Engineering the Alameda Corridor – East Project

By

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ABSTRACT

The Alameda Corridor – East (ACE) grade crossing elimination and improvements program includes a mix of new as well as traditional improvements to address mobility and safety concerns at some 55 grade crossings along the transcontinental main lines of the Union Pacific Railroad’s Alhambra Subdivision (formerly Southern Pacific) and Los Angeles Subdivision through the San Gabriel Valley east of downtown Los Angeles.

The ACE Project was initiated by the San Gabriel Valley Council of Governments (SGVCOG) subsequent to the 1996 San Gabriel Valley Grade Crossings Study, that identified significant increases in mobility and safety impacts as a result of projected growth in train and roadway traffic levels.

This paper describes techniques used to develop the program, highlights the “Jump Start” program for crossings to remain at grade, and summarizes key successes and challenges to date.

Some of the keys to the program’s success to date include:

- Quantitative evaluation of grade crossing impacts based upon projected rail operations and traffic forecasts;
- Use of specified indicators and/or thresholds for selection of proposed improvements;
- Orchestrated effort by affected communities used to assemble local and outside program funding.

Some of the notable challenges have been:

- Keeping the project moving forward while negotiating an agreement with the railroad and managing “scope creep” associated with accommodation of rail engineering standards and future rail needs;
- Negotiating with utility companies over franchise rights as a third-party agency and dealing with the
  California utilities in the aftermath of electric power deregulation;

And,

- Dealing with potential funding losses due to the California fiscal crisis and struggling to secure additional
  funding under a more competitive environment for outside funds.
OVERVIEW

The Alameda Corridor – East (ACE) grade crossing elimination and improvements program includes a mix of new as well as traditional improvements to address mobility and safety concerns at some 55 grade crossings along the transcontinental main lines of the Union Pacific Railroad through the San Gabriel Valley east of downtown Los Angeles. This paper describes techniques used to develop the program, highlights the “Jump Start” program for crossings to remain at grade, and summarizes key successes and challenges to date.

The ACE project is located in the San Gabriel Valley immediately east of downtown Los Angeles. The Valley is bisected by two major transcontinental main lines – the Alhambra Subdivision (formerly part of the Southern Pacific Railroad network but now part of the Union Pacific system) is located to the north and the Los Angeles Subdivision of the Union Pacific Railroad is located to the south (see Figure 1.)

The scope of the ACE project includes (see Figure 2):

- Up to 20 Grade Separations
- 39 Grade Crossing Safety Projects
- Up to 4 Grade Crossing Closures
- An ITS Demonstration Project

Included in the candidate grade crossing closures are two crossings west of the City of Pomona, which may be eliminated by a diversion of the main line from the Alhambra Subdivision to the Los Angeles Subdivision in order to eliminate the need for a costly grade separation at a geometrically complex grade crossing.

The ACE Project was initiated by the San Gabriel Valley Council of Governments (SGVCOG) as a direct follow-on to the 1996 San Gabriel Valley Grade Crossings Study, which identified significant increases in mobility and safety impacts at the 55 project-area grade crossings as a result of projected growth in train and roadway traffic levels.
The success of the ACE project to date is based upon a solid initial study backed up with strong local support from involved and friendly cities in the San Gabriel Valley and with aggressive project management by the ACE Construction Authority. Local constituents were successful at assembling committed funds of nearly $400-million for construction of Phase I improvements. This represents nearly 45% of the $900-million plus program identified in the initial study, which was completed in January of 1997.

Some of the key technical elements of the approach include:

- Quantitative evaluation of grade crossing impacts based upon projected rail operations and traffic forecasts;
- Use of specified indicators and/or thresholds for selection of proposed improvements;
- Use of state-of-the-art treatments for crossings to remain at grade, such as:
  - Use of four-quadrant gates;
  - Use of pre-signals;
  - Comprehensive treatment of pedestrians;
- Intelligent Transportation Demonstration Project with traffic signals.

