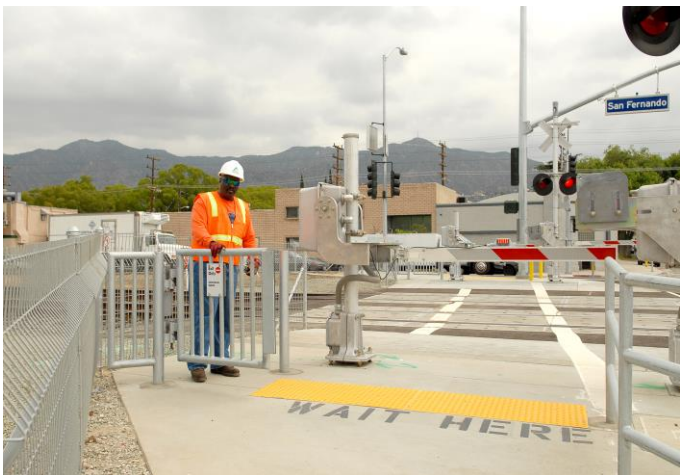




METROLINK



SCRRA HIGHWAY–RAIL GRADE CROSSINGS

RECOMMENDED DESIGN PRACTICES AND STANDARDS MANUAL

JUNE 30, 2009



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1.0 INTRODUCTION

1.1 BACKGROUND

SCRRA (aka Metrolink) is a five-county joint powers authority, created pursuant to California Public Utilities Code Section 130255 and California Government Code Section 6500 et seq., to plan, design, construct, and then maintain and administer the operation of the regional passenger rail lines serving the counties of Los Angeles, Orange, Riverside, San Bernardino, and Ventura.

The five-county SCRRA member agencies are comprised of the following: Los Angeles County Metropolitan Transportation Authority (“METRO”); Ventura County Transportation Commission (“VCTC”); Orange County Transportation Authority (“OCTA”); San Bernardino Associated Governments (“SANBAG”); and Riverside County Transportation Commission (“RCTC”). SCRRA plans, designs, builds, operates, and maintains a commuter rail system in the five-county area on rail rights-of-way owned by the member agencies. Two major freight rail carriers, BNSF and UPRR, and the inter-city passenger carrier Amtrak, operate on SCRRA tracks through shared track agreements; SCRRA in turn operates on tracks owned by BNSF, UPRR, and North County Transit District (NCTD).

SCRRA’s service territory is located in the Southern California metropolitan region. The operating environment can be typically categorized as urban and suburban, with some limited rural or undeveloped regions. SCRRA trains operate over 464 highway-rail grade crossings; of these, SCRRA is jointly responsible, with the applicable highway agency, for managing the design, construction, operation, and maintenance of over 312 highway-rail grade and pedestrian-rail grade crossings.

Changes and modifications to SCRRA’s existing and any proposed new highway-rail grade crossings are subject to the regulations and approval of the California Public Utilities Commission (CPUC) and also certain provisions of Federal Railroad Administration (FRA) regulations. Most SCRRA highway-rail grade crossings are operated under relatively dense (> 50 daily) mixed commuter, freight, and inter-city passenger train traffic, with relatively high levels of motor vehicle, pedestrian, and bicycle traffic.

A large proportion of SCRRA highway-rail grade crossings feature multiple tracks and vehicle lanes. Table 1-1 summarizes the categories of highway-rail grade crossings over which SCRRA operates. (More detailed information regarding the characteristics of SCRRA’s service patterns and service territory are provided in Appendix A).



TABLE 1-1 Summary of SCRRRA Highway-Rail Grade Crossings

Crossing Type	Owner and/or Operator/Maintenance Responsibility			
	Metrolink	BNSF	UPRR	NCTD
Public Highway	255	64	66	3
Public Pedestrian	10	2	0	0
Private Highway	29	1	5	0
Private Pedestrian	0	0	0	0
Station Pedestrian	18	3	8	0
Total	312	70	79	3

1.2 PURPOSE AND USE OF THE MANUAL

The large number of SCRRRA highway-rail grade crossings, combined with high and increasing levels of train, motorized vehicle, and pedestrian traffic, has driven the need for SCRRRA to develop a new, comprehensive single document that incorporates current and applicable highway-rail and pedestrian-rail grade crossing design standards and recommended design practices. This document has been titled the “SCRRRA Highway-Rail Grade Crossing Recommended Design Practices and Standards Manual”, or the “Manual” for short. This new Manual addresses many of the unique and complex planning, design, construction, maintenance and operational challenges associated with highway–rail grade crossings located on the SCRRRA’s Regional commuter rail network.

In this Manual, the term “highway-rail grade crossing” shall have the same meaning as rail-grade crossing, rail crossing, at-grade crossings, or crossing. The term “highway” will be used to mean roadway, road, street, or approach road, including medians, lighting, fencing, landscaping, sidewalks, traffic signs, traffic signals, traffic striping and all other highway improvements. The term “highway agency” shall mean the owner or owners of the highway including the property, easements, licenses, and all highway improvements. The “highway agency” will typically be a local municipality (a City), a County, the State, or in the case of a private crossing, a private party. The term “railroad” shall mean the SCRRRA.

One challenging aspect of highway-rail grade crossing design, particularly in urban metropolitan areas, is that highway-rail grade crossings must typically be designed to allow for the safe and efficient mobility of three entirely different and conflicting modes of mobility: 1) the train; 2) the motor vehicle; and 3) non-motor vehicle pedestrians and bicycles. Adding to the uniqueness and complexity associated with highway-rail grade crossings is that the jurisdiction for the planning, design, maintenance and operations of highway-rail grade crossings is jointly controlled by at least two, and in some cases as many as four or five, owner/operators, and many other stakeholders.

Another contributing factor of complexity is that most SCRRRA highway-rail grade crossings have experienced significant train, motor vehicle and pedestrian traffic growth, especially in the last two decades, and have high levels of traffic for all modes. National and regional Southern California studies have indicated that the combined vehicle and train use of most highway-rail grade crossings has increased by a factor of 2.5 over the past two decades, and this growth is anticipated to continue.



A final factor contributing to the challenges associated with operating highway-rail grade crossings is that a significant number of highway-rail grade crossings, as well as highway and pedestrian approaches, are due, or will soon be due, for a cycle of major rehabilitation and renewal (R&R). These R&R programs typically occur every 15 to 30 years and keep highway-rail grade crossings current with traffic growth, design practices, technological improvements, and changes in regulations. For all the reasons stated above, a new and improved Manual was developed.

The primary purpose of the new Manual is to educate its user on the improved guidelines, practices, procedures, and policies that reflect current regulations, proven and accepted technological developments, and best available highway and rail industry design practices. Secondly, the Manual user will apply these standards and recommended design practices to SCRRA highway-rail grade crossings.

Applying the standards and recommend design practices in this Manual will enhance the safety and efficiency of the highway-rail grade crossing and result in a highway-rail crossing that reflects “best practices” on a national basis. However, when considering the standards and recommended design practices in this Manual, any design team must exercise sound judgment and take into consideration the particular and unique conditions that may exist at a location.

For example (and as stated above), many highway-rail grade crossings and the associated highway and pedestrian approaches have not been significantly rehabilitated or renewed for two or three decades and often include design, right-of-way and operational characteristics that have evolved over several years. Such highway-rail crossings and approaches may not conform fully to current practices and standards as a result. This new Manual provides general guidance on how to enhance the safety and operations of a highway-rail grade crossing, in a relatively cost-effective manner and with minimal right-of-way impact, while providing a design team the flexibility necessary to meet site-specific and special “legacy” circumstances found at many crossings.

The new Manual will be used when significant changes and modifications are proposed to the 300-plus existing SCRRA highway-rail and pedestrian grade crossings and the approaches thereto. Another application of this Manual may arise when new SCRRA service is proposed and changes and modifications to existing highway-rail grade crossings may be warranted. Examples of new SCRRA service include start-up of commuter rail service on the Perris Valley Line or Redlands Branch.

A less frequent application of the Manual will occur when temporary (12 to 36 month) or permanent relocations are required of existing SCRRA highway-rail grade crossings. These relocations are most often associated with the construction of a new grade separation, railroad line change, or other similar major construction project. A very infrequent use anticipated for this Manual would be for any new highway-rail grade crossings. Any new highway-rail grade crossings are strongly discouraged by not only the SCRRA but by the CPUC and FRA and other State and Federal Agencies. New crossings typically require the closure of one or more nearby existing highway-rail grade crossings (refer to Section 1.3).

In conjunction with developing this Manual and compiling “recommended design practices and standards”, a thorough review was made of current standards, manuals, regulations, handbooks and other documents available from other highway agencies and



private sector railroads. A nation-wide literature search was made of highway-rail grade crossing design practices, and site inspections were conducted of public agency and private railroads in both Southern and Northern California and on several large Northeastern Commuter Railroads to determine “best design practices and standards” and application of new but proven technologies.

The costs of implementing the safety enhancements included within this Manual may be 50% to 100% higher than the Manual user has experienced in past grade highway-rail grade crossing improvement project and programs. The significant increase in costs may be due, in part, to the long time span since the last significant highway-rail grade crossing and highway approach improvement project was performed and the resulting backlog of required changes. The application of more costly and complex recommended design practices and new technologies such as exit gates and advanced preemption also contribute to increased costs.

A recent Orange County program involving nearly 50 highway-rail grade crossings resulted in costs ranging from an average of \$1.5 million to \$2.5 million per crossing. In some cases numerous minor right-of-way acquisitions (sliver or small takes less than 1,000 square feet) were also required.

Typical safety enhancements in the Orange County Program included: extended and widened center medians; improved sidewalks; improved highway approach geometry; four-quadrant pedestrian gates and flashers; exit gates; pre-signals; queue-cutter signals; vehicle traffic signal system interconnections with simultaneous and advanced preemption; and reconstructed and lengthened highway-rail grade crossing surfaces.

In addition to meeting or exceeding the recommended design practices and standards in an interim version of this Manual, the Orange County program included an option to allow local cities to apply for the crossings to be converted to a “quiet zone”, but only after all the interim Manual’s recommendations had been included in the program and placed in-service, and the relevant Federal Quiet Zone application and approval process had been completed.

1.3 MANUAL LIMITATIONS AND DISCLAIMERS

This Manual is not a textbook, nor a substitute for engineering knowledge, experience, or judgment. This Manual provides specialized guidelines, standard drawings, recommended design practices, procedures, and policies including graphs, tables, flowcharts, and associated “design aids” not ordinarily contained in many reference documents or textbooks. Some of these “design aids” are provided to facilitate solutions to a particular aspect of highway-rail grade crossing design. Sound judgment by experienced highway-rail grade crossing engineers and designers working as part of a multi-disciplinary and multi-agency design team must be exercised in the application of the Manual provisions to specific circumstances.

This Manual summarizes and outlines guidelines, recommended design practices and standards, procedures, and policies that have been developed to increase highway-rail grade crossing safety through treatments that generally reduce hazards and risks, while still maintaining sufficient functionality for the motorized vehicle, non-motorized pedestrian and bicycle, and train operations. These recommended design practices and standards have been adopted to facilitate and promote uniformity and consistency to the



design of SCRRRA highway-rail grade crossing modifications. SCRRRA assumes no liability for the use of information contained in this Manual. It is not intended that any standard of conduct or duty toward the public shall be created or imposed by the use of the Manual. SCRRRA does not warrant the accuracy or completeness of this Manual or that the Manual does not contain errors and omissions. The Manual user shall independently validate and verify the information in the Manual and promptly notify SCRRRA of any discrepancies or inconsistencies discovered in the course of utilizing this Manual.

Except for new developments, no attempt is made to detail basic engineering techniques; for these, existing design manuals (as provided in the Reference Standards list) and applicable engineering textbooks should be used. For routine design processes and procedures, the Manual's recommended design practices and standards should be intuitive. The contents of this Manual do not preclude use of different methods when special or highly atypical conditions arise, and when approval (through the design exception process) is requested and approved. In any event, all highway-rail grade crossing designs under the jurisdiction of SCRRRA must be approved by SCRRRA as well as the local highway agency owner of the highway-rail grade crossing and highway approaches. Additionally, all highway-rail grade crossing designs must comply with all applicable CPUC, FRA, and Manual on Uniform Traffic Control Devices (MUTCD) regulatory requirements.

It is not intended that all the recommended design practices and standards included in this Manual be applied retroactively to minor physical or operational changes or to routine maintenance upgrades to existing crossings and highway approaches, as this would not be warranted or economically feasible.

It is intended that the recommended design practices and standards in this Manual be applied when significant physical or operational changes have occurred or are proposed, applicable regulatory approval has been received, realistic scopes and estimates have been developed, the required funding has been obtained, and there is an agreement on the scope, cost, schedule, responsibility and delivery of the proposed changes with the principal highway-rail grade crossing stakeholders.

