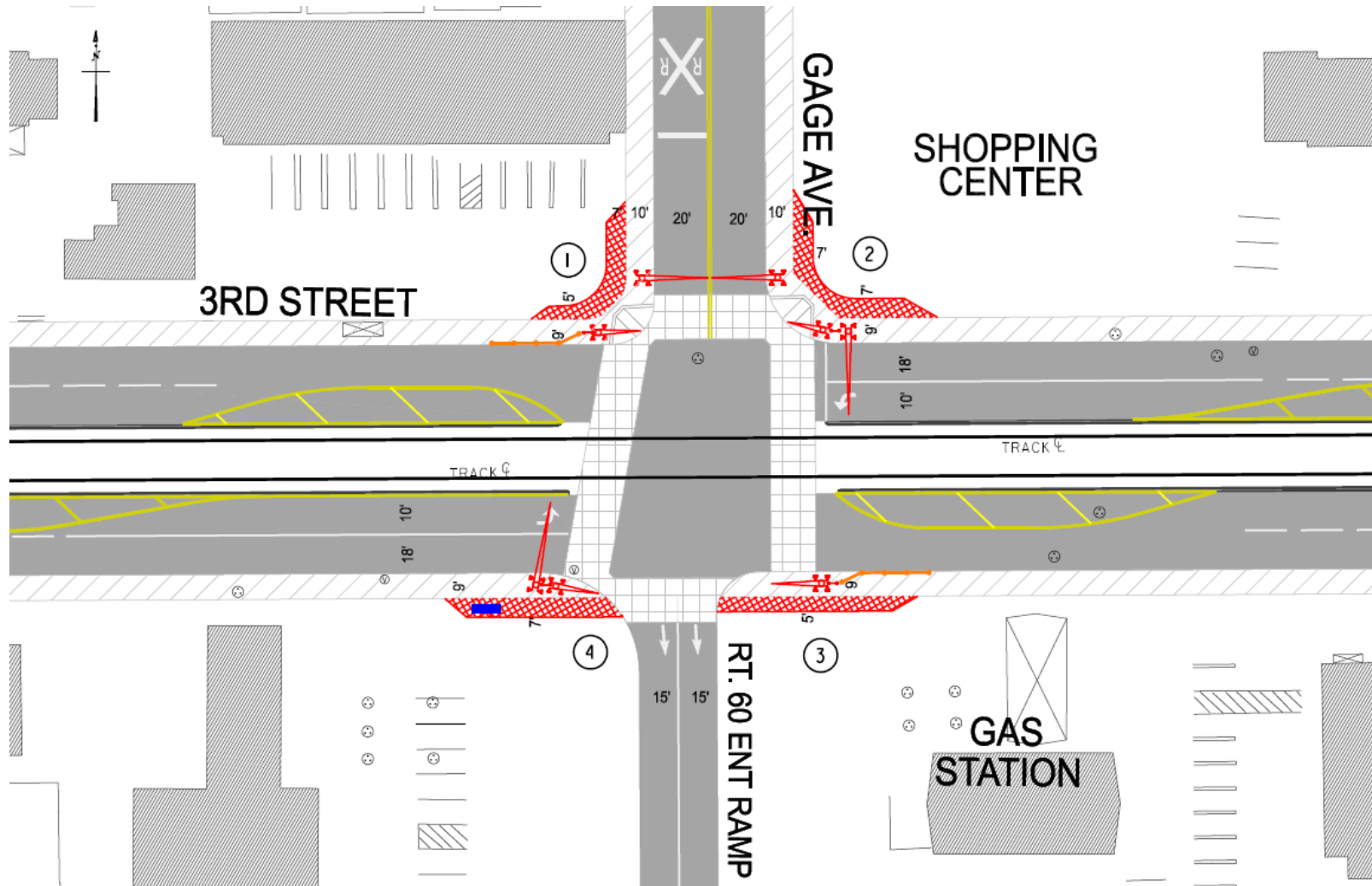
**3<sup>rd</sup> & Rowan**

| Number | Address         | Square Footage | Property Type         |
|--------|-----------------|----------------|-----------------------|
| 1      | 3763 3rd Street | 800            | Commercial/Industrial |
| 2      | 3777 3rd Street | 330            | Commercial/Industrial |
| 3      | 3772 3rd Street | 1210           | Other                 |
| 4      | 3748 3rd Street | 630            | Commercial/Industrial |