1996 SAN GABRIEL VALLEY GRADE CROSSING STUDY

Cities in the San Gabriel Valley, members of the San Gabriel Valley Council of Governments (SGVCOG) were concerned about the impact of increasing levels of transcontinental train traffic resulting from expansive economic conditions at the Ports of Los Angeles and Long Beach. There are only three principal rail lines heading east out of
Los Angeles and two of these lines bisect the San Gabriel Valley. At the same time, the Alameda Corridor Project was proceeding, which would grade separate and consolidate rail traffic between the Ports and downtown Los Angeles, facilitating train movements to the mouth of the Valley. SGVCOG commissioned a study of grade crossing impacts and potential mitigation. The study elements included:

- Field review of 55 grade crossings in Los Angeles County
- Development of up-to-date forecasts of future rail traffic levels
- Assembly of projected future highway traffic levels at the crossings
- Evaluation of the crossing gate blockage, vehicular delay and queuing at grade crossings
- Identification and evaluation of candidate improvements
- Development of a comprehensive, phased program of improvements

In particular, the information developed on mobility impacts as presented below was instrumental in spurring the San Gabriel Valley Cities into action to pursue funding for grade separations and related grade crossings improvements.

**Rail Traffic**

The Grade Crossing Study identified the possibility of significantly increased levels of train traffic. Most heavily impacted was the City of Pomona, where the two main lines run immediately parallel to each other through the heart of the downtown. Existing train levels of about 67 trains per day observed in 1994 were projected to exceed 109 trains per day by Year 2010. There has been recent media attention due to the fact that train levels since the opening of the Alameda Corridor in Los Angeles and Long Beach has not attained the levels required to pay off the project bonds, and this in turn has focused attention on the ACE Project.

ACE is currently using the Pilot Implementation of the Intelligent Roadway/Rail Interface (IR/RIS) to collect monthly train traffic levels. These counts have confirmed that train traffic has not grown at the anticipated rate; however, current economic conditions certainly affect the growth, or lack of growth in rail and highway traffic.
**Highway Traffic**

Highway traffic levels are also expected to climb in the San Gabriel Valley. The Valley is the heart of regional distribution for Southern California, with major rail intermodal yards, extensive warehousing and truck terminal operations, a large cargo operation at Ontario Airport, and with the Ports to the southwest. Residential development is continuing to take place and additional suburban employment centers are developing. As a result, aggregate growth between 1994 and 2020 is expected to increase by 15 to 60% or more. Even more so than the rail traffic, year-to-year growth is dependent upon local economic conditions.

**Assessment of Impacts**

In order to assess the impact of combined traffic increases both on the rail mode as well as the highway mode, a comprehensive, rational impact assessment process was utilized to evaluate the following four key operational parameters for each grade crossing:

- **Crossing Gate Blockage Time** – The total amount of gate down time due to rail operations including “warning time” prior to activation of the grade crossing gear, the time to lower the crossing gates, the train passage time required for the train to cross the roadway centerline, plus the clearance time required for the train to cross the roadway right-of-way and the lag time for the gates to raise after the train has departed the “island circuit” controlling the crossing gates.

- **Vehicular Delay** – The impact on vehicular traffic flow due to the number and type of cars and trucks approaching the crossing, the delay while stopped and the delays encountered during deceleration and acceleration.

- **Crossing Spillback Queue vs. Available Storage** – The crossing spillback queue is the queue which develops from the lowered crossing gate; if this queue extends back to an upstream principal intersection, traffic disruption to both cross-street traffic as well as parallel roadway traffic may result.
• Crossing Influence Zone Queue vs. Available Storage – The influence zone queue is the queue of vehicles from and nearest signalized intersection towards the grade crossing. In accordance with the Millennium Edition of the Manual of Uniform Traffic Control Devices, engineering study is recommended to determine whether the influence zone extends beyond the nominal “200 foot” criteria formerly used as a “rule of thumb” – In the event the grade crossing falls within the influence zone, pre-emption or other countermeasures should be considered even if the signal is located beyond the nominal “200 foot” distance indicated in the MUTCD.