In most cases, the primary responsibility for funding highway-rail grade crossing safety and operational changes does not reside with the SCRRRA, but with the highway agency that owns and maintains the approach highways and pedestrian paths. In many cases, grade crossing safety enhancements are funded by applicable State and Federal grants funding. The SCRRRA or SCRRRA member agencies may elect to participate in funding improvements for a highway-rail grade crossing on a case-by-case basis or as part of a corridor-wide program.

The designs applied to any proposed highway-rail grade crossing modification or new highway-rail grade crossing should, to the maximum extent feasible, equal or exceed the recommended design practices and standards provided in the Manual. When considering changes and modifications to existing highway-rail grade crossings or if a new grade highway-rail grade crossing is proposed, the highest priority should be given first to treatments resulting in safety improvements and hazard reduction. After safety enhancements and hazard reductions are prioritized, appropriate consideration should then be equally given to: 1) availability of funding; 2) project costs—both the initial and the recurring operation and maintenance costs; 3) vehicular/pedestrian and train



throughput, capacity, and operation; 4) short, mid-term, and long term maintenance impacts; 5) socio-economic and environmental impacts, especially those associated with noise (primarily locomotive horn blowing, but also warning bells) and the implementation of “quiet zones” by local highway agencies; and 6) right-of-way acquisitions.

In some cases, the recommended design practices and standards are subject to amendment as conditions and experience seems to warrant. Special situations may call for variation from the recommended design practices, standards, policies and procedures, subject to SCRRRA and CPUC or FRA approval, or such other approval as may be specifically provided for in the Manual. A process for requesting deviations from the recommended design practices and standards has been provided.

SCRRRA advises the user to completely review the entire Manual and develop a thorough level of understanding prior to beginning a project or study involving the design, assessment, or diagnostic evaluation of a SCRRRA highway-rail grade crossing.

Due to the complexity of intersecting train, vehicle, and pedestrian traffic, combined with relatively high traffic and train volumes and the multi-jurisdictional ownership associated with most SCRRRA highway-rail grade crossings, SCRRRA strongly recommends a “lead Engineer” or “lead Designer” be designated and placed in “responsible charge” of the inter-disciplinary team involved with any highway-rail grade crossing modification. The lead Engineer shall be a registered California Civil or Traffic Engineer, and have at least five (5) years of recent experience associated with California highway-rail grade crossings.

Ideally, the lead Engineer or Designer, supported by the interdisciplinary and inter-agency design team, should have a good understanding of, and significant experience with, all aspects of the design, construction, operation, and maintenance of highways and streets, traffic signals, railroad track, and railroad active warning devices, as well as being very familiar with applicable CPUC, MUTCD and FRA regulations. Additionally, the lead Engineer’s or Designer’s experience should include significant exposure to the diagnostic processes, safety certification and hazard analyses, inter-disciplinary track and highway geometric design, and rail and traffic signal system design.

1.4 SYSTEM SAFETY PROGRAM PLAN AND SCRRRA GENERAL POLICIES

The Manual supports the goals and objectives included within SCRRRA System Safety Program Plan (SSPP). The goal of the SCRRRA SSPP is the facilitation of a safe work environment through the integration of Standard Operating Procedures (SOPs), System Safety Standards (such as this Manual) and FRA/APTA (American Public Transportation Association) Audit recommendations. Consideration will be given to incorporating critical safety elements of this Manual into the SOP’s within the SSPP.

SCRRRA Board Resolutions 91-3 and 98-21 in Appendix H provide SCRRRA’s high level Board Policies with regard to high-rail grade crossings. Aside from section and paragraph headings and table and figure descriptions within the Manual, SCRRRA general policy statements supporting the intent of Board Resolutions appear as *italicized dark blue* text. Although these are not recommended design practices and standards, as defined in the following paragraph, they are policies the lead Engineer should endeavor to adhere to during the design of highway-rail and pedestrian-rail grade crossings.



1.5 ESSENTIAL DESIGN PRACTICES, STANDARDS, AND DEVIATIONS

SCRRA intends to apply the recommended design practices and standards provided in this Manual when a significant physical change is proposed, or occurs, to an existing highway-rail grade crossing, including motor vehicle highway and non-motor vehicle pedestrian and bicycle approaches.

In addition, SCRRA will apply the recommended design practices and standards included in this Manual when a significant change in use is proposed, or occurs, to the highway-rail grade crossing; especially changes in use resulting in significant increases in vehicle, pedestrian, bicycle, and train traffic, or changes in traffic patterns.

Examples of changes in traffic patterns would include: the installation of a new left-turn lane near the highway-rail grade crossing approach; installation of new traffic signals on an adjacent intersection; or the opening of a new passenger rail station near an existing highway-rail grade crossing. It is not intended that the requirements in the Manual be applied retroactively to existing highway-rail grade crossings absent any proposed major physical or use changes, nor should they in the absence of an appropriate level of funding.

Recommended design practices and standards identified in the Manual, and listed in Table 1-2, are those considered most essential to enhancing and reducing the hazards at highway-rail grade crossings. Aside from section and paragraph headings, and table and figure descriptions, these **essential recommended design practices, standards, and policies** are called out in the Manual in **Boldface** type.

Deviations from the recommended design practices and standards listed in this Manual will require the approval of the SCRRA Director of Engineering and Construction, or a Change Review Committee, designated by the Director. The Change Review committee will typically include a cross section of senior managers representing the SCRRA Civil, Signal, Safety and Rail Crossings groups.

The current procedure for requesting a deviation from the Manual is to prepare and then request the necessary approvals by completing the SCRRA Design Exception form. This form is included in the Manual as Appendix F. The request should be signed and sealed by a registered engineer, preferably the lead Engineer for the highway-rail grade crossing design.



Table 1-2. SCRRA Essential Design Practices, Standards and Policies

Section	List of Essential Design Practices, Standards and Policies
2.5.1	Maintenance costs for exit gate systems, if used solely for establishing a quiet zone, shall be addressed in the C&M Agreement and shall not be funded by the SCRRA.
3.1.2	All private highway-rail grade crossings shall be subject to the recommended design practices and standards included in the Manual and applied to permanent highway-rail grade crossings.
3.1.4	Relocated or temporary highway-rail grade crossings shall be subject to the recommended design practices and standards included this Manual and applied to permanent highway-rail grade crossings.
3.2	Modifications of all highway-rail grade crossings or proposals for new highway-rail grade crossings shall be subject to the CPUC approval process.
3.5.1	Active warning devices shall be installed 15 feet from the centerline of the track, as measured from the center of the mast, at new or existing highway-rail grade crossings. A design deviation may be requested for active warning devices installed less than 15 feet; in no case shall an active warning device be installed less than 12 feet from the centerline of the track.
3.5.2	For skewed crossings, highway active warning devices shall be installed perpendicular to the highway 15 feet from the centerline of the track, as measured from the tip of the gate. If the geometry of the highway-rail grade crossing precludes installing the gates at 15 feet, then a design deviation may be requested to place the device closer to the crossing, but in no case less than 12 feet.
3.5.2	When a right-angle highway-rail grade crossing cannot be achieved due to physical constraints, the interior angle shall be designed as close to 90 degrees as practical, but shall not be less than 75 degrees.
3.5.4	The AASHTO WB-65 semi-tractor-trailer shall be used as the highway-rail grade crossing and grade crossing approach highway “design vehicle” for horizontal highway geometry.
3.5.5	The horizontal and vertical geometry of the approach highways and adjacent intersections (immediately upstream and downstream of the highway-rail grade crossing) shall safely accommodate all anticipated traffic movements and required clearances of the highway “design vehicle”.
3.5.10	Vertical curves within the highway at a highway-rail grade crossing shall be avoided.
3.5.10	At multiple track highway-rail grade crossings, the tops of the rails for all tracks shall be in the same plane.
3.5.10	The highway vertical profile grade at lip of gutter pan should be 0% within 10 feet of the centerline of the nearest track and the grade can be increased to 1.11% up to 37.50 feet from the centerline of the nearest track. Beyond 37.50 feet from the centerline of the nearest track, the grade on the approach to the highway-rail grade crossing shall be minimized, with due respect for low-ground-clearance vehicles, to allow maximum acceleration by heavy trucks.
3.5.10	Highway-rail grade crossing vertical profiles shall be analyzed with the Low-Ground Clearance Vehicle template, to determine the clearance for this vehicle type. The Low-Ground Clearance vehicle template has a nominal six (6) inch ground clearance. Highway-rail grade crossings should provide a minimum clearance of three (3) inches between the street surface and the lowest point on the Low-Ground Clearance vehicle template.



3.5.10	In the event site conditions do not allow for the design to meet the Low-Ground Clearance vehicle template, a design exception may be requested to allow a W10-5 low-ground-clearance sign (as specified in the CA MUTCD) to be installed on each approach to the highway-rail grade crossing sufficiently in advance to allow the vehicles to turn around in advance of the highway-rail grade crossing.
3.5.13	If the railroad geometry and facilities in the vicinity of the highway-rail grade crossing do not meet current SCRRRA standards, or the railroad facilities are not in acceptable condition, the railroad should be reconstructed to correct any deficiencies.
3.5.16	Highway-rail grade crossings shall not be less than 24 feet wide and in addition shall be of a width not less than the traveled approach portions of the adjacent sections of the highway including usable shoulders, sidewalks, or pedestrian pathways.
3.5.16	A vehicle entering the footprint of the highway-rail grade crossing should have an unimpeded means of clearing the crossing.
3.6.1	Raised median islands shall be used on both approaches to the highway-rail grade crossing to constrain undesirable traffic movements, such as driving around the automatic crossing gates or making U-turns in the vicinity of the highway-rail grade crossing.
3.6.1	On each approach to the highway-rail grade crossing the raised median shall begin 10 feet from the centerline of the nearest track. The end of the median adjacent to the highway-rail grade crossing shall be square, with a six (6) inch radius on the corners.
3.6.2	The preferred minimum length of the median as measured from the highway-rail grade crossing gate shall be 100 feet. A design deviation may be requested where the 100 feet is unobtainable, but in no case shall the median be less than 60 feet. The width of the median shall be nine (9) feet if a warning device is installed in the median and four (4) feet if no warning device is installed in the median. The minimum width of the median may be two (2) feet with the approval of SCRRRA and the local highway agency. Raised median curbs shall be eight (8) inches.
3.6.3	Trees, shrubbery, and similar view obstructing landscaping are not allowed on highway approaches within 100 feet of a highway-rail grade crossing. Low maintenance stamped concrete, pavers, or other hardscape materials shall be the standard landscape treatment for median islands and sidewalk approaches.
3.7	Driveways (private or public) located within 100 feet of the nearest highway-rail grade crossing active warning gate are strongly discouraged. Driveways within 100 feet of highway-rail grade crossings shall be removed or appropriately reconfigured to achieve safety objectives.
3.7	Driveways adjacent to a highway-rail grade crossing which require vehicle reversing (backing) movements shall not be allowed and the local highway agency shall prohibit the reversing movements.
3.7	The design and actual usage of the driveway shall preclude the movement of vehicles over the tracks while ingressing or egressing the driveway.
3.7	Special traffic signage shall be installed to control undesirable traffic movements, especially reverse or slow movements into or out of driveways near tracks.
3.8	Sidewalks and pavement approaches to the highway-rail grade crossing shall be constructed using hot mix asphalt concrete between the zero curb line and the panels.
3.9	Vehicle parking within 100 feet of the highway-rail grade crossing, as measured from the furthest automatic warning device from the tracks, shall be prohibited.
3.12.2	For intersections within 100 feet of a highway-rail grade crossing with multiple main tracks, an exit gate shall be installed to prevent left turn movements accessing the track area.