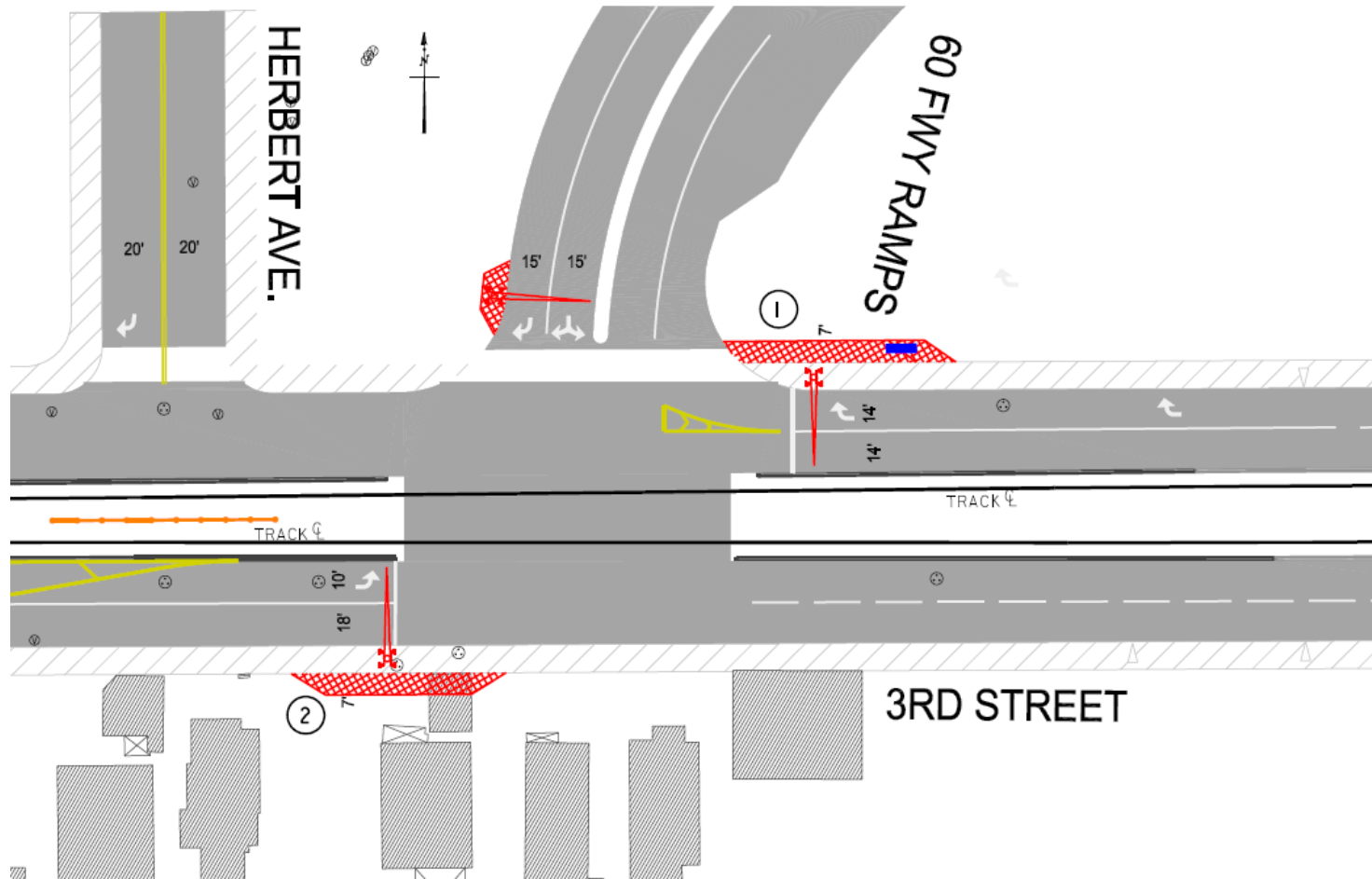
### 3<sup>rd</sup> & Gage

| Number | Address         | Square Footage | Property Type         |
|--------|-----------------|----------------|-----------------------|
| 1      | 3845 3rd Street | 375            | Commercial/Industrial |
| 2      | 3853 3rd Street | 470            | Commercial/Industrial |
| 3      | 3856 3rd Street | 350            | Commercial/Industrial |
| 4      | 3834 3rd Street | 420            | Commercial/Industrial |



### 3rd & 60 Ramps

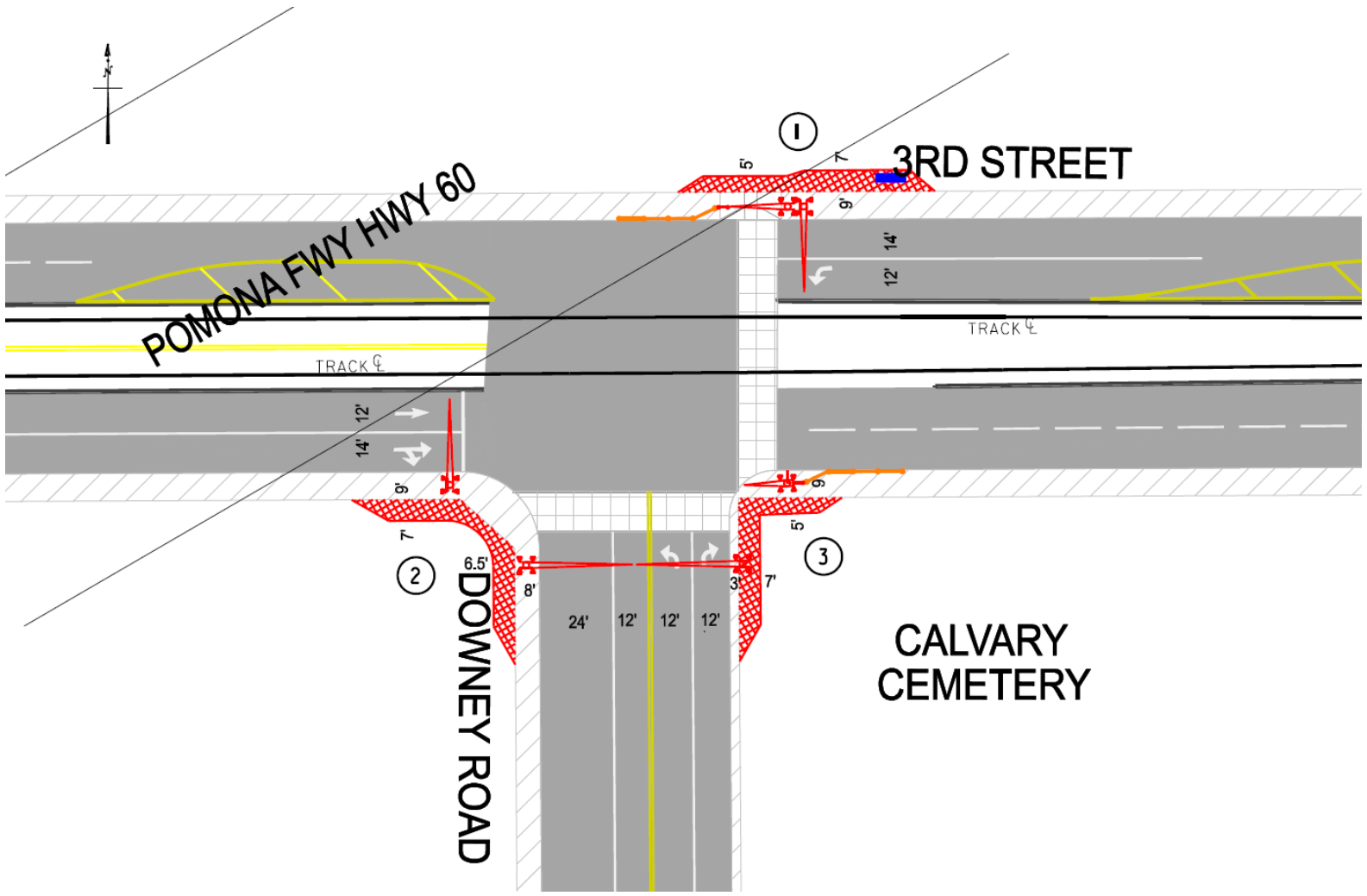
| Number | Address         | Square Footage | Property Type         |
|--------|-----------------|----------------|-----------------------|
| 1      | CalTrans        | 470            |                       |
| 2      | 3900 3rd Street | 405            | Commercial/Industrial |