The vehicular delays were developed using the following equation:

$$D = \frac{T_g^2 \cdot q}{120 \cdot (1 - q/d)}$$

**Where:**

- $D$ = Delay (vehicle-hours)
- $T_g$ = Gate Blockage Time (minutes)
- $q$ = Vehicle Arrival Rate (vehicles/minute)
- $d$ = Vehicle Departure Rate (vehicle/minute)

Using the maximum crossing blocking times computed for ordinary train movements (e.g. excluding parked trains or switching), the queuing was computed using the following equation:

$$N = q \cdot T$$

**Where:**

- $N$ = Number of Vehicles in Queue
- $q$ = Vehicle Arrival Rate (vehicles/minute)
T = Tg – Gate Blockage Time (minutes) – for Gate Spillback Queue

Tr – Red Signal Time (minutes) – for Influence Zone Queue

As noted above, for the gate spillback queue, the crossing blocking time was evaluated and for the influence zone queue, the estimated average red time at the downstream traffic signal was evaluated. The queues were then compared to the available storage lengths with appropriate adjustments for the number of lanes to determine whether the projected queue would exceed the available storage. Field review was used to identify other factors contributing to queuing, such as adverse impacts from more highly-congested traffic signals further downstream.

Projected Impacts

The impact assessment was conducted for all grade crossings along the Alhambra and Los Angeles Subdivisions in Los Angeles County as well as a portion of San Bernardino County between the Los Angeles County line and the point west of Ontario Airport where the two mains diverge. There are 66 grade crossings at some 55 different cross streets due to the fact that the mains from both subdivisions have shared crossings in Pomona, Montclair and Ontario the location where the two rail main lines diverge at Ontario Airport.

The projected impacts of the increases in rail and highway traffic indicated very large increases in mobility impacts could be expected as a result of higher levels of traffic and train movements:

- Crossing Blocking (Table 1) – Whereas 68% of the grade crossings would be in the “low” impact category with the remaining 32% in the “moderate” blocking time category in 1994, by the Year 2020 conditions would be reversed with nearly 20% of the crossings in the “very high” category and additional 29% in the “high” category.

- Vehicular Delay (Table 2) – Whereas more than 90% of the crossings studied were evaluated in the “low” delay category for existing conditions, by Year 2020, about 26% of the crossings would be operating with

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1 The influence zone equation is a simplified form of Webster’s equation valid for low to moderate levels of congestion; it assumes random arrivals, which is correct for most of the San Gabriel Valley grade crossings.
“high” vehicular delay levels, 29% in the “moderate” category and only 45% remaining in the “low” category.

- **Aggregate Delay** – An aggregate measure of delay was also developed for the entire corridor. This metric indicated that 621 daily vehicle-hours of delay under existing conditions would increase about 300% to nearly 1,800 vehicle-hours of delay by Year 2020.

- **Gate Queue Spillback** – With significant increases in traffic predicted, crossing gate spillback queues exceeding storage identified at 24 locations in 1994 and was projected to increase to 26 locations by Year 2020. Given these results, additional analysis was conducted to capture secondary delay and air quality impacts to traffic passing through traffic signals impacted by gate queue spillback.

- **Influence Zone Queue** – Possible queuing from adjacent traffic signals back across the railroad tracks was zone storage concerns were identified at 18 of the 55 study cross streets for 1994, and forecast projected to increase to 22 locations by Year 2020. Similarly, crossing gate spillback queues exceeding storage were estimated at 24 locations in 1994 and were projected to increase to 26 locations by Year 2020.

**Grade Separations**

As noted, mobility considerations were the principal factor. A literature search was conducted to identify criteria for grade separation, which indicated a variety of considerations for grade separation but few standards. The literature search identified the following considerations:

- **Safety** – The California Public Utilities Commission regulations indicate safety as the key criterion for grade separation, to be accomplished “wherever practicable” in the event significant safety concerns cannot be addressed by other means. However, the crash data assembled for the San Gabriel Valley grade crossings showed relatively low crash rates with very few and infrequent fatalities at the crossings.
• Economic – Classic cost-benefit analysis could be conducted to evaluate the value of the vehicle-hours of delay eliminated with grade separation vs. the cost of a separation. However, at this point in the study, no conceptual designs were available to indicate the possible cost of separation. More importantly, since most of the highest-volume principal arterials and highways already had grade separations, it was unclear whether provision of separations on the remaining roadways would strictly show a positive cost-benefit.