3.13	Pedestrian crosswalks parallel and adjacent to highway-rail grade crossings are strongly discouraged.
3.15.4	During the preemption hold interval, the traffic signal indications shall prevent vehicles from moving toward the track area.
3.15.4	A blank-out, changeable message sign, appropriate highway signal indication, or other similar control shall be used to prohibit turning movements toward the highway-rail grade crossing during preemption.
3.15.5	In case there is an existing left-turn lane and it is not provided with a signal head equipped with protected left-turn arrow, the traffic signal shall be modified to provide a protected left-turn arrow, or a blank-out sign.
3.15.5	A left-turn lane pocket configuration extending across the tracks is not allowed.
3.15.6	The use of a Standard No. 9-A cantilever for a pre-signal is not allowed.
3.15.7	In all cases, pre-signal poles shall be positioned so as to maintain visibility of the railroad flashing lights.
3.15.8	The farside intersection signal heads shall be equipped with programmed-visibility heads or louvers to restrict visibility of the intersection signal displays to drivers at the pre-signal stop line.
3.15.14	Backup or standby power systems shall be required at all traffic signals interconnected with railroad signals.
3.16.4	Limited service shall be used for traffic signals interconnected to SCRRRA active warning devices.
3.16.5	The Los Angeles Department of Transportation “(LADOT) Railroad Preemption Worksheet” should be used to calculate the duration of the queue clearance interval.
4.1	Pedestrian treatments shall be installed at pedestrian grade crossings in accordance with the Pedestrian-Rail Grade Crossing Design Consideration Flowchart in Figure 4-2.
4.5	ADA must be incorporated into the overall design for pedestrian-rail grade crossings.
4.6	Pedestrian-rail grade crossing active warning devices shall be installed 15 feet from the centerline of the track, as measured from the center of the mast at new or existing crossings. A design deviation may be requested for active warning devices installed less than 15 feet, but in no case shall an active warning device be installed less than 12 feet from the centerline of track.
4.7.1	At stations, track centers shall be a minimum of 18 feet but not more than 25 feet to accommodate a center track fence.
4.10.3	Station pedestrian-rail grade crossings shall provide “full pedestrian treatments” (signage, channelization, active pedestrian warning devices with gates, and swing gates) and fencing, and shall not cross more than two (2) tracks.
4.10.3	Station pedestrian-rail grade crossings shall be installed approximately 60 feet from the ends of the station platform, and include full pedestrian treatments.
4.10.3	New pedestrian-rail grade crossings in the middle of platforms shall not be allowed.
4.10.4	New pedestrian-rail grade crossings shall not be allowed unless one or more existing pedestrian-rail or highway-rail grade crossings are closed.
4.11	“Full pedestrian treatments” shall include signage, markings, channelization, fencing, active warning devices with gates, and swing gates.
4.11	The process in Section 4.11 and Figure 4-2 shall be used to determine the designs of pedestrian-rail grade crossings and appropriate warning treatments.
8.3	LRT (Light Rail Transit) tracks located adjacent to SCRRRA highway-rail and pedestrian-rail grade crossings shall be analyzed as a joint system. If the combined number of SCRRRA and LRT tracks exceeds three (3), a grade separation shall be constructed.



8.6	The height of the fence within 150 feet of highway-rail grade crossings shall be four (4) feet. The height of the fence in the balance of the right-of-way shall be at least six (6) feet.
9.1	Highway agency and its contractors shall comply with the rules and regulations contained in the current editions of the SCRRRA documents during construction of the project.
9.4	When a highway-rail grade crossing exists either within, or in the vicinity of, a temporary traffic control zone, lane restrictions, flagging, or other operations shall not be performed in a manner that would cause vehicles to stop on the railroad tracks unless a law enforcement officer or qualified flagger is provided at the highway-rail grade crossing to minimize the possibility of vehicles stopping on the tracks.
10.1	Highway agency shall independently inspect the preempted traffic signals intersection a minimum of every three (3) months, and shall report the results of this inspection to SCRRRA.
10.2	The highway-rail grade crossings with preempted traffic signals shall be jointly inspected on a semi-annual basis.
10.3	Any changes to railroad or highway traffic conditions discovered during routine inspection and tests shall be reported to each party.



1.6 MANUAL CHANGES AND UPDATES AND THE MANUAL EFFECTIVE DATE

The various sections of the Manual, as dated in the lower right hand footer of each page, supersede all prior dated sections, Office Standards, Special Orders, and other directives relating to material covered. Revisions and updates to the Manual will be posted on the Metrolink website: Manual users shall be solely responsible for frequently checking for updates to ensure the latest version is being used when performing design or related work on SCRRA highway-rail grade crossings. The Manual is available on the SCRRA Website: www.metrolinktrains.com. The user shall ensure the latest version of the Manual, inclusive of any and all changes and updates, is being utilized. **The effective date of this Manual is June 30, 2009.**

1.7 SCRRA POLICY ON NEW HIGHWAY-RAIL GRADE CROSSINGS

The SCRRA Board (Board) has passed Resolution 91-3 and Resolution 98-21 pertaining to the establishment of a new highway-rail grade crossing on the SCRRA system. *SCRRA policy, in concert with State and National policy, strongly discourages the construction of new highway-rail grade crossings and seeks to reduce the number of active highway-rail grade crossing by promoting grade separation or closure of existing highway-rail grade crossings.* In accordance with Resolution 98-21, a new, additional highway-rail grade crossing is not allowed unless the member agency of SCRRA sponsors the request to construct it and the Board approves the request. This resolution also requires the member agency to sponsor the closure of existing highway-rail grade crossing(s) in order to open a new highway-rail grade crossing, so there will be no net increase in the number of highway-rail grade crossings on SCRRA's commuter rail system. These resolutions are attached as Appendix H. Any new highway-rail grade crossings shall be consistent with the recommended design practices and standards in this Manual and are subject to CPUC approval.

1.8 REFERENCE STANDARDS

The most current editions of the following standards, codes, specifications, and guidelines shall be consulted in the design of highway-rail grade crossings:

Primary References

- The California Manual on Uniform Traffic Control Devices (CA MUTCD), issued by the California Department of Transportation (Caltrans)
- California Public Utilities Commission General Orders (CPUC GO)
- California Public Utilities Code (PU Codes)
- Code of Federal Regulations (CFR), Title 23 and Title 49
- SCRRA Documents:
 - Design Criteria Manual (specifically, the Signal Design Criteria and Standard Drawings related to highway-rail grade crossings)
 - Design Procedures Manual
 - Landscape Design Guidelines
 - Form 36: Right-of-Way Encroachment Approval Procedures
 - Rails with Trails Guidelines



- Quiet Zone Implementation Guidelines and Procedures
- Track Maintenance and Engineering Instructions
- CADD Standards
- CADD Users Guide
- SCRRA Temporary Traffic Control Guidelines for Highway-Rail Grade Crossings
- Grade Separation Guidelines

Secondary References

- The Communications & Signals Manual issued by the American Railway Engineering and Maintenance of Way Association (AREMA).
- The Document for Railway Engineering issued by the American Railway Engineering and Maintenance of Way Association (AREMA).
- The Portfolio of Track Work Plans (companion volume to the Railway Engineering Manual), issued by the American Railway Engineering and Maintenance of Way Association (AREMA).
- Green Book Standard Specifications for Public Works Construction by the Green Book Committee, BNI Building News.
- Railroad-Highway Grade Crossing Handbook, U.S. Department of Transportation, Federal Highway Administration.
- The California Highway Design Manual published by the California Department of Transportation (Caltrans).
- Caltrans Standard Plans (current edition).
- A Policy on Geometric Design of Highways and Streets, published by the American Association of State Highway and Transportation Officials (AASHTO).
- Local jurisdictions' standards and design criteria for traffic signals.
- Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 4th edition, 2006 Interim, published by the American Association of State Highway and Transportation Officials (AASHTO).
- National Electrical Code.
- Preemption of Traffic Signals near Railroad Crossings, Institute of Transportation Engineers (ITE).
- Standard Plans for Public Works Construction, American Public Works Association.
- WATCH-Work Area Traffic Control Handbook.
- Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities (ADAAG).

Detailed drawings related to highway-rail grade crossings, pedestrian crossings and signal system automatic warning devices are included in SCRRA Engineering Standards. Highway-rail grade crossing drawings are included in Appendix J. These standards are not intended to replace existing regulatory standards or to be a substitute for engineering knowledge, experience and judgment, but are requirements, which are most important for safe construction, maintenance and operation of highway-rail grade crossings. Since the actual design will typically be site specific, information shown on these standard drawings will be modified as necessary in close collaboration with SCRRA and as per diagnostic process mentioned in Section 7.3. SCRRA completed design drawings and contract documents for 53 highway-rail grade crossings on SCRRA's Orange and Olive Subdivisions in Orange County in 2008-09. Some of the



sample drawings are include in Appendix K for reference purposes. SCRRA requires the highway agencies to prepare drawings and cost estimates showing highway, rail, traffic signal, pedestrian, signal and other details similar to the one shown on the sample drawings. Table 1-3 shows the list of SCRRA's Engineering Standards related to highway-rail grade crossing which are included in Appendix J.

Table 1-3. List of Highway-Rail Grade Crossing Engineering Standards

STANDARD NO.	TITLE
ES4001	Highway-Rail Grade Crossing – Typical Sections
ES4002	Pedestrian Swing Gate Details
ES4004	Pedestrian Crossing Design Consideration Table
ES4005	Pedestrian Barricade and Metal Hand Railing Details
ES4011	Pedestrian Facilities at Vehicle Crossing - Entrance Gates Only
ES4012	Pedestrian Facilities at Vehicle Crossing - Entrance/Exit Gates
ES4013	Pedestrian Facilities at Acute Angle Vehicle Crossing - Entrance Gates Only
ES4014	Pedestrian Facilities at Acute Angle - Vehicle Crossing Entrance/Exit Gates
ES4015	Pedestrian Facilities at Obtuse Angle - Vehicle Crossing Entrance Gates Only
ES4016	Pedestrian Facilities at Obtuse Angle - Vehicle Crossing Entrance/Exit Gates
ES4017	Typical Pedestrian Treatment Details
ES4018	Pedestrian Crossing Only
ES4031	Pedestrian/Vehicle Crossing Adjacent to Station
ES4032	Pedestrian Crossing Adjacent to Station
ES8308	Typical Gate Assemblies for Pedestrian Treatments at Vehicle Crossings
ES8309	Typical Gate Assemblies for Pedestrian and Bicycle Only Crossings
ES8350	Location Plan Flashing Light Signals with Entrance Gates
ES8355	Typical Location Plan Flashing Signals with Entrance and Exit Gates
ES8260	Typical Location Plan Cantilever Flashers with Entrance Gates
ES8365	Typical Location Plan Cantilever Flashers with Entrance and Exit Gates
ES8370	Typical Location Plan Flashing Light Signals with Gates and Median
ES8375	Typical Location Plan Flashing Light Signals with Entrance and Exit Gates and Median
ES8380	Typical Location Plan Cantilever Flashers with Entrance Gates and Median
ES8385	Typical Location Plan Cantilever Flashers with Entrance and Exit Gates and Median
ES8390	Typical Location Plan Pedestrian Flashing Light Signals with Gates Crossing Configuration
ES8405	Vital Placement for Inductive Loops used with Exit Gates



1.9 RECOMMENDATIONS OF SCRRRA SAFETY PEER REVIEW PANEL

In January 2009, SCRRRA received a report authored by the Metrolink Commuter Rail Safety Peer Review panel entitled *Metrolink Commuter Rail Safety Peer Review Panel: Final Report*. The subject and purpose of the report was to discuss the observations and recommendations made by this Panel.

The Panel was appointed by a SCRRRA Board Ad Hoc Subcommittee, and consisted of experts and professionals from across the nation having diverse backgrounds and experience from commuter rail and passenger agencies, private companies, and members of academic society.

The report recommended the implementation of an “Enhanced Safety Action Plan”, which included short, medium, and long term safety and operational enhancements to the Metrolink System. This plan was organized into eight (8) key issues, the fifth being Infrastructure and Maintenance. The importance of this report to the Manual is that Grade Crossing Safety Enhancements and Sealed Corridors were included in the recommendations for Infrastructure Safety Improvements. Recognizing the importance of grade crossing to overall system safety, the Panel report recommended that SCRRRA continue with its programs to enhance safety at highway-rail grade crossings and continue programs to either close or grade separate existing grade crossings.

1.10 ACKNOWLEDGMENTS

The Manual is the compilation of the collective effort of a Technical Advisor Group (TAG) formed specifically to develop the Manual. This TAG contributed hundreds of hours of effort over a period of one and one half years.

Several members of the TAG conducted inspections of other rail properties, regionally and across the nation, and met with rail engineering and safety professionals with regard to highway-rail grade crossing design practices and standards. The TAG consisted of highly experienced individuals, with expertise in the fields of: highway-rail grade crossing design and construction; railroad track design and construction; railroad signal design and construction; highway and roadway design and construction; traffic engineering; traffic signal design and construction; and safety and risk management.

Grateful recognition is due to the TAG members listed below and to the following contributors:

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2.0 FEDERAL, STATE, AND LOCAL REGULATIONS AND SCRRRA AGREEMENTS

2.1 INTRODUCTION

Regulatory agencies include those agencies with jurisdiction for modifications to existing and private highway-rail grade crossings, as well as any proposed new high-rail grade crossings. Highway-rail grade crossing closures, quiet zones, and grade separation are issues that may arise and need to be addressed in detail in conjunction with the modification of an existing or proposed new highway-rail grade crossing.

With regard to modifications and changes to existing SCRRRA highway-rail grade crossings, the primary regulatory agency and point of contact will always be the California Public Utilities Commission (CPUC). Federal Railroad Administration (FRA) applicable regulations will also apply, especially in those instances when a quiet zone may be under consideration. The principal CPUC General Orders (G.O.) associated with highway-rail grade crossings are G.O. 72, 75 and G.O. 88.

In accordance with CPUC and Federal Highways Administration (FHWA) guidelines, representatives from both railroad and local highway agencies are required to participate with the regulatory authorities in all activities that involve the analysis and design of proposed changes to a highway-rail grade crossing. The SCRRRA will be the regulatory point of contact, in the lead railroad role for highway-rail grade crossings it maintains and operates. The most likely other agency to be involved with highway-rail grade crossings will be the highway owner, which in most cases is the local City who owns and maintains the grade highway-rail grade crossing highway approaches. In some cases the highway owner is the County, or the State of California (Caltrans). Other stakeholders in the process of modifying, closing an existing highway-rail grade crossing or proposing a new highway-rail grade crossing may include local emergency services (fire and police), school districts, neighborhood associations, and nearby businesses. Technical, funding, or planning representatives from SCRRRA's member agencies (METRO, OCTA, VCTC, SANBAG, and RCTC) will often participate in the grade crossing planning, design, and funding process, and will also participate in discussions with the regulatory agencies.