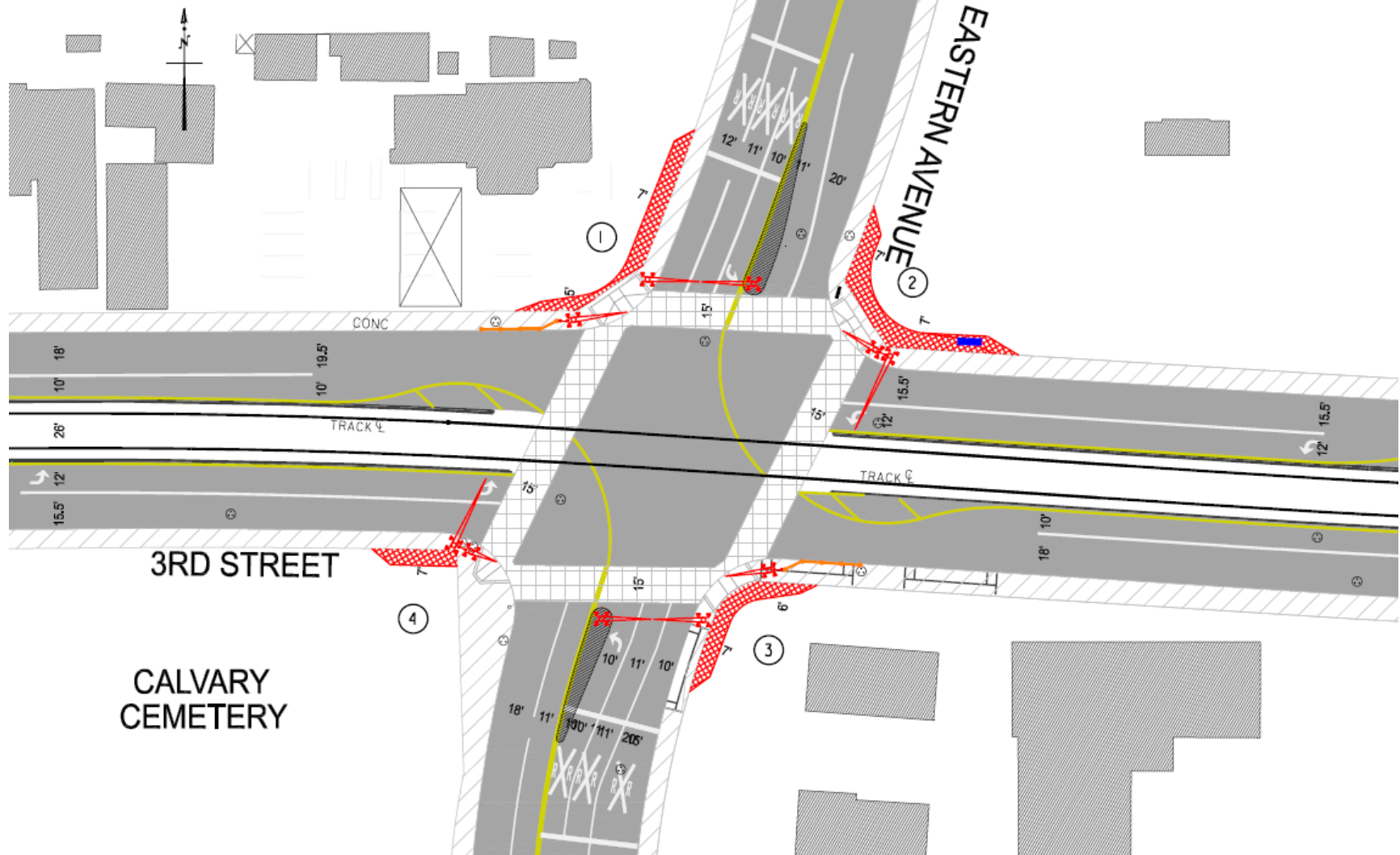
### 3<sup>rd</sup> & Downey

| Number | Address            | Square Footage | Property Type |
|--------|--------------------|----------------|---------------|
| 1      | CalTrans           | 475            |               |
| 2      | CalTrans           | 520            |               |
| 3      | 4201 Whittier Blvd | 440            | Other         |