• Mobility – Some of the sources reviewed indicated a “rule of thumb” of 40 to 50 vehicle hours of delay per day as being a threshold for separation. A technical committee of the Institute of Transportation Engineers has prepared an Informational Report for rail transit grade crossings, which has criteria for identifying conditions under which at-grade operation is inadvisable due to traffic impact.\(^2\)

Based upon the above concerns, it was decided to use the “rule of thumb” vehicle hours of delay criteria in conjunction with the ITE criteria, modified to take into account the duration of gate blockage associated with mainline freight railroad operation, resulting in the following two grade separation thresholds:

1. **Total Vehicular Delay Exceeding 40 Vehicle Hours**

2. **Combination of Gate Blockage Time and Traffic Density** (see table below):

\(^2\) Refer to the ITE Committee 6A-42, Light Rail Transit Grade Separation Guidelines, March 1992.
### Rail Operations vs Roadway Traffic Level

<table>
<thead>
<tr>
<th>Hourly Gate Blockage (mins)</th>
<th>Hourly Volume (veh/lane)</th>
<th>V/C Ratio</th>
<th>Level of Service</th>
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<tbody>
<tr>
<td>15</td>
<td>575</td>
<td>.85</td>
<td>D</td>
</tr>
<tr>
<td>14</td>
<td>610</td>
<td>.9</td>
<td>D/E</td>
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<tr>
<td>13</td>
<td>640</td>
<td>.95</td>
<td>E</td>
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<tr>
<td>12</td>
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<td>1.0</td>
<td>E/F</td>
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### Improvements Program

Projects that met the above thresholds were assembled into a phased improvements program. Key elements of the framework included:

1. Designation of a high-priority, near term safety and operational improvements for crossings to remain at grade – this has been called the “Jump Start” by The ACE Project;

2. Efforts were made to separate out a geographically diverse set of individual grade separation projects which could proceed independently subject to securing near-term funding;

3. High-cost projects that would raise or lower the track grade through multiple crossings were moved to the later years of the program.
One of the early-on issues that was addressed was consideration for consolidation of the two main lines: Given the fact that each of the two existing subdivisions in the ACE Project area include substantial section of single track line with passing sidings, a minimum of three tracks would be needed to consolidate operations along one of the two San Gabriel corridors. However, development of a three-track railway within the existing rights-of-way would be difficult and costly given the presence of supplemental industry sidings and the need to make grades conform at the edge of the right-of-way. As a result, the Grade Crossing Study and the ACE Project are proceeding with the expectation that there will continue to be two principal rail lines through the Valley for the foreseeable future. The Union Pacific is however, demanding that capability for additional tracks at the new separation locations.

Application of these principles lead to the development of the following $950-million improvements program indicated on the following page:
# PROGRAM OF IMPROVEMENTS