2.2 FEDERAL

The SCRRRA rail network is regulated by the FRA. FRA regulations are included in 987 pages in Title 49, Parts 200 to 299 of the Code of Federal Regulations (CFR). The purpose of the FRA is to: enforce rail safety regulations; administer railroad assistance programs; conduct research and development in support of improved railroad safety and national rail transportation policy; and consolidate government support of rail transportation activities.

The FRA maintains the federal database of highway-rail grade crossings in the United States. A US DOT crossing number identifies each public highway-rail grade crossing in the United States. This crossing number is a random number issued by the FRA to the operating railroad. The number consists of seven characters: six numerical characters, followed by one letter (e.g. 123456A). The US DOT and the FRA use this number to maintain the federal crossing inventory. The available statistics applicable to a particular crossing can be found by using its number to search the federal database for accident, traffic, and basic inventory information. The user should verify this information with the



railroad and the highway agency. The operating railroad is responsible for supplying current information regarding the highway-rail grade crossing to the FRA. Information regarding a particular highway-rail grade crossing can be found on the FRA website at <http://www.fra.dot.gov>.

The “Safety” page on the FRA website includes information regarding the regulation of highway-rail grade crossings, as well as important database information. To access the desired information, the user is able to search using a number of different queries.

The principal FRA regulations associated with highway-rail grade crossings in CFR Title 49 are Parts 222 (*“locomotive hours at public highway-rail grade crossings”*) and Part 234 (*“grade crossing signal system safety”*). Other Parts in CFR 49 also apply.

In October 2008, the Rail Safety Improvement Act of 2008 was passed and includes new provisions addressing grade crossing safety. The FRA also sponsors a number of programs promoting safety, inspection, highway-rail grade crossing safety, and trespass prevention. Additional details regarding FRA programs involving safety can be found on the FRA website.

2.3 STATE

In the State of California, the CPUC has regulations and standards governing many aspects of highway-rail grade crossings design, construction, maintenance and operation. The Rail Crossing Engineering Section (RCES) of the CPUC is the primary point of contact within the CPUC for issues involving highway-rail grade crossings. General Orders (GO) of the CPUC, combined with regulations contained in the California Manual on Uniform Traffic Control Devices (MUTCD), defines the requirements for application of warning devices and traffic control. In most cases, the highway agency has jurisdiction on the highway and pedestrian approaches outside of the crossing, in accordance with the standards of the agency and the CA MUTCD.

The criteria established within the GOs are developed through a formal rule-making process to become part of the standards. Each GO has a revision letter appended to the end of its number. For example, GO 88-B refers to revision B of GO 88. In the Manual, revision letters that apply to each referenced GO have been omitted, with the understanding that the user will refer to the latest version.

The construction or modification of any new highway-rail grade crossing must comply with regulatory process defined in Sections 1201–1205 of the Public Utilities Code. Construction of improvements cannot begin until authorization is received from the CPUC.

In most cases, the modification of an existing highway-rail grade crossing shall be applied for through the CPUC GO 88 process.

Each highway-rail grade crossing in California has a CPUC-issued identification number. Unlike the random nature of the FRA numbering system, the CPUC numbers identify the railroad, branch or subdivision, milepost, and nature of the track (main or branch track, pedestrian crossing, etc.).



By way of example, 101VY-123.40-A is a typical CPUC highway-rail grade crossing number array. That number is obtained as follows:

- 101 = Railroad company/authority
- VY = Subdivision and branch/line (see Table 2-1)
- 123.40 = Railroad milepost (to the nearest hundredth of a mile)
- A, B, C, D = Type of crossing (see Table 2-2 below)

Each SCRRA highway-rail grade crossing CPUC number uses “101” as a prefix, assigned by CPUC on behalf of SCRRA.

The following tables list some of the more commonly used highway-rail grade crossing identifiers:

Table 2-1. SCRRA Subdivision Identifiers

Subdivision	Identifier
River	RI
Valley	VY
Ventura	VE
Orange	OR
Olive	OL
Montalvo	MO
San Gabriel	SG
Pasadena	PA

Table 2-2. Highway-Rail Grade Crossing Type Identifiers

Overhead (RR under), grade-separated highway over railroad	A
Underpass (RR over), grade-separated highway under railroad	B
Spur Track (Industry Track) crossing	C
Pedestrian crossing	D
Railroad-railroad crossing (track over track)	T
Private crossing	X
Overhead pedestrian crossing	AD*
Underpass pedestrian crossing	BD*
Pedestrian private crossing	DX*
Overhead pedestrian private crossing	ADX*
Underpass pedestrian private crossing	BDX*

*Note: these are combinations of the above identifiers

As another example of how these identifiers are generated, crossing number 101VY-18.40-A is an overhead highway crossing in the SCRRA Valley Subdivision at mile post 18.40.



2.4 LOCAL

A highway agency or municipality has ownership and jurisdiction over the highway and highway approaches on which the highway-rail grade crossing is located. While agreements between the railroad and the agency define the physical limits of the highway-rail grade crossing, the approach highways and sidewalks outside of those defined limits falls under the jurisdiction of the local highway agency. (The lead Engineer is referred to CPUC General Order 72 for a description of these limits).

In carrying out this responsibility, the highway agency will define the engineering standards and design practices to be used in the development of designs for the highway-rail grade crossing's approaches. These standards must be minimally compliant with CA MUTCD and should be consistent with the recommended design practices and standards in this Manual.

Highway-rail grade crossing and the associated highway and sidewalk approaches typically involve the intersection of three transportation modes (rail, motor vehicles, and non-motor vehicle pedestrian and bicycles) and include overlapping ownership, design, construction, maintenance, operation and funding responsibilities. SCRRRA, the local highway owner, CPUC, and other stakeholders should develop highly-collaborative approaches when planning and designing highway-rail grade crossing modifications or new crossings.

The local highway agency responsible for the highway approach is strongly encouraged to follow the recommended design practices and standards included within this Manual when planning and designing physical or use changes to the highway-rail grade crossing and highway approaches.

2.5 SCRRRA

2.5.1 Construction and Maintenance Agreements

The construction or modification of a highway-rail grade crossing within the SCRRRA system shall be defined in one or two agreements, ultimately culminating in a Construction and Maintenance (C&M) Agreement. In many cases, the C&M Agreement will be preceded by simple letter agreements to initiate the review of the conceptual plans, followed by more detailed agreements addressing complicated design services support, including scope development, full design, cost estimates and schedules, construction, and construction management of the railroad improvements.

Typical changes and modifications that trigger SCRRRA review and approval to highway-rail grade crossings include, but are not limited to: 1) interconnections with traffic signals and traffic signal preemption; 2) making enhancements to the railroad warning devices or traffic controls associated with the highway-rail grade crossing; 3) performing significant highway or pedestrian pathway work on the approaches and within the limits of the crossing; 4) adding pedestrian or bicycle paths parallel and intersecting grade crossings; 5) creating significant changes in the use of the highway approaches; and 6) implementing other projects that may have a significant effect on the traffic patterns over the crossing.



Before any designs can be finalized and before any construction work can begin, an agreement that includes a detailed work description must be executed by the SCRRA and the highway agency and any other outside parties participating in the funding. This agreement specifies the method of payment; assigns responsibility for design, construction, funding, and maintenance; provide cost estimates of the SCRRA work; and specifies the form, duration, and amount of insurance and liability. The CPUC must also approve the final design of changes and modifications to existing crossings before any construction can begin.

It is important that the development of documents outlining the responsibilities of the parties and SCRRA begin early, as the design is established in order to properly define the scope of work and the project cost. A new C&M Agreement will typically supersede any existing railroad/highway agency agreement. The SCRRA will require that the funding for SCRRA services associated with highway-rail grade crossing agreements (including “Letter Agreements”, “Design Service Agreements” or “Design Scoping and Cost Estimating Agreements” as well as C&M Agreements) be deposited with SCRRA upon execution of the Agreement and in advance of SCRRA incurring any costs.

The maintenance costs associated with automatic warning devices is partially reimbursed by the CPUC for highway agencies and shall be in accordance with CPUC Code Section 1202.2. **Maintenance costs for exit gate systems, if used solely for the establishing a quiet zone, shall be addressed in the C&M agreement and shall not be funded by the SCRRA.**

SCRRA has developed standard specifications that define the responsibilities of contractors working within rights-of-way operated and maintained by SCRRA. The local highway agency should be familiar with these specifications and include these specifications with any bid documents associated with the work at the crossing. A list of these specifications can be found in Appendix I.

All project maintenance shall be conducted in accordance with the C&M Agreement. The local highway agency shall maintain and keep in a state of good repair the traveled way, fence, gates, signs, traffic signals, landscaping, and any other improvements within the jurisdiction and ownership (or easement, or licensed traveled-way) of the local highway agency.

As part of the C&M agreement, the highway agency shall notify SCRRA within five (5) working days in advance of any maintenance activity, and within thirty (30) days in advance of any construction activity to occur within the right-of-way. The highway agency shall be required to reimburse SCRRA the actual cost and expense incurred by SCRRA for all services and work performed in connection with the project, including a computed surcharge representing SCRRA’s costs for administration and management.

2.5.2 Right-of-Entry Agreements

In order to perform work on a right-of-way operated and maintained by SCRRA, Right-of-Entry Agreements are required. For temporary or short-term uses of rights of way (such as surveying activities and shallow geotechnical investigations), the highway agency or contractor is required to submit SCRRA Form 5 – Indemnification and Assumption of Liability Agreement. For projects involving construction on the SCRRA rights-of-way, the highway agency or contractor is required to enter into SCRRA Form 6 – Temporary



Right-of-Entry Agreement. This agreement defines the nature of the work, the flagging requirements, and the appropriate safety measures that must be in place during the work. This includes all work within the right-of-way, from initial design through the completion of construction. Additionally, the movement of oversize vehicles over SCRRA-maintained and operated crossings requires a fully executed Form 4 – Agreement for Moving Oversized Loads Over Highway-Rail Grade Crossings. These agreements are available on the SCRRA website: <http://www.metrolinktrains.com>.

2.5.3 Rights-of-Way

In many cases, railroad right-of-way is maintained by SCRRA and owned in fee by the member agencies. Highway agency or third party projects that affect the right-of-way must be coordinated with SCRRA's Rail Corridor C&E Division.

The modification of highway-rail grade crossings often has an effect on the existing right-of-way defining the crossing. At the earliest stages of the project, the highway agency shall determine the status of the right-of-way within the limits of the project in order to properly identify the encumbrances and issues related to the crossing.

In cases where additional right-of-way is required, the lead Engineer shall develop the appropriate mapping and right-of-way definitions in accordance with SCRRA or local highway agency standards for the proper definition of the right-of-way. The application of the SCRRA's recommended design practices and standards in this Manual to a highway-rail grade crossing will likely result in the need for additional right-of-way for sidewalks, highways, or other civil features related to safety enhancements.

In most cases, the local highway agency takes the lead for land acquisition. The lead Engineer shall properly define the necessary right-of-way, provide legal descriptions, and work with SCRRA's right-of-way administrator and the member agency's real estate department, as needed, to forward the process of property acquisition, easement, or preparing a license agreement.

In some cases, SCRRA also shares the right-of-way with the BNSF Railway Company (BNSF) and the Union Pacific (UPRR) railroads; in order to perform work on their rights-of-way, approval shall be obtained from BNSF and UPRR.

The procedures for applying for right-of-way encroachment, and the appropriate forms, are found in Form 36: Right-of-Way Encroachment Approval Procedures, available on the SCRRA website: <http://www.metrolinktrains.com>.



3.0 HIGHWAY-RAIL GRADE CROSSINGS

3.1 SCOPE

Highway-rail grade crossings are the level intersection of the railroad and highway, and include the pedestrian and bicycle paths located at the edges and parallel to the highway. Pedestrian-rail grade crossings and station pedestrian-rail grade crossings are discussed in Section 4.0. Grade separations are discussed briefly in Section 5.0. Section 3.0 of the Manual provides the design process for modifying and enhancing existing highway-rail grade crossings or constructing new highway-rail grade crossings.

3.1.1 Public Highway-Rail Grade Crossings

A “public highway-rail grade crossing” is a highway-rail grade crossing where the highway is owned or controlled by a highway agency; typically a city, in some cases a county, and less frequently, the state. “At-grade” public highway-rail grade crossings, also known as “level” crossings or highway-rail crossings, are locations where trains intersect with other modes of transportation, including motor vehicles, pedestrians, and bicycles.