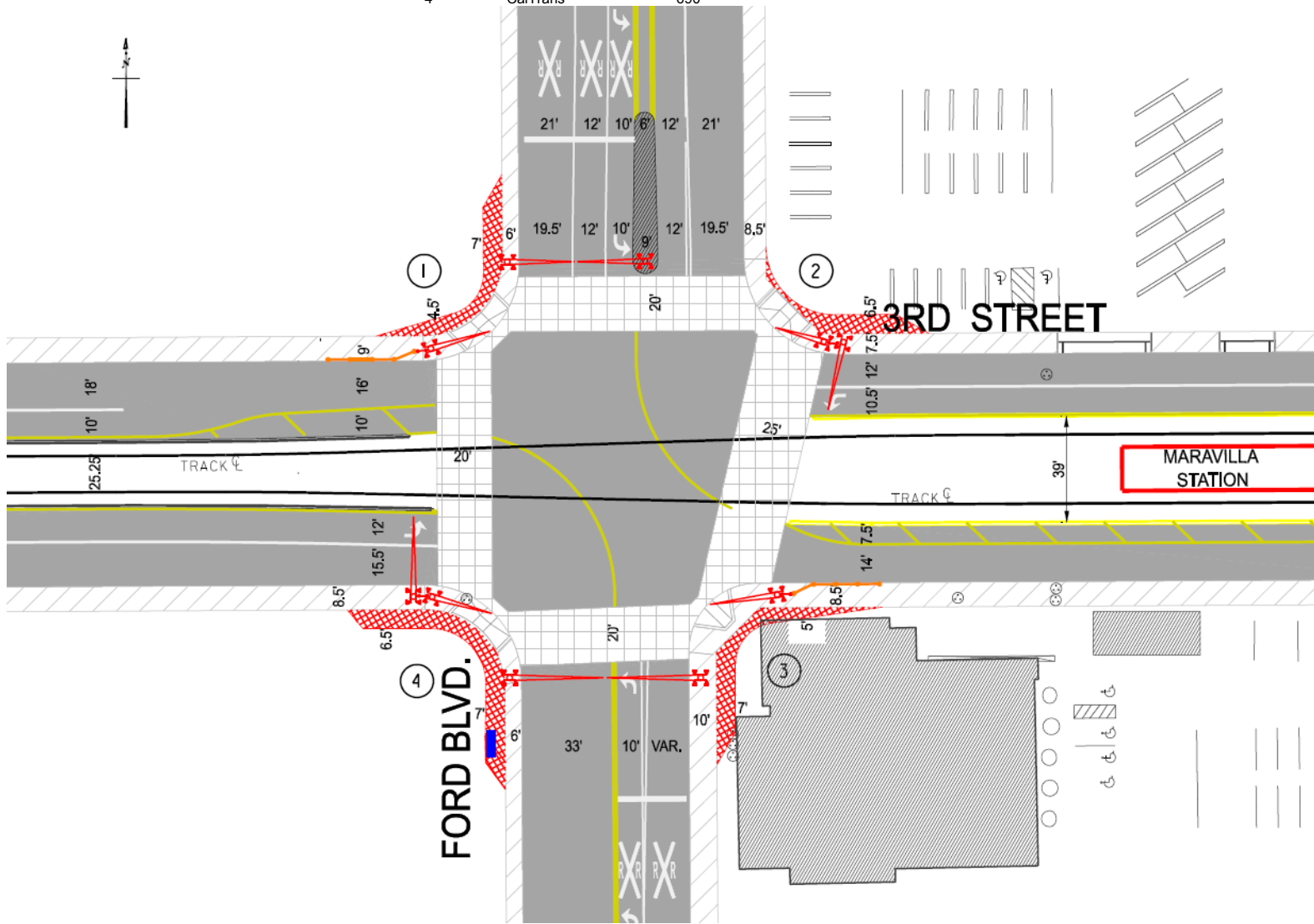
### 3<sup>rd</sup> & Eastern

| Number | Address            | Square Footage | Property Type         |
|--------|--------------------|----------------|-----------------------|
| 1      | 4249 3rd Street    | 580            | Commercial/Industrial |
| 2      | 260 Eastern Ave    | 660            | Other                 |
| 3      | 4300 3rd Street    | 450            | Commercial/Industrial |
| 4      | 4201 Whittier Blvd | 210            | Other                 |



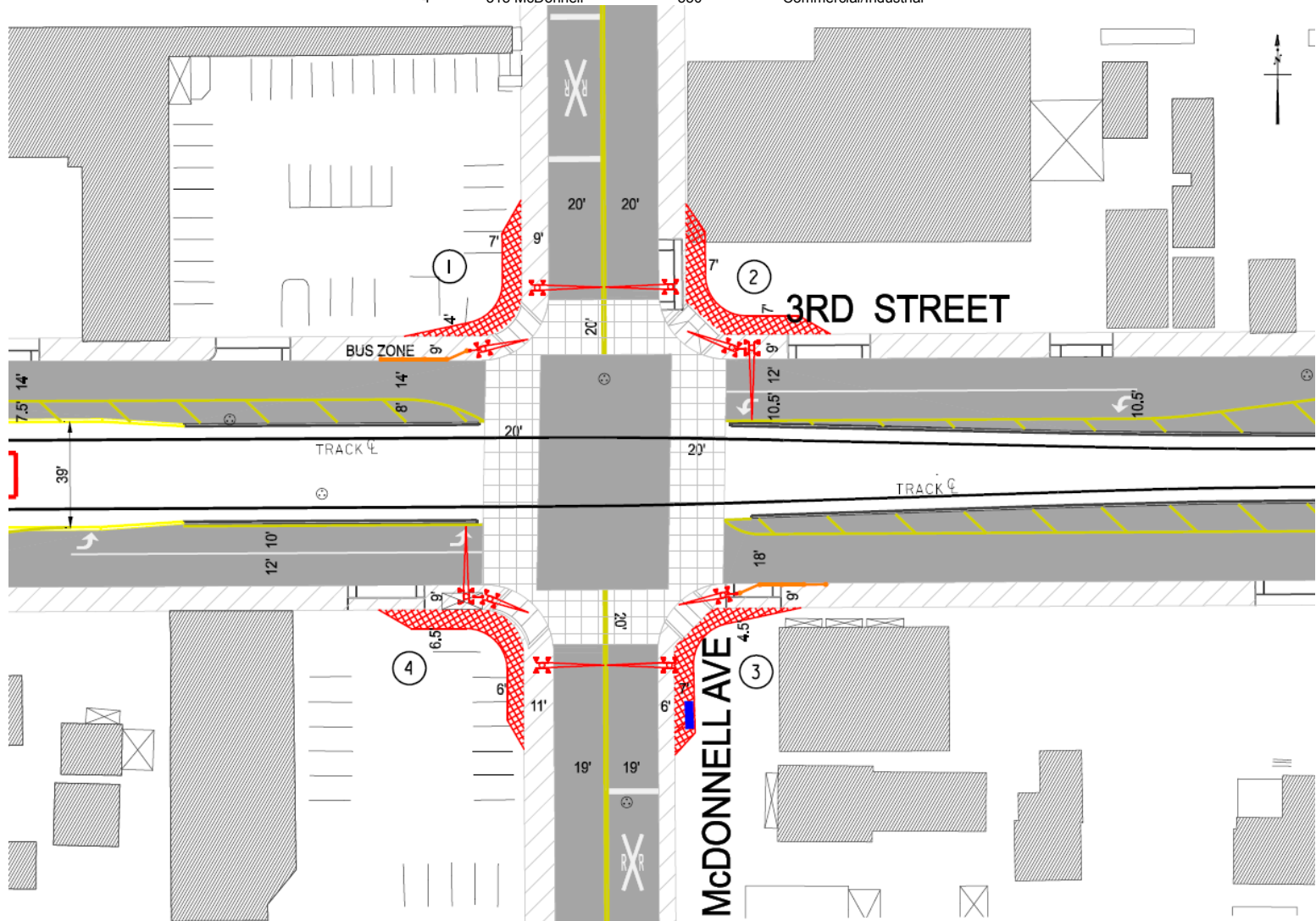
### 3<sup>rd</sup> & Ford Blvd

| Number | Address         | Square Footage | Property Type         |
|--------|-----------------|----------------|-----------------------|
| 1      | CalTrans        | 425            |                       |
| 2      | 4501 3rd Street | 300            | Vacant                |
| 3      | 4504 3rd Street | 465            | Commercial/Industrial |
| 4      | CalTrans        | 690            |                       |