As Identified in 1996 San Gabriel Valley Grade Crossing Study

<table>
<thead>
<tr>
<th>Description</th>
<th>Item Cost (Millions)</th>
<th>Total Cost (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>JUMP START</strong></td>
<td></td>
<td></td>
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<tr>
<td>Corridor Safety Upgrade</td>
<td>30</td>
<td></td>
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<tr>
<td>Traffic Signal Control Measures</td>
<td>31</td>
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<tr>
<td><strong>Subtotal: JUMP START</strong></td>
<td><strong>61</strong></td>
<td></td>
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<tr>
<td><strong>NEAR TERM</strong></td>
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<tr>
<td>Roadway Widening (9 locations)</td>
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<td></td>
</tr>
<tr>
<td>Fairway Drive/UP, LA County, Roadway Underpass</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Nogales Street/UP, LA County, Roadway Underpass</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Ramona Boulevard/SP, El Monte, Roadway Underpass</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Temple Avenue/SP, Pomona, Roadway Underpass</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Fullerton Road - Fairway Drive/SP, Industry, Elevated Track</td>
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<td></td>
</tr>
<tr>
<td>7th Avenue/UP, Industry, Roadway Underpass</td>
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</tr>
<tr>
<td><strong>Subtotal: NEAR TERM</strong></td>
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<td><strong>INTERMEDIATE</strong></td>
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<tr>
<td>Roadway Widening (5 locations)</td>
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</tr>
<tr>
<td>Baldwin Avenue/SP, El Monte, Roadway Underpass</td>
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<tr>
<td>East End Avenue/SP/UP, Pomona, Roadway Underpass</td>
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<td>Montebello Boulevard/UP, Montebello, Depressed Track</td>
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<tr>
<td>Ramona St-San Gabriel Bl/SP, San Gabriel, Depressed Track</td>
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<tr>
<td><strong>Subtotal: INTERMEDIATE</strong></td>
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<td></td>
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<tr>
<td><strong>LONG TERM</strong></td>
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<td></td>
</tr>
<tr>
<td>Roadway Widening (3 locations)</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Brea Canyon Road/UP, Industry, Roadway Underpass</td>
<td>27</td>
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<tr>
<td>Reservoir Street/SP/UP, Pomona, Roadway Underpass</td>
<td>29</td>
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<tr>
<td>Rose Hills Road/UP, Industry, Roadway Underpass</td>
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<tr>
<td>Turnbull Canyon Road/UP, Industry, Roadway Underpass</td>
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<tr>
<td>Valley Boulevard/SP, Los Angeles, Roadway Overhead</td>
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<tr>
<td>Vineland Ave-California Ave/SP, Industry, Elevated Track</td>
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<td><strong>Subtotal: LONG TERM</strong></td>
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</tr>
<tr>
<td><strong>GRAND TOTAL</strong></td>
<td></td>
<td><strong>950</strong></td>
</tr>
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</table>
THE ALAMEDA CORRIDOR – EAST (ACE) CONSTRUCTION AUTHORITY

Extensive efforts were undertaken to fund the program. This included obtaining consensus from the 26 member cities in the SGVCLOG to pursue outside funding for the program and initiation of efforts to assemble funding commitments. Short-term accomplishments lead to the assembly of nearly $400-million in funding for the program. SGVCLOG formed a wholly owned subsidiary, the Alameda Corridor – East (ACE) Construction Authority, to manage the program.

The ACE Construction Authority initiated efforts to refine and deliver the program. One of the first activities was to refine the “Jump Start Safety” category of improvements. A design criterion was developed to guide the selection of safety improvements for those crossings, which were to remain at grade. Diagnostic field reviews were accomplished involving the California Public Utilities Commission (CPUC), the Union Pacific Railroad (which at the time of the formation of the ACE Project had taken over the former Southern Pacific main line), and involved local transportation and public works officials.

Jump Start Safety Program

The ACE Jump Start Safety design criteria included the following key considerations:

1. Provide Consistent Treatment for Similar Conditions – Applicable to all standard devices as required under MUTCD

2. Verify Length of “Influence Zone” – To define appropriate pre-emption requirements; utilize active signing and “pre-signals” or “queue cutters” to control predicted or observed queuing across grade crossings

3. Constant Warning Time – Upgrade grade crossing “predictors” to provide constant warning time to minimize likelihood of gate drive-around events and increase motorist respect for grade crossing control activations
4. Supplemental Lanes / Roadway Widening – Where possible, widen crossing areas and/or provide supplemental lanes to control traffic near grade crossings

5. Medians – Where possible, provide medians, preferably raised, to reduce gate drive-around activity

6. Four Quadrant Gates – At locations where switching and gate drive-around activity has been observed, provide four quadrant gates to preclude gate drive around (applicable to crossings in City of Pomona)

7. Pedestrian Accommodation – The Union Pacific Railroad installed additional grade crossing panels to provide a pedestrian walkway across the crossings and ACE constructed sidewalk connections at numerous locations where pedestrian activity levels were significant