In this Manual, the term “highway-rail grade crossing” will be used to mean rail-grade crossing, rail crossing, at-grade crossings, or crossing. The term “highway” will be used to mean highway, road, or approach road. Over 250 (about 90%) of SCRRA’s highway-rail grade crossings are categorized as public highway-rail grade crossings. The chance for conflict at public highway–rail grade crossings increases whenever other modes of transportation are introduced which cross the traveled path of a train, and when the quantity or volume of modal traffic increases. To reduce the chance of such a conflict, appropriate warning treatments are applied to warn motorists and pedestrians of oncoming trains. Highway-rail grade crossing conflicts at public highways are exacerbated by the fact that highway agencies have a very limited ability to control the public’s access to highway-rail grade crossings; additionally, the nature of railroad operating mode does not permit trains to stop in same relative distances as vehicles.

In order to provide a consistent and minimal level of safety at the highway-rail grade crossing, warning devices such as vehicle gates, flashing lights, bells, signage, and pavement markings are incorporated to warn users of the highway-rail grade crossing of approaching trains.

3.1.2 Private Highway-Rail Grade Crossings

A “private crossing” is a highway-rail grade crossing in which the highway is owned or controlled by a private party, and not a highway agency. Private highway-rail grade crossings are generally on highways or at driveways to private property, and in many cases are used by the general public essentially in the same manner as a public crossing. A private party normally owns the highway on at least one side. SCRRA has 29 private highway-rail grade crossings.

In many cases, the SCRRA, or the member agency, provides access to private property under an agreement between the property owner and the SCRRA or SCRRA member agency. These highway-rail grade crossings are prevalent where a highway or driveway is used as the means of accessing private property that would otherwise be landlocked.



A private highway-rail grade crossing might also be used in cases where the railroad intersects private property and the private crossing allows necessary access between sections of the private property divided by the railroad (e.g., farmland). **All private highway-rail grade crossings shall be subject to the recommended design practices and standards included in this Manual and applied to permanent highway-rail grade crossings.**

3.1.3 Temporary Construction Highway-Rail Grade Crossings (Not Public)

Temporary Construction Crossings (TCC's) are normally gated and locked when not in use. Access across these TCC's is controlled with a SCRRA Employee-in-Charge (EIC). Temporary highway-rail grade crossings are generally not open to the public and shall be designed and constructed in accordance with SCRRA Engineering Standards.

3.1.4 Temporary Highway-Rail Grade Crossings (Used by the Public)

A temporary highway-rail grade crossing occurs when the highway, railroad, or both is temporarily relocated to a new location which, in turn, triggers the temporary relocation of the highway-rail grade crossing. The temporary relocations can be due to the construction of a grade separation, a railroad line change, or some other major construction project that requires the relocation of road or track. **Relocated or temporary highway-rail grade crossings shall be subject to the recommended design practices and standards included in this Manual and applied to permanent highway-rail grade crossings.**

3.2 DESIGN PROCESS AND SEQUENCE

The process and sequence for the proper analysis and design of highway-rail grade crossing improvements involves several different engineering disciplines. A typical highway-rail grade crossing design considers motorist and pedestrian behaviors; civil, railroad, and railroad signal design; safety and risk analysis; land use and right-of-way issues; and traffic engineering. This design process involves all engineers and other professionals that participate in the ultimate configuration of the crossing, from the onset of design. The process is outlined in Figure 3-1.

Modifications of all highway-rail grade crossings or proposals for new highway-rail grade crossings shall be subject to the CPUC approval process. The lead Engineer and grade crossing design team should allow ample time [at least four (4) weeks] in the design process for Conceptual (5%) and Pre-Final Design (90%) diagnostic reviews by the engineering team (refer to Section 7.1). All major elements including rail and traffic signals of highway-rail grade crossing project shall be at the at the 90% design, calculation, and cost estimate level before conducting the per-final design level diagnostic review. After Pre-Final Design diagnostic reviews, the ultimate scope of the project, and ultimately the final design scope, will be "locked down". These diagnostics are an important part of the design process and require the necessary input from stakeholders to determine the effectiveness of the changes proposed. The lead Engineer shall take note of the results of the diagnostic meetings, record all comments, and incorporate the appropriate recommendations and changes into the design.

The design of the highway-rail grade crossing shall be circulated for review and approval within SCRRA in order to include the input received from various departments or



functional groups (signals, track, safety, rail crossings) within SCRRRA, as well as from the highway agency and CPUC. The overall functionality and effectiveness of a highway-rail grade crossing will be determined by operational and maintenance needs as well as engineering design needs. The input from these departments early in the engineering process will provide important information that will affect the overall design of the crossing.

A design checklist (included in Appendix G) shall be signed by the lead Engineer in responsible charge for the design of the project. This checklist defines what is expected to have been included in each of the design level submittals, and shall be submitted with each of the submittals listed below (Figure 3-1). In general:

- Project Concept & Design Criteria (5% Design) submittal will incorporate alternative design solutions, program cost estimates, and confirm the correctness and completeness of project objectives.
- Preliminary Design (30% Design) submittal will advance the design to a level in which: potential impacts to the environment, utility lines, and drainage can be identified; traffic and pedestrian counts, and traffic engineering analysis have been performed; construction staging and sequencing alternatives have been identified; and a preliminary engineer's estimate can be provided. A C&M Agreement may be developed and executed between the 30% and 90% designs.
- Pre-Final Design (90% Design) submittal will incorporate comments and advance the design to the near-completion level. Designs for all functional areas, including highway, traffic signals, track, signals, utilities, and right-of-way, will be complete and coordinated. Specifications will be complete. The design scope should be "locked down" at this point: the method of contract delivery has been identified; the roles and responsibilities of the parties have been determined; and a realistic funding plan developed. Only minor revisions should be expected in response to comments at this level.

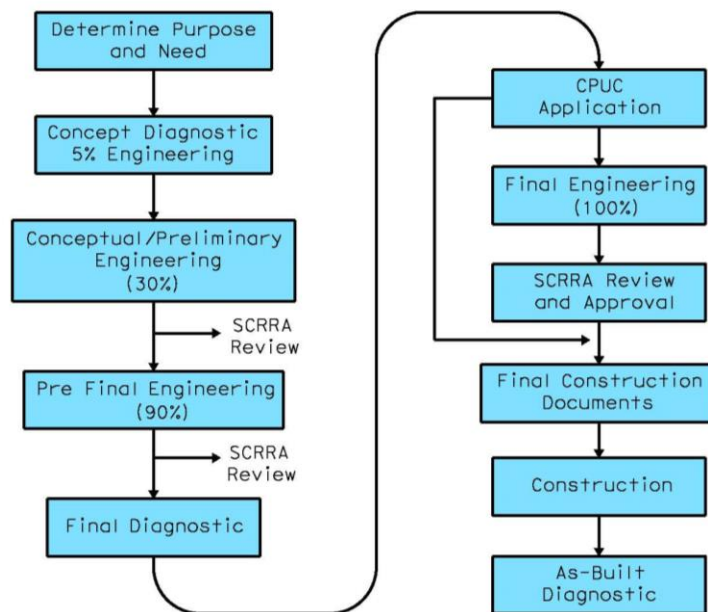


Figure 3-1. Highway-Rail Grade Crossing Design Process Flow Chart



- Final Design (100% Design) submittal incorporates the 90% comments and will be signed and sealed by a registered engineer. Comments may be generated and must be incorporated and resubmitted to SCRRA as Camera Ready Bid Documents.
- Typically, the railroad signal (active warning device) design for a highway-rail grade crossing shall be performed by a different design firm than the civil design. The signal design will often lag the civil design. However, at the Pre-Final (90%) and Final (100%) design phases, both civil, traffic and signal design shall be at the same level of completion.

3.3 DESIGN GOALS

The purpose of, and need for, modifications should be set forth at the start of design. This will form the basis for the overall design of the project, and set the ultimate goals for the improvements. The purpose and need of the project will be developed taking into consideration the overall safety aspects of the crossing, as well as its operational and maintenance aspects. In addition, the source of funding for the improvements and the stakeholders involved with the project, will be defined. The evolving diagnostic process may define changes in those ultimate goals; changes that will ultimately decide the outcome of the final design.

The initial efforts of design should include:

- Meetings and field surveys with SCRRA engineering and maintenance staff to determine existing conditions of the project site that could affect the construction of the proposed improvements.
- Determination and understanding of the site characteristics and condition of the railroad facilities, including track, crossing and wayside signals, and the railroad operating environment. The railroad operating environment (train speeds, number of trains, train operating patterns) may have a major impact on the means and methods for construction and any proposed permanent grade crossing improvements. In addition, the designer will need to coordinate with SCRRA ongoing maintenance planning so the construction schedule can be incorporated into a regular maintenance cycle. This is especially important in areas where heavy rail traffic minimizes opportunities to remove tracks from service in order to perform construction and maintenance.

3.4 HIGHWAY

The overall design of the highway (and requirements for that design) is set forth in the requirements of the highway local agency, in AASHTO Publications, in the CA MUTCD, and in Caltrans Standards, and should be consistent with the requirements of this Manual. In most cases, the local highway agency has jurisdiction over the highway outside of the immediate area of the crossing. SCRRA and local highway agency jurisdictional limits are generally defined by the CPUC and covered in more detail in the C&M Agreement, which may include project plans as an attachment.



The overall quality of the constructed highway, including approaches to the highway-rail grade crossing and the crossing itself, shall be sufficient to:

- Provide for a smooth ride for motor vehicles at the posted speed limit.
- Provide a smooth ride for train traffic at the designated operating speeds.
- Provide safe stopping sight distances (in keeping with the posted speed limit).
- Provide adequate highway and adjacent intersection capacity so motor vehicles do not queue on the tracks.
- Include the display of appropriate signing and pavement markings.
- Provide for ADA compliance for pedestrians through the crossing.
- Minimize sight restrictions for highway users and train operations.
- Allow highway users to make clear and informed decisions that will minimize traffic congestion and the potential for conflict.
- Comply with the recommended design practices and standards in this Manual.

On the approaches to a crossing, the characteristics of the approach highway, traffic signals, and approach sidewalks are an extremely important factor in developing an effective design of the highway-rail grade crossing.

3.5 HIGHWAY AND RAILROAD GEOMETRY

As applied to highways and railroads, geometry defines the horizontal and vertical curvature. “Crossing geometry” refers to the geometrical relationship between the alignment of the crossing highway and the railroad. This horizontal relationship may be perpendicular or skewed. The vertical relationship may include “humps” or vertical curves. These geometric features can affect traffic operations at a highway-rail grade crossing. Additional geometric concerns, such as the elevation of the crossing and the number of lanes, are also aspects that shall be considered during the crossing design. The geometric characteristics of a highway-rail grade crossing greatly affect the visibility of the crossing to users—drivers and pedestrians alike.

Sight distance requirements for horizontal and vertical highway geometry are defined within the Caltrans Highway Design Manual, the AASHTO Manual, the CA MUTCD, and local jurisdiction standards and regulations. The lead Engineer shall consider sight distance to the extent possible within the design of the highway-rail grade crossing geometry, and provide horizontal and vertical curves that provide an unobstructed view of the crossing. The horizontal and vertical alignment of the highway at the approaches to the crossing—in addition to the geometry of the railroad tracks—are major factors in considering sight distance and overall visibility at the crossing.

3.5.1 Perpendicular Highway Rail Crossings

It is SCRRRA's policy, wherever possible, to have the highway intersect the railroad at a right angle. This highway-rail grade crossing configuration allows the most direct and consequently the safest means of traversing the railroad right-of-way. An example of a perpendicular highway-rail grade crossing is shown on Figure 3-2. **Active warning devices shall be installed 15 feet from the centerline of the track, as measured from the center of the mast, at new or existing highway-rail grade crossings. A design deviation may be requested for active warning devices installed less than 15 feet; in no case shall an active warning device be installed less than 12 feet**



from the centerline of the track. This standard is consistent with the requirement of Part 8 of the CA MUTCD. The benefits of a perpendicular highway-rail grade crossing are as follows:

- Shortest route across the crossing.
- Minimal gate-arm length and standard location for placement.
- Decreased opportunity for the wheels to become caught in the flangeways.
- Improved visibility of the highway-rail grade crossing and all approaches.