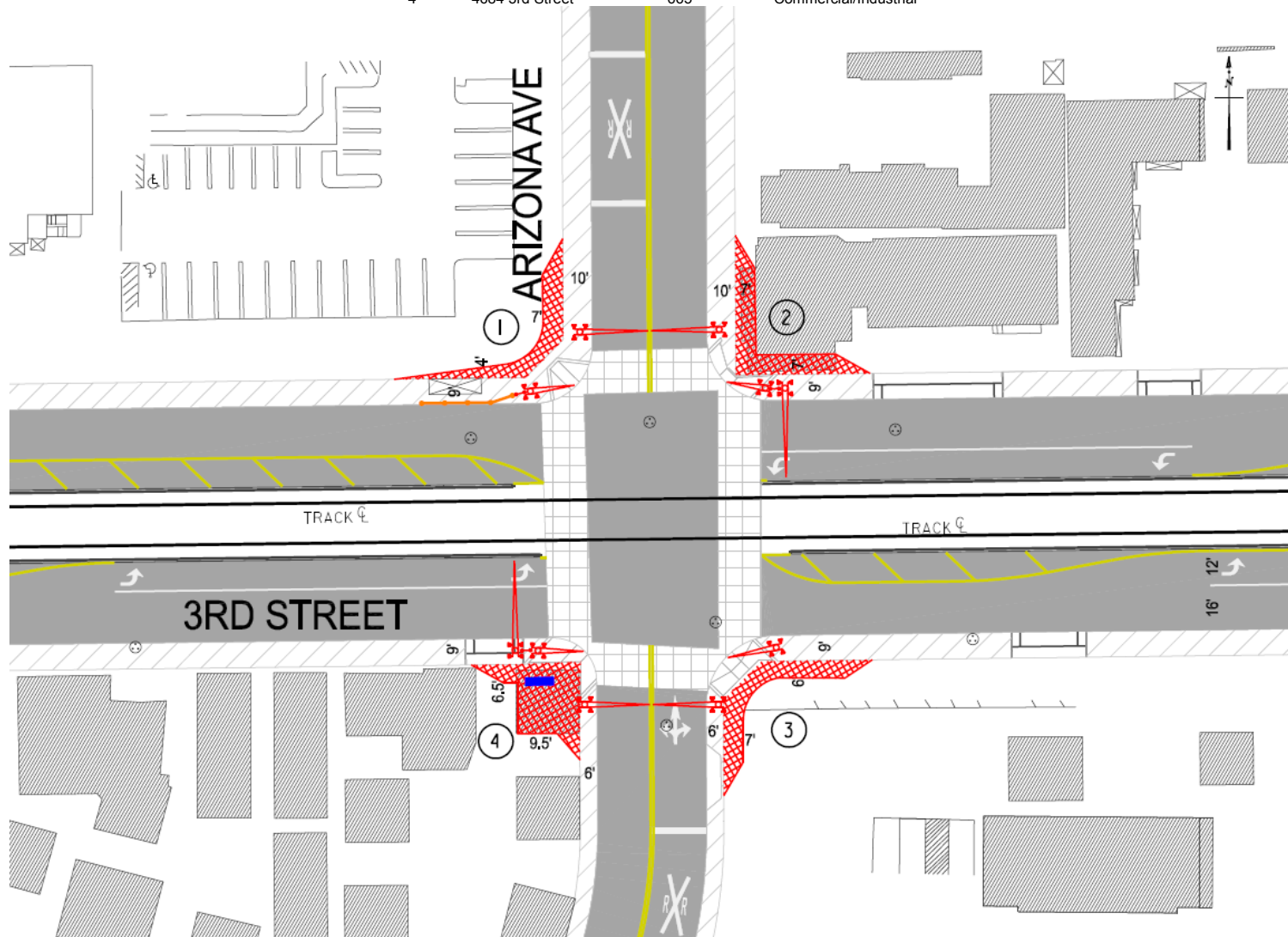
### 3<sup>rd</sup> & McDonnell

| Number | Address         | Square Footage | Property Type         |
|--------|-----------------|----------------|-----------------------|
| 1      | 4547 3rd Street | 415            | Commercial/Industrial |
| 2      | 4605 3rd Street | 540            | Commercial/Industrial |
| 3      | 4600 3rd Street | 450            | Commercial/Industrial |
| 4      | 315 McDonnell   | 550            | Commercial/Industrial |