Traffic Signalization Measures

The other element of the Jump Start program consisted of an advanced traffic control system. Designated as the Intelligent Roadway/Rail Interface System (IR/RIS), the improvements are being developed as part of a Demonstration Program in the City of Pomona. Pomona was selected due to the fact that it has a grid street system with three existing grade separations, two programmed future grade separations, and five streets to remain at grade for the foreseeable future. The IR/RIS Demonstration Project includes the following provisions:

- Remote Wayside Detection – Magnetometers buried alongside the track as far as five miles (8 km) from Pomona will provide five minutes or more advance notice of the speed and location of approaching trains

- Train Predictor Software – The wayside detection units are connected by spread spectrum radio to a control center which analyzes the approaching train data to determine predicted occupancy of the Pomona grade crossings

- Dynamic Message Signs – Roadway message signs will alert motorists to impending grade crossing delays; in the event switching activity, slow moving long trains, or parked trains are detected, detours will be advised
• Traffic Responsive Signal Control Software – Traffic responsive software will implement alternative traffic management strategies depending upon the circumstance; capabilities will include modification of background traffic signal timing plans as well as responding to modified traffic conditions due to diverted traffic.

Grade Separation Projects

ACE has continued to refine the grade separation projects. Examples include:

• A costly multiple-crossing concept along Valley Boulevard in the City of Industry has been refined to provide a single separation at the most heavily-traveled crossing with closure of an adjacent crossing, resulting in reduced cost and accelerated project delivery.

• A difficult and costly grade separation at Temple Avenue near California Polytechnic University, Pomona, has been reconfigured as a main line track relocation, which will result in closure of two crossings and construction of additional multi-track main line. This project will also allow Union Pacific to shunt trains to and from the Chino Branch line with reduced impact to the remaining at grade crossings in Pomona.

CURRENT STATUS

Since its inception, ACE has the following accomplishments to its credit:

• Secured $395 million in Federal, State and local funding

• Initiated master and standard form agreements with UPRR

• Obtained cooperative agreements with 12 different agencies

• 7 grade separations and 1 train diversion in final design
• August, 2002 groundbreaking for first separation; June, 2003 groundbreaking for second separation

• Design completed on all 38 safety projects; construction complete on 4 out of 5 construction packages

• ITS application train detection technology proved out; proceeding with full install of Demonstration Project

Examples of completed Jump Start improvements include the pre signal at the Fairway / Valley Boulevard / Alhambra Subdivision grade crossing (see Figure 3), the reconstruction of the Walnut Grove grade crossing to provide sidewalks and median channelization (see Figure 4).

Figure 5 shows the design concept plan for four quadrant gates at the Hamilton Avenue / North First Street grade crossing, a three-track crossing of both the Alhambra and Los Angeles Subdivisions.

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Figure 4
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Sidewalk and Median Improvements
Figure 5
Four Quadrant Gate
Design Concept Plan – Hamilton at First Street, Pomona
Figure 6
Intelligent Roadway / Rail Interface System (IR/RIS)
Conceptual Architecture
<table>
<thead>
<tr>
<th>Year</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>Very High</th>
</tr>
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<td>1994</td>
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<td>17</td>
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<td>26%</td>
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<td>2020</td>
<td>12</td>
<td>22</td>
<td>19</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>18%</td>
<td>33%</td>
<td>29%</td>
<td>20%</td>
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</table>

Scale: “Low” – 0 to 5% blockage; “Moderate” – 5% to 7.5% blockage; “High” – 7.5% to 10% blockage; and “Very High” – more than 10% blockage
Table 2
Daily Total Vehicle Delay
Number of Crossings by Delay Level

<table>
<thead>
<tr>
<th>Year</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
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</thead>
<tbody>
<tr>
<td>1994</td>
<td>61</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>92%</td>
<td>6%</td>
<td>2%</td>
</tr>
<tr>
<td>2010</td>
<td>41</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>62%</td>
<td>27%</td>
<td>11%</td>
</tr>
<tr>
<td>2020</td>
<td>30</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>45%</td>
<td>29%</td>
<td>26%</td>
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Scale: “Low” – up to 20 vehicle-hours of delay; “Moderate” – 20 to 40 vehicle-hours of delay; “High” – more than 40 vehicle hours of delay.