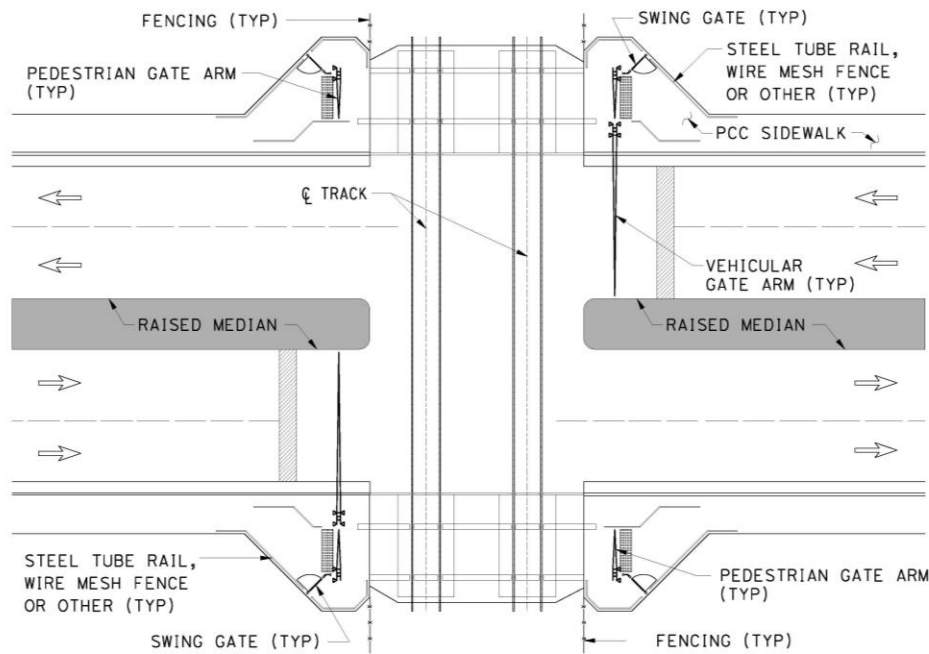


Figure 3-2. Perpendicular Highway-Rail Grade Crossing

3.5.2 Skewed Crossings

A skewed highway-rail grade crossing is one where the highway intersects the track at an obtuse or acute angle. Although this is undesirable highway-rail grade crossing geometry, it is often unavoidable. Examples of the standard layouts for a skewed highway-rail grade crossing are shown in Figures 3-3 and 3-4. A skewed highway-rail grade crossing has several undesirable characteristics, including the following:

- Increased time for motor vehicles and pedestrians to traverse the highway-rail grade crossing.
- Highway geometry may significantly increase the length of the gate arms.
- Often results in undesirable locations of highway-rail grade crossing devices that may affect overall design needs.
- Increased opportunity for wheels to become caught in the flangeways.



A skewed highway-rail grade crossing injects additional complicating factors into the design of the overall highway-rail grade crossing. Where standard applications of warning devices may be applied without modification at perpendicular highway-rail grade crossings, the skewed highway-rail grade crossing requires adapting the standard design to meet the highway-rail grade crossing angle. For example, an angled crossing may require that gates be placed at greater, nonstandard distances from the track in order to provide proper lane coverage.

For skewed crossings, highway active warning devices shall be installed perpendicular to the highway 15 feet from the centerline of the track, as measured from the tip of the gate. If the geometry of the highway-rail grade crossing precludes installing the gates at 15 feet, then a design deviation may be requested to place the device closer to the crossing, but in no case less than 12 feet. Application of these recommended design practices and standards: 1) minimizes the length of gate arms; and, 2) directs the lights on the arm along the highway approaches for maximum visibility.

When a right-angle highway-rail grade crossing cannot be achieved due to physical constraints, the interior angle shall be designed as close to 90 degrees as practical, but shall not be less than 75 degrees. Refer to Figure 3-5. In instances where this crossing geometry is satisfied, the gates shall be installed perpendicular to the highway-rail grade crossing highway. If the angle of skew must be less than 75 degrees due to physical constraints, then the lead Engineer shall develop highway-rail grade crossing geometry that will maximize the angle of skew.

A significant challenge that arises with modified, nonstandard gate placement is the increased travel distance for pedestrians and vehicles traversing the highway-rail grade crossing. The lead Engineer shall develop configurations that will minimize pedestrian travel time between pedestrian gates over the highway-rail grade crossing, while providing pedestrian gate arms of minimum length.

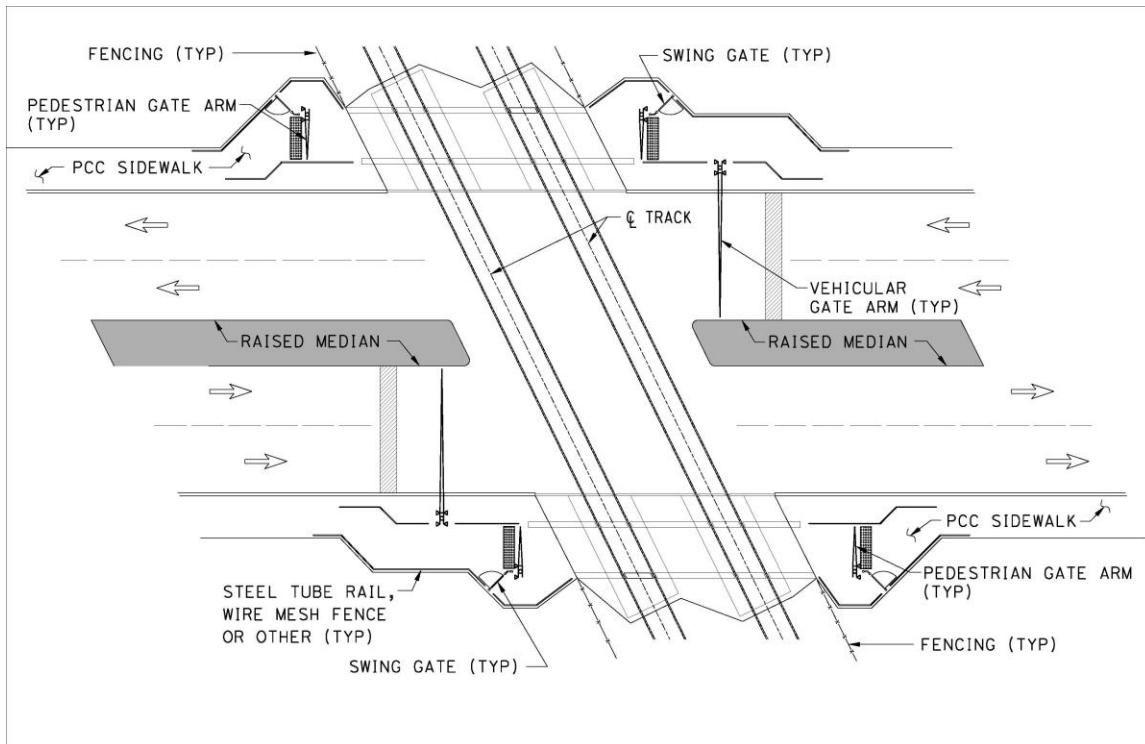


Figure 3-3. Skewed Highway-Rail Grade Crossing (Left)

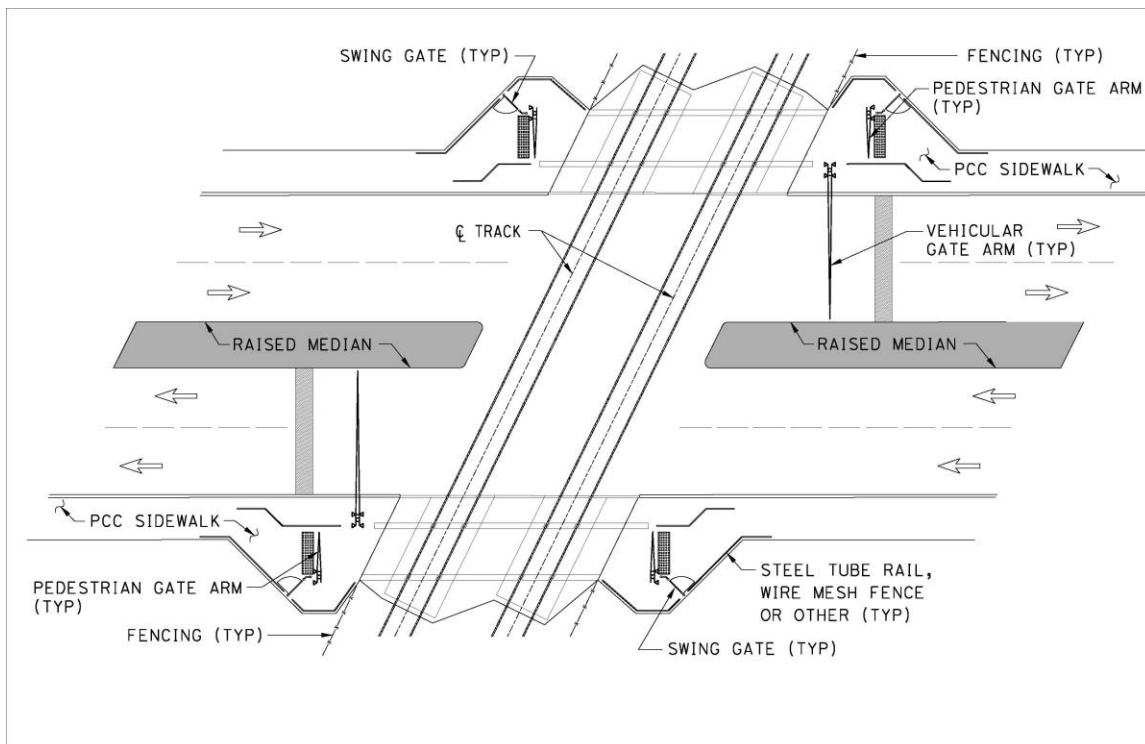


Figure 3-4. Skewed Highway-Rail Grade Crossing (Right)

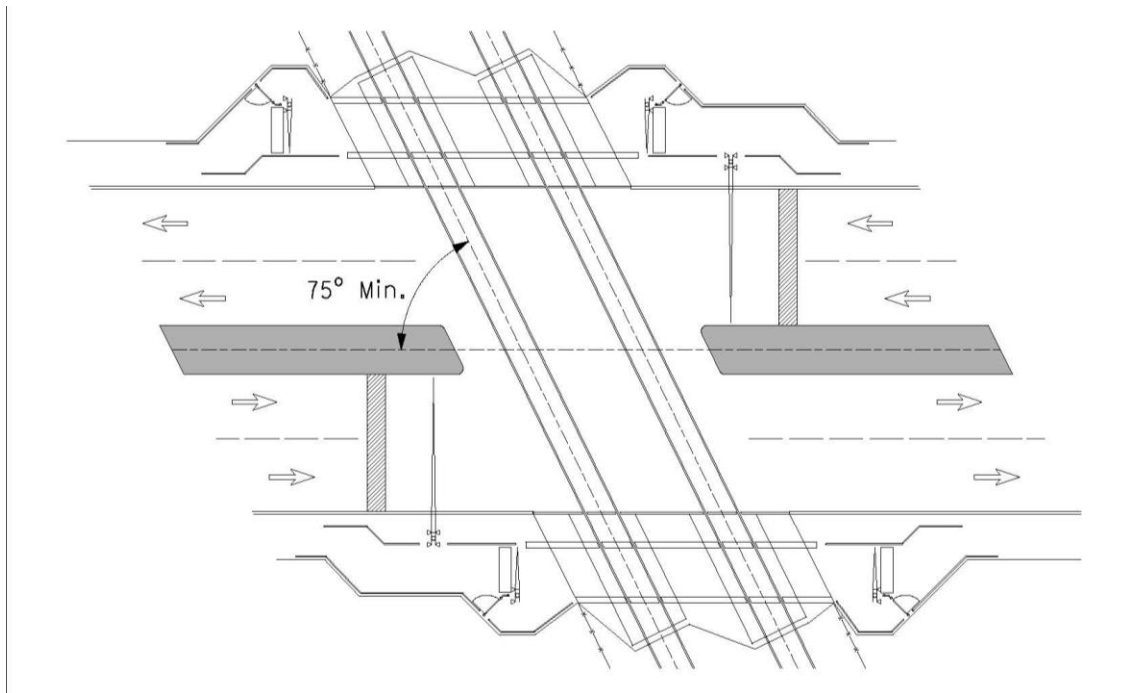


Figure 3-5. Skewed Highway-Rail Grade Crossing (75° Minimum)

3.5.3 Highway Features

Several highway features pertinent to the design of the highway-rail grade crossing must be considered to ensure an adequate design. The design should satisfy both the physical and operational needs of the railroad, as well as accommodate the traffic (vehicles, pedestrians, and bicycles) that must safely traverse the highway-rail grade crossing.

3.5.4 Highway Design Vehicles

Both the highway horizontal and vertical design criteria and the design vehicles are established by the highway agency having jurisdiction over the highway. The highway shall be designed to accommodate the largest, longest, and lowest ground clearance vehicle that may be expected to traverse the highway-rail grade crossing. These vehicles and their characteristics are discussed in the AASHTO publication, A Policy on Geometric Design of Highways and Streets. In the State of California, and for SCRRRA highway-rail grade crossings, **the AASHTO WB-65 semi-tractor-trailer shall be used as the highway-rail grade crossing and grade crossing approach highway “design vehicle” for horizontal highway geometry.** In locations where the WB-65 vehicle may be prohibited access, the mere posting of signage restricting access to a highway—such as “NO TRUCKS OVER 3 AXLES,” or “NO TRUCKS OVER 3 TONS” should not be considered a reliable deterrent for controlling truck access to a SCRRRA highway-rail grade crossing.

3.5.5 Horizontal and Vertical Alignment

The horizontal and vertical geometry of the approach highways and adjacent



intersections (immediately upstream and downstream of the highway-rail grade crossing) shall safely accommodate all anticipated traffic movements and required clearances of the highway “design vehicle”.