### 3rd & Arizona

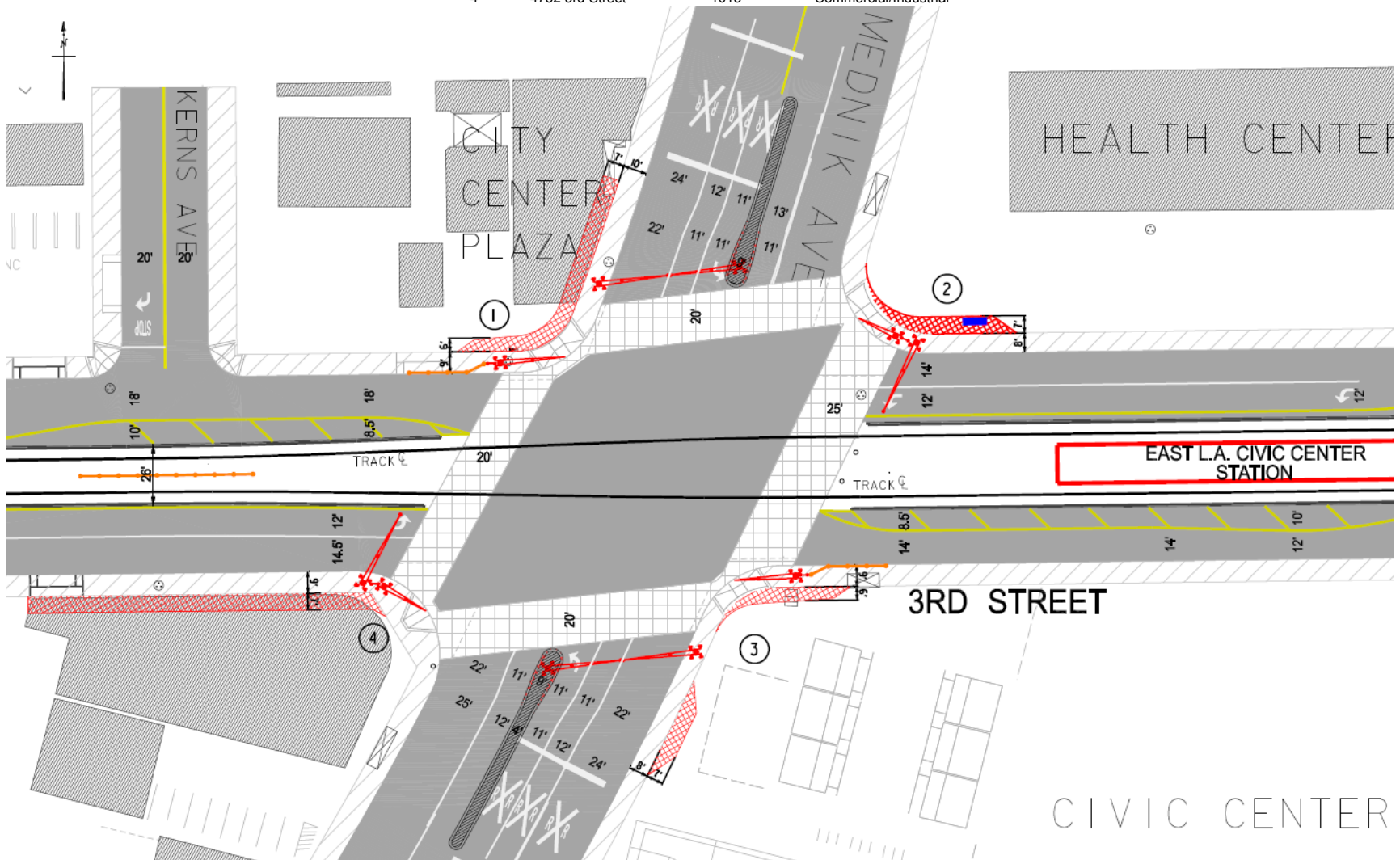
| Number | Address         | Square Footage | Property Type         |
|--------|-----------------|----------------|-----------------------|
| 1      | 249 Arizona Ave | 410            | Other                 |
| 2      | 4711 3rd Street | 530            | Commercial/Industrial |
| 3      | 4716 3rd Street | 480            | Commercial/Industrial |
| 4      | 4684 3rd Street | 665            | Commercial/Industrial |