3.5.6 Proximity to Adjacent Traffic Outlets

The design must consider highway-rail grade crossing proximity to highway intersections, alley intersections, and driveways, and the impact of adjacent traffic control devices on the operation of the highway-rail grade crossing. Refer to Section 3.7 for additional information on driveways.

3.5.7 Drainage and Highway Pavement

The proper drainage of both the highway and the track structure shall be considered by the lead Engineer at all phases of the design. Improper drainage can lead to failure of the track and highway approach pavement, which in turn may affect the overall operations. The pavement near (within 50 feet) of the highway-rail grade crossing should be “overdesigned”, or designed to very high standards in terms of thickness, materials, and quality of construction, in order to minimize or prevent the need for any future repairs or rehabilitation. The need for a high quality low maintenance pavement is particularly important where any exit gate loop detectors are located. Pavement repairs and rehabilitation in the vicinity of a highway-rail grade crossing can be extremely difficult, disruptive (both to motor vehicle users and to the railroad), and costly to perform, due to the difficulty of coordinating traffic outages of both the highway and railroad.

3.5.8 Design Speed

The design speed of the highway-rail grade crossing highway is usually equal to or slightly above the posted speed limit that is set by the highway agency. If the posted speed limit cannot readily be determined, the lead Engineer shall inquire with the highway agency having jurisdiction over the highway-rail grade crossing.

3.5.9 Highway Horizontal Curves

Horizontal curves in the highway may create overall visibility challenges to the lead Engineer. In many cases, enhancements to highway-rail grade crossings do not include modifications to the existing highway geometry. Often, the existing highway geometry cannot be modified due to limited right-of-way or other reasons. In cases where existing horizontal curves in the highway affect the overall visibility of the crossing, the lead Engineer shall adhere to the following process:

- Analyze the sight distance through the approaches to the highway-rail grade crossing, utilizing highway design criteria defined by the agency having jurisdiction over the highway.
- Determine the feasibility of highway geometry modifications to enhance the visibility of the crossing.
- Use additional signaling or warning devices as necessary to mitigate the effects of horizontal curves on visibility.



3.5.10 Vertical Profile of the Highway and Highway Cross Slope

The vertical profile of the highway is often a matter of matching existing topography with the surface geometry of the railroad highway-rail grade crossing. As a result, the lead Engineer may be faced with several design options in order to design an efficient and safe crossing. The following items shall be followed when developing the design of the vertical profile of the highway:

- The approach grades to the highway-rail grade crossing shall be minimized. This is to allow large vehicles to properly accelerate and quickly traverse the highway-rail grade crossing when stopped before the highway-rail grade crossing warning gates. A steeper slope on the approaches to the highway-rail grade crossing will increase the acceleration time and, consequently, will increase preemption time for the traffic signals related to the crossing. Refer to Section 3.16 for additional information on preemption.
- Transitions of the edges of the pavement (EP) of the highway-rail grade crossing approach highway—from the normal 2% cross-fall (from centerline to EP) to the track grade (where both halves of the highway will slope to match the profile of the railroad track)—shall be accomplished in a manner that will not create any abrupt changes in the highway. The lead Engineer shall follow the guidelines shown in Figure 3-6 below, to determine the length of the EP transition.

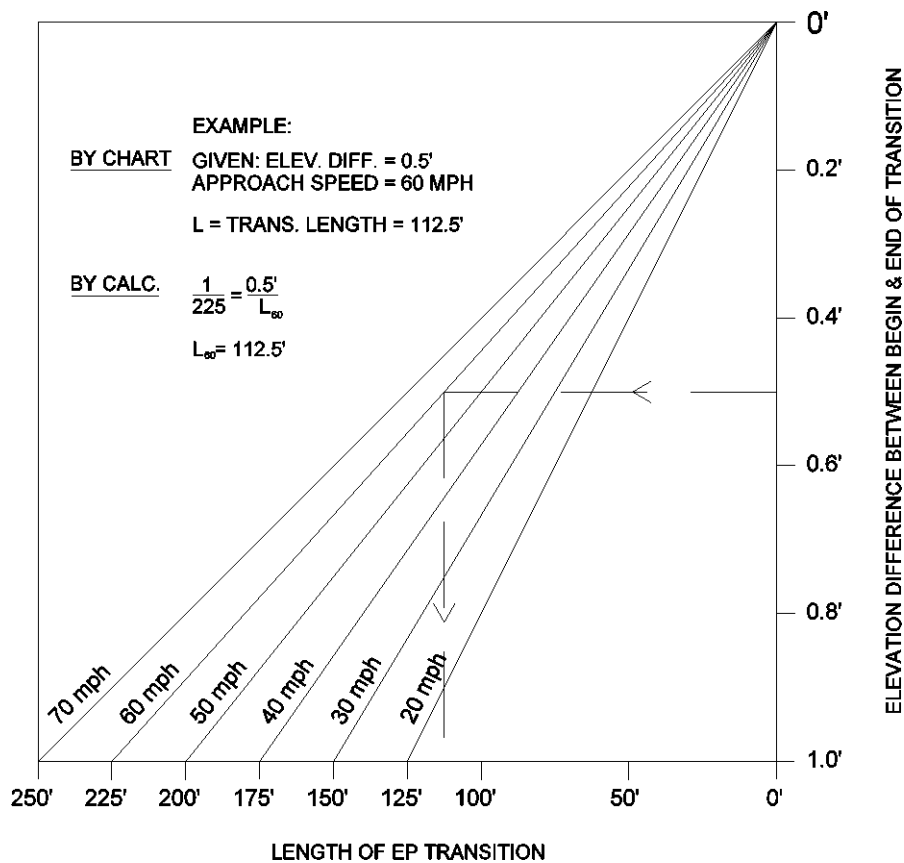


Figure 3-6. Rate of Change in Pavement-Edge Elevation Changes for Highway Approaches to Highway-Rail Grade Crossings



- **Vertical curves within the highway at a highway-rail grade crossing shall be avoided.** If necessary, vertical curves should meet the Stopping Sight Distance requirements from the Caltrans Highway Design Manual, or AASHTO publication entitled A Policy on Geometric Design of Highways and Streets.
- **At multiple track highway-rail grade crossings, the tops of the rails for all tracks shall be in the same plane.** If this is not accomplished, traffic tends to slow down as vehicles traverse the uneven crossing. This leads to traffic congestion and increases the probability of rear-end accidents. In addition, highway-rail grade crossing maintenance requirements shall increase due to the need for pavement repairs adjacent to, and in between, highway-rail grade crossing panels.
- The intersection of highway and railroad shall be as level as possible.
- **The highway vertical profile grade at lip of gutter pan should be 0% within 10 feet of the centerline of the nearest track and the grade can be increased to 1.11% up to 37.50 feet from the centerline of the nearest track. Beyond 37.50 feet from the centerline of the nearest track, the grade on the approach to the highway-rail grade crossing shall be minimized, with due respect for low-ground-clearance vehicles, to allow maximum acceleration by heavy trucks.** This shall minimize track clearance time during railroad preemption. Refer to Figure 3.7, SCRRRA's Engineering Standard for additional details. Refer to Section 3.16 for additional information on preemption and highway-rail grade crossing profiles.

Often railroad tracks are constructed higher than adjacent topography to allow for proper drainage of the railroad right-of-way. This often creates a vertical “hump” at the crossing. A severe hump may cause long and low trailers to become “high centered” and stranded on the crossing. A similar situation can occur with long limousines. These trapped vehicles, in addition to stopping or slowing traffic, represent a serious hazard to both the vehicle and train.

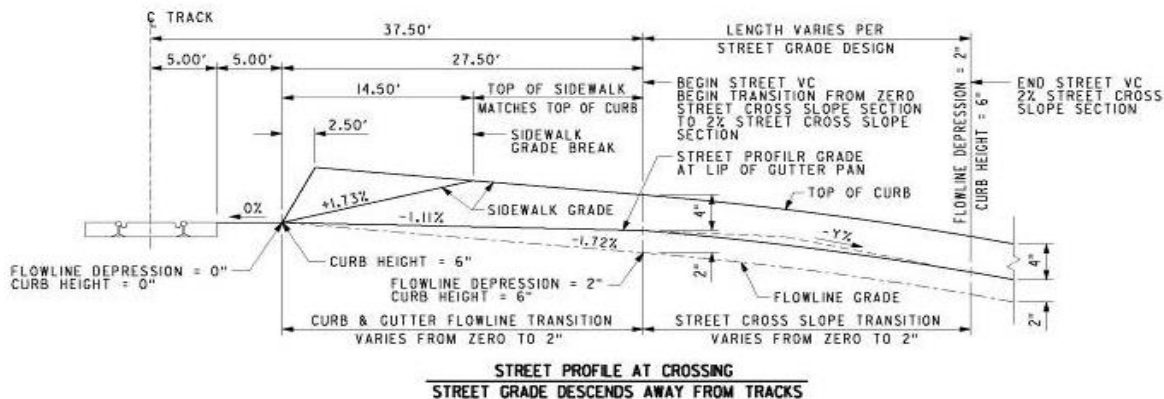


Figure 3-7. Highway Profile at Highway-Rail Grade Crossing

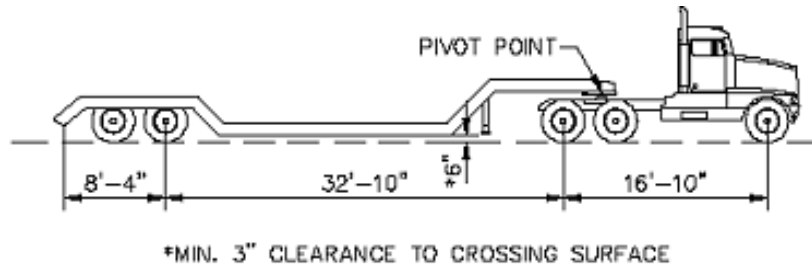


Figure 3-8. Low-Ground Clearance Vehicle Template for Highway-Rail Grade Crossing Design

Highway-rail grade crossing vertical profiles shall be analyzed with the Low-Ground Clearance Vehicle template to determine the clearance for this vehicle type. The Low-Ground Clearance Vehicle template has a nominal six (6) inch ground clearance. Highway-rail grade crossings should provide a minimum clearance of three (3) inches between the street surface and the lowest point on the Low-Ground Clearance Vehicle template as illustrated in Figure 3-8.

The lead Engineer shall consider all vehicles that may utilize the crossing, regardless of posted signs prohibiting access.

In the event site conditions do not allow for the design to meet the Low-Ground Clearance Vehicle template, a design exception may be requested to allow a W10-5 low-ground-clearance sign (as specified in the CA MUTCD) to be installed on each approach to the highway-rail grade crossing sufficiently in advance of the crossing to allow low-ground clearance vehicles to turn around in advance of the highway-rail grade crossing. In addition, as recommended by the CA MUTCD, a supplemental message such as “Ahead,” “Next Crossing,” or “Use Next Crossing” (with appropriate arrows) should be placed at the nearest intersecting road where a vehicle can detour, or at a point on the highway wide enough to permit a U-turn.

3.5.11 Truck Turning Capabilities

The design of improvements to the highway-rail grade crossing must factor in all likely means by which the highway-rail grade crossing shall be traversed. The design shall allow for the free movement of all motor vehicles throughout the highway-rail grade crossing envelope. In areas of heavy industrial use, truck size becomes a factor in the design of the crossing. A truck that cannot safely traverse the highway-rail grade crossing represents a serious hazard. The lead Engineer shall apply the turning radius of the horizontal design vehicle for all allowable turning movements, superimposing the vehicle wheel paths and vehicle body paths onto the proposed highway-rail grade crossing design. This shall be accomplished using the appropriate truck turning templates or computer software.

Figure 3-9 shows the turning radii of the AASHTO WB-65 design vehicles when traversing a designed crossing. As shown in this figure, the characteristics of the design



vehicle have a major impact on the design of the crossing. Issues such as curb return radius, the placement of medians, and the overall length of medians are affected by this placement. In some cases, the installation of additional traffic control methods such as medians may not be recommended if the median (or other control measure) would prevent a design vehicle from safely exiting the crossing.

The lead Engineer shall provide for the effective egress of the typical design vehicle traversing the crossing. The following steps shall be followed during the design process:

- Determine the proper design vehicle expected to traverse the crossing. The design vehicle to be used as a standard is determined by the municipality having jurisdiction over the highway.
- Analyze the turning radius of this vehicle within the proposed design.
- Mitigate the effects of insufficient turning radius within the design.
- The lead Engineer shall demonstrate the effects of the vehicle turning radius and the swept path of the wheels and body of the vehicle on the overall design of the highway and crossing.

3.5.12 Turning Radius Mitigations

The following mitigations shall be implemented to cope with an inadequate turning radius:

- Where multiple lanes are involved, provide for a truck's unobstructed movement, so it may easily traverse the highway-rail grade crossing without being impeded by cross traffic. This may include the use of additional traffic signaling to control cross traffic.
- Consider revising a proposed median design to allow the free movement of the truck. This may require a request for design exception.