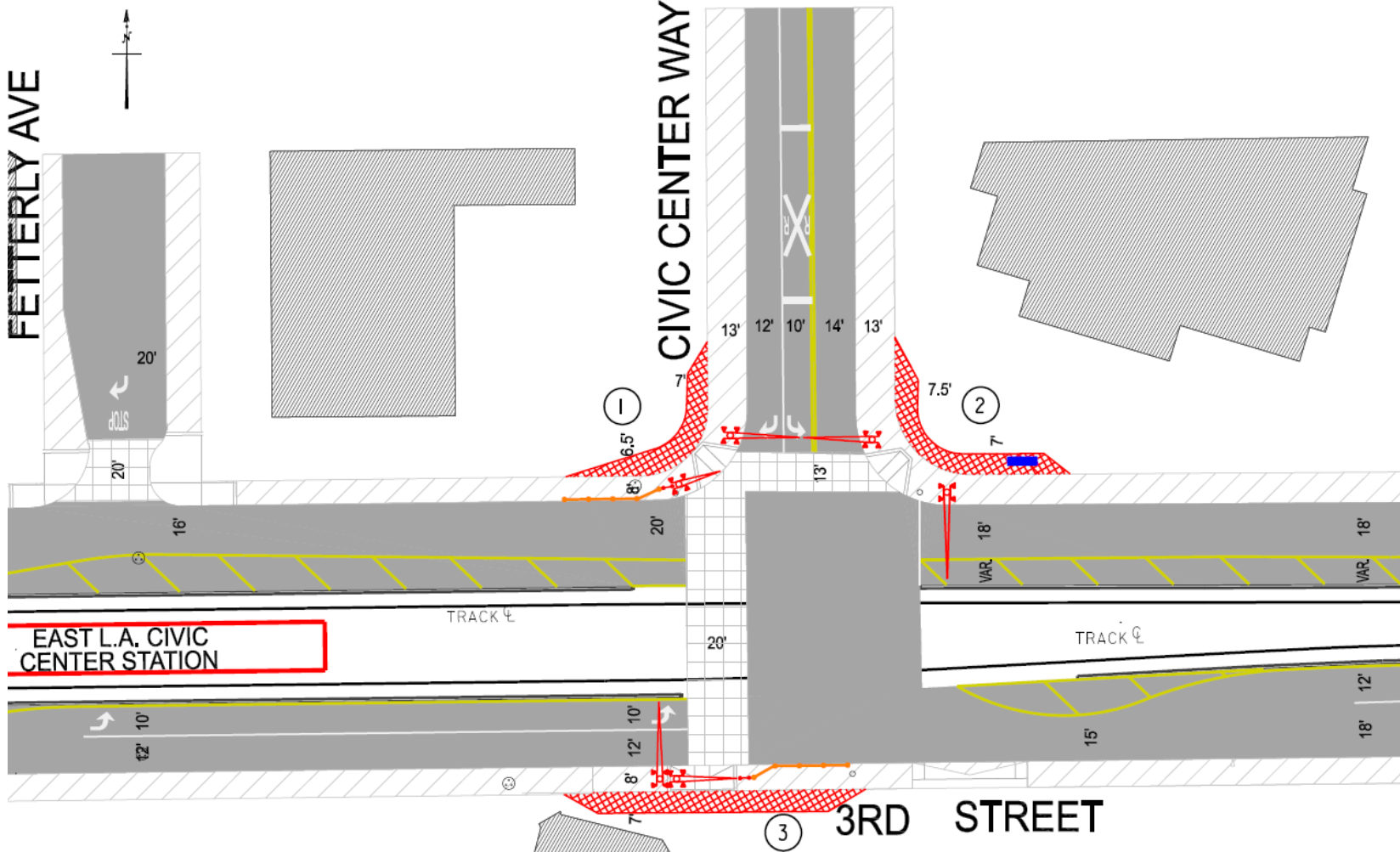
### 3rd & Mednik

| Number | Address          | Square Footage | Property Type         |
|--------|------------------|----------------|-----------------------|
| 1      | 249 Mednik Ave   | 680            | Commercial/Industrial |
| 2      | 245 Fetterly Ave | 355            | Commercial/Industrial |
| 3      | 4765 4th Street  | 475            | Other                 |
| 4      | 4732 3rd Street  | 1015           | Commercial/Industrial |



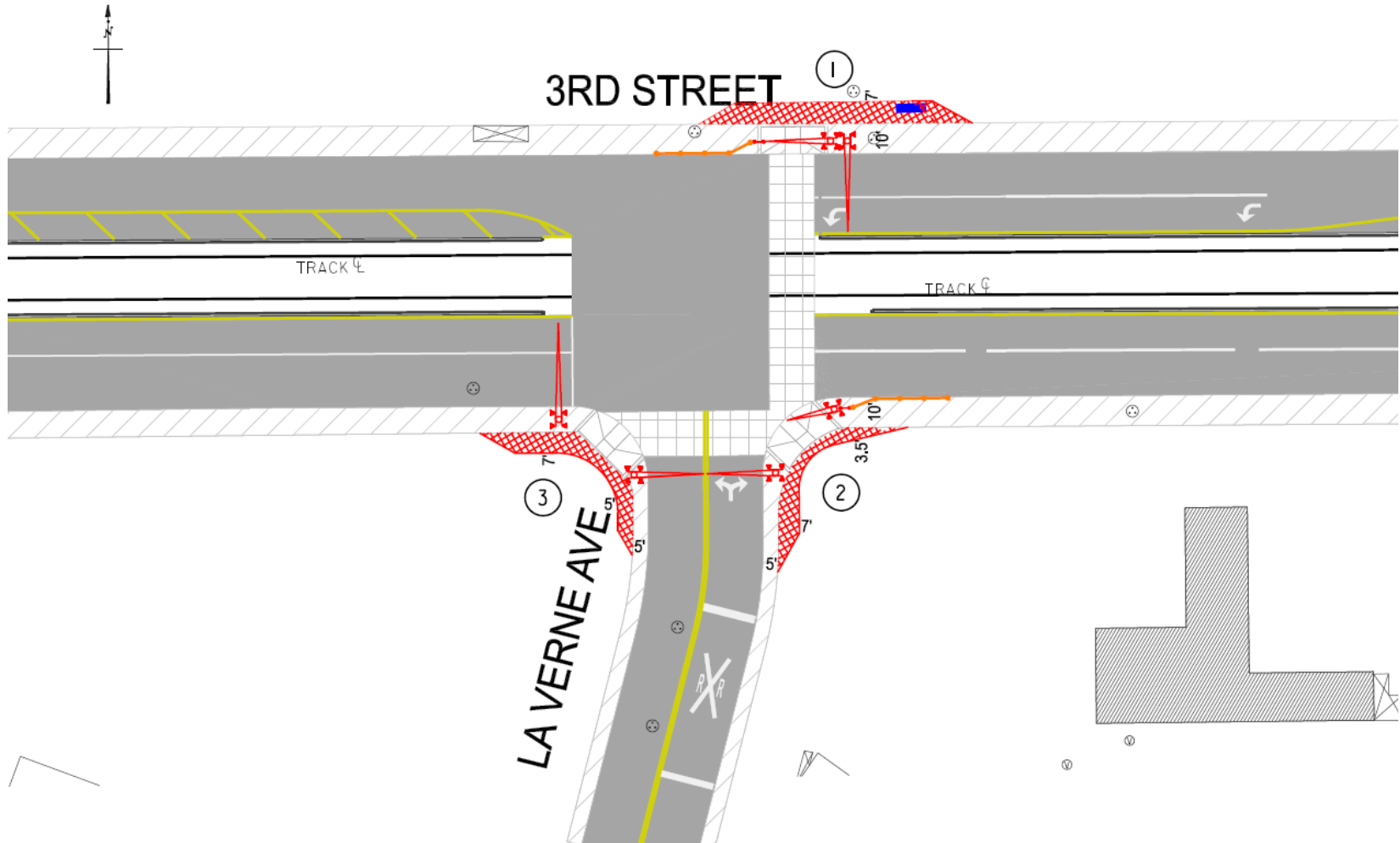
3rd & Civic Center Way

| Number | Address          | Square Footage | Property Type |
|--------|------------------|----------------|---------------|
| 1      | 214 Fetterly Ave | 430            | Other         |
| 2      | 4837 3rd Street  | 530            | Other </td    |
| 3      | 4816 3rd Street  | 620            | Other         |



### 3<sup>rd</sup> & La Verne

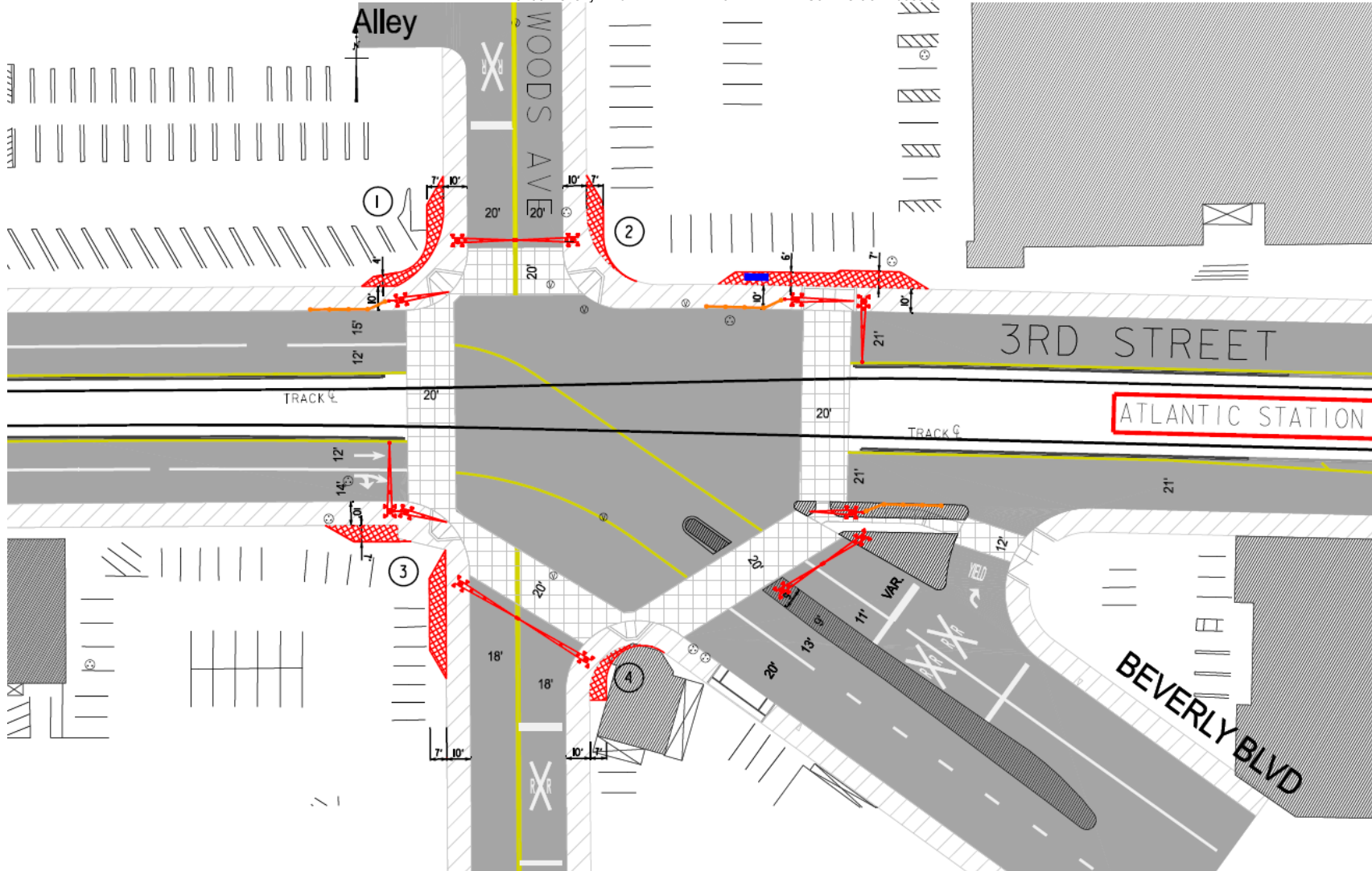
| Number | Address         | Square Footage | Property Type         |
|--------|-----------------|----------------|-----------------------|
| 1      | 5019 3rd Street | 570            | Other                 |
| 2      | 5010 3rd Street | 300            | Commercial/Industrial |
| 3      | 4850 3rd Street | 610            | Vacant                |





### 3<sup>rd</sup> & Woods & Beverly

| Number | Address                                  | Square Footage | Property Type         |
|--------|--|----------------|-----------------------|
| 1      | 5051 3rd Street                          | 275            | Commercial/Industrial |
| 2      | 5119 Pomona Blvd<br>No Address Available | 645            | Commercial/Industrial |
| 3      | 5100 Beverly Blvd                        | 465            | Other                 |
| 4      | 5100 Beverly Blvd                        | 210            | Commercial/Industrial |



## Appendix J – Schedule

# Quad Gate Implementation Schedule

| Year 1  |       |       |       | Year 2                              |                           |  |       | Year 3 |       |                        |       | Year 4 |       |       |       |
|---|-------|-------|-------|-------------------------------------|---------------------------|--|-------|--------|-------|------------------------|-------|--------|-------|-------|-------|
| 1st Q   | 2nd Q | 3rd Q | 4th Q | 1st Q                               | 2nd Q                     | 3rd Q                                      | 4th Q | 1st Q  | 2nd Q | 3rd Q                  | 4th Q | 1st Q  | 2nd Q | 3rd Q | 4th Q |
| <b>I. Preliminary Engineering &amp; Environmental Clearance</b> |       |       |       |                                     |                           |  |       |        |       |                        |       |        |       |       |       |
| Preliminary Engineering   |       |       |       |                                     |                           |  |       |        |       |                        |       |        |       |       |       |
| City/County Preliminary Approval                                |       |       |       |                                     |                           |  |       |        |       |                        |       |        |       |       |       |
| CPUC Preliminary Approval                                       |       |       |       |                                     |                           |  |       |        |       |                        |       |        |       |       |       |
| Environmental Clearance (SEIS/SEIR)                             |       |       |       |                                     |                           |  |       |        |       |                        |       |        |       |       |       |
|   |       |       |       | ◆ Metro Board Certifies (SEIS/SEIR) |                           |  |       |        |       |                        |       |        |       |       |       |
| <b>II. Right-of-Way Acquisitions &amp; Final Engineering</b>    |       |       |       |                                     |                           |  |       |        |       |                        |       |        |       |       |       |
|   |       |       |       |                                     | Right-of-Way Acquisitions |  |       |        |       |                        |       |        |       |       |       |
|   |       |       |       |                                     |                           | Utility Relocations                        |       |        |       |                        |       |        |       |       |       |
|   |       |       |       |                                     |                           | Final Engineering (Plans & Specifications) |       |        |       |                        |       |        |       |       |       |
|   |       |       |       |                                     |                           | City/County Final Approval                 |       |        |       |                        |       |        |       |       |       |
|   |       |       |       |                                     |                           | CPUC Final Grade Crossing Approval         |       |        |       |                        |       |        |       |       |       |
| <b>III. Bid &amp; Construction</b>                              |       |       |       |                                     |                           |  |       |        |       |                        |       |        |       |       |       |
|   |       |       |       |                                     |                           |  |       |        |       | Advertise, Bid & Award |       |        |       |       |       |
|   |       |       |       |                                     |                           |  |       |        |       | Construction           |       |        |       |       |       |