Figure 3-9 demonstrates an effective mitigation for an inadequate turning radius. In this example, the AASHTO WB-65 design vehicle is unable to remain in the curb lane throughout its right turn after exiting the crossing. The traffic signal at the intersection, which controls both the movement of the vehicle over the crossing and the cross traffic (and therefore the mitigation), was to modify the signal phasing so that the truck has a clear movement path over the highway-rail grade crossing and onto the adjacent street.

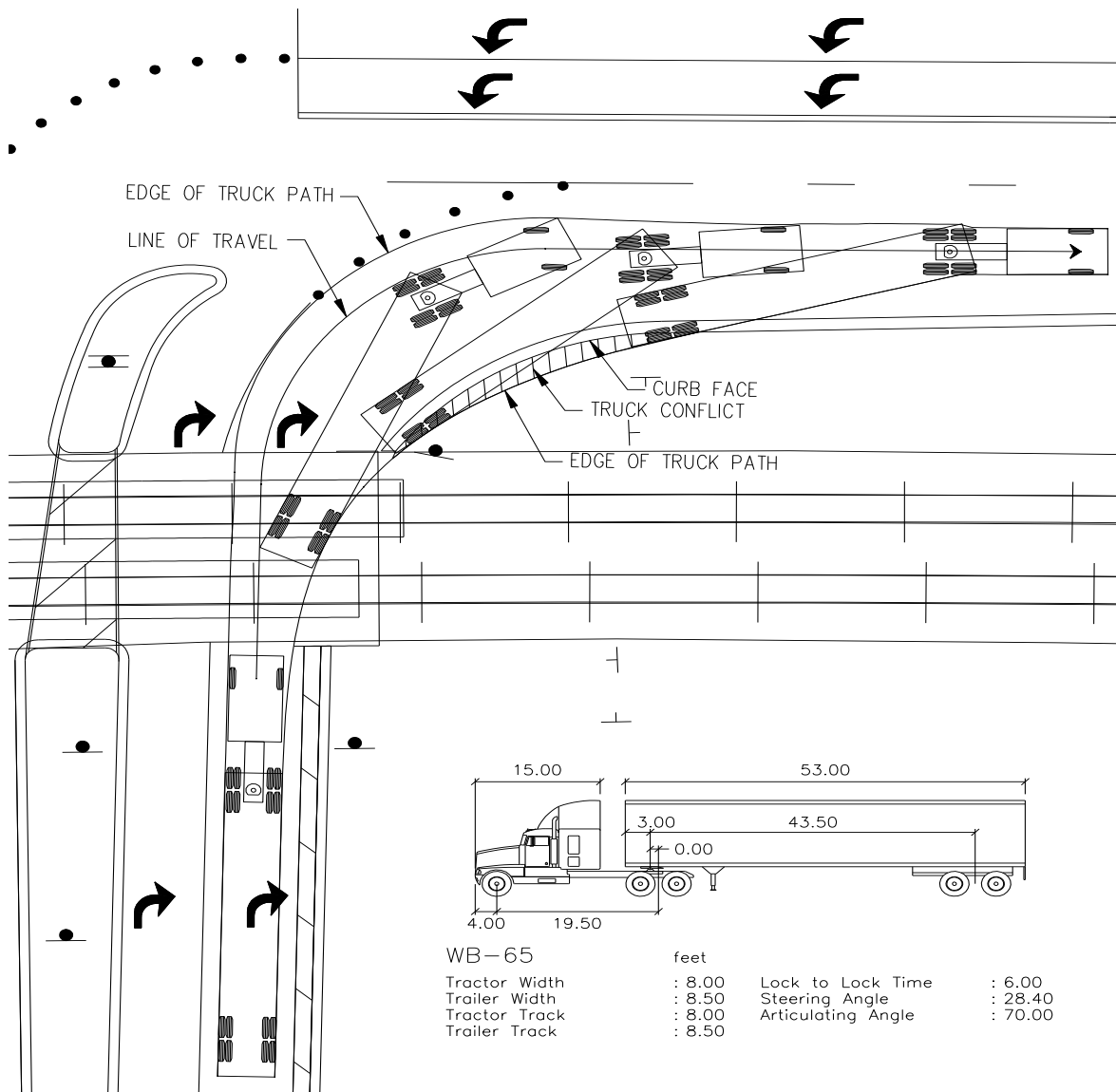


Figure 3-9. Turning Radius of the WB-65 Design Vehicle

3.5.13 Railroad Geometry and Condition of Railroad Facilities

In conjunction with investigating and analyzing the highway geometry in the vicinity of the highway-rail grade crossing, the railroad geometry and condition of the railroad facilities should also be investigated and analyzed to determine compliance with current SCRRRA standards and design practices. **If the railroad geometry and facilities in the vicinity of the highway-rail grade crossing do not meet current SCRRRA standards, or the railroad facilities are not in acceptable condition, the railroad should be reconstructed to correct any deficiencies.** It is very important to bring the railroad up



to current standards and good condition as part of the overall grade crossing safety enhancement project: it is extremely difficult and costly to coordinate the simultaneous closure of both the railroad and highway for repair, rehabilitation, and construction activities. The overall objective should be to reconstruct both the highway and railroad elements of the highway-rail grade crossing so major repairs or rehabilitation will not be required for 20 to 30 years. Additional information regarding the design of the railroad tracks and highway-rail grade crossing facilities is included in Section 3.17.

A review and analysis of the railroad geometry is particularly important if the highway-rail grade crossing is located within, or near, a railroad curve; or if other special railroad facilities exist near the crossing such as special trackwork (turnouts and crossovers), a passenger station, or a railroad bridge. Preliminary surveys, aerial photographs, and detailed topographic maps of the grade crossing should extend outward along the railroad alignment for 1000 feet or to the end of any curves in both directions for the crossing. The survey should include: the top of rail of any track(s); the amount and location of superelevation; the beginning and end of any spirals and curves; the distance (every 100 feet) between track centerlines; and the limits of the existing grade crossing surface.

Additionally, the location of special trackwork, station platforms, bridges, wayside signals, signal or communication houses, pull boxes, longitudinal utilities (both surface and underground), and the location of all existing active warning devices should be determined. The mapping accuracy of the railroad facilities should be as accurate as the highway facilities: typically one-inch per 40-foot scale. The SCRRA should also be consulted to determine the likelihood of needing additional track or other railroad facilities, or if SCRRA plans include future tracks or other facilities; the lead Engineer should incorporate these future facilities into the plans.

After the survey of the existing railroad geometry and facilities is conducted, the lead Engineer and SCRRA will perform the necessary engineering and condition analysis to determine the changes and modifications required to bring the railroad facilities into compliance with current standards (and to an acceptable condition).

3.5.14 Highway and Railroad Drainage

All surface drainage along the highway approaches to the highway-rail grade crossing and across the crossing itself shall be channeled away from the highway-rail grade crossing to minimize opportunities for hydroplaning within the highway-rail grade crossing and approaches. In particular, the following conditions shall apply to surface drainage within the area of highway-rail grade crossings:

- All surface runoff within the highway-rail grade crossing shall be collected by appropriate drainage devices outside the limits of the track structure. No surface flow shall be allowed to enter the area of the track structure.
- For all approaches to the highway-rail grade crossing, the lead Engineer shall consider highway cross-fall and cross-slope transition at a nominal 2% to the highway gutter.
- The lead Engineer shall demonstrate sufficient drainage and cross-flow within the design drawings.



- Highway and track drainage systems shall be continuous within the limits of the crossing.

Poor drainage is the primary cause of track structure and highway pavement failure. In the initial analysis of a crossing, the lead Engineer shall examine the existing conditions to determine the effectiveness of existing drainage and correct any deficiencies, and shall also produce a Hydraulics and Hydrology (H&H) Report, to be reviewed and approved by SCRRRA, which studies onsite and offsite flows, and recommends drainage improvements to be incorporated into the project. Table 3-1 below lists possible drainage issues that warrant consideration, but the scope of the improvements should follow the H&H Report.

Table 3-1. Drainage Considerations

Condition	Possible Reason	Solution
Rough crossing	Track settlement and tie or roadbed failure	Reconstruct track structure and improve drainage and roadbed
“Alligator” pavement adjacent to the highway-rail crossing panels.	Poor drainage of highway and insufficient pavement structure	Install additional catch basins. Re-profile highway to affect surface flow. Reconstruct highway with high quality low maintenance pavement
Rough pavement on approaches	Highway structure failing, or in poor condition	Reconstruct highway profile to affect surface flow. Reconstruct highway with high quality low maintenance pavement.

3.5.15 Level of Service

The term “Level of Service” (LOS) is normally used to describe the performance of a road or street in terms of its operational ability to meet traffic volume demands. LOS describes the operational characteristics of the traffic stream, based on qualitative measures of the highway facility. Factors that characterize LOS include vehicle speed, travel time, freedom to maneuver, traffic interruptions, comfort, and convenience. LOS is a mechanism used by highway departments, or local jurisdictions, to determine if a road is operating at ideal, average, or poor efficiency. The LOS relates the quality of traffic service to given traffic volumes. The Highway Capacity Manual defines six levels of service, designated A through F, with A being the highest (free flow) and F the lowest (extreme congestion). The following factors are used to determine LOS:

Highway Factors

- Number and width of lanes
- Exclusive turn lanes
- Lateral clearance
- Horizontal and vertical alignment
- Number of access points (driveways, alleys, side streets, etc.)
- Drainage



Traffic Factors

- Free-flow speed
- Heavy vehicles
- On-street parking
- Bus stops
- Peak hour factor
- Turning movements

Traffic Control Factors

- Signal phasing
- Signal timing
- Signal cycle length
- Signal coordination
- Pedestrian phasing at crosswalks

Factors other than LOS will affect the overall operation of traffic at a highway-rail grade crossing. For example, a highway may have a LOS of 'A' but also have a downstream driveway that will force traffic to queue back onto the tracks in the event of a right turn into the driveway. To accommodate traffic-related issues, the design of a highway-rail grade crossing should include all aspects affecting the flow of traffic—regardless of LOS.

The LOS is affected by warning devices and signage associated with highway-rail grade crossings. Also, the LOS may directly affect the coordination between traffic signals at adjacent intersections with the highway-rail grade crossing signaling system. Refer to Section 3.14 for additional information.

3.5.16 Traffic Lanes

The following highway-rail grade crossing requirements are contained in General Order 72 of the CPUC:

- **Highway-rail grade crossings shall not be less than 24 feet wide and in addition shall be of a width not less than the traveled approach portions of the adjacent sections of the highway including usable shoulders and sidewalks or pedestrian pathways.**
- Deceleration and acceleration lanes for vehicles required to stop at highway-rail grade crossings should be provided wherever highway agencies determine such lanes are necessary.
- At the time of construction, the surface of the highway shall be installed to conform substantially to the plane of the rails for the entire area between rails, between tracks, and to lines two (2) feet outside the rails.
- Where crossings involve two or more tracks, the top of rails for all tracks are normally in the same plane. The surface of the highway shall be at the same plane as the top of rails for a distance of at least two feet outside of rails for either multiple or single-track highway-rail grade crossings. The top of rail plane shall be connected with the grade line of the highway each way by vertical curves of such length as is required to provide riding conditions and sight distances normally applied to the highway under consideration, per the Caltrans Highway Design Manual or AASHTO publication entitled "A Policy on Geometric Design of Highways and Streets".



- Approach grades of less than 6% are desirable, but where not reasonably obtainable due to local topographical conditions, the gradients in the vicinity of the rails shall be kept as low as feasible.

Often a highway intersection may be immediately adjacent to the highway-rail grade crossing. It is important that vehicles traversing the highway-rail grade crossing be given a clear avenue of escape after or downstream of the highway-rail grade crossing. To clarify, **a vehicle entering the footprint of the highway-rail grade crossing should have an unimpeded means of clearing the crossing.** In cases where there is an intersection adjacent to the crossing, it may be necessary to add a refuge in the cross-traffic direction to allow a design vehicle to clear the intersection and move onto the cross street without constraining the movement of cross traffic.

3.6 MEDIAN ISLANDS

3.6.1 General

Installing raised medians at the centerline of highway approaches to highway-rail grade crossings is an effective way to discourage gate circumvention or making U-turns in the vicinity of the highway-rail grade crossing. As shown in Figure 3-10, the use of a median island(s) minimizes opportunities for violations by creating a well-defined corridor across the tracks. For a two-gate system, installation of median barriers can reduce violations up to 80%t (source: National Safety Council and National Highway Traffic Safety Administration – Cost-Effectiveness Analysis). In addition, FRA's Final Rule on Use of Locomotive Horns lists gates with median islands, or channelization devices, as an approved supplementary safety measure for a quiet zone.

Raised median islands shall be used on both approaches to the highway-rail grade crossing to constrain undesirable traffic movements, such as driving around the automatic crossing gates or making U-turns in the vicinity of the highway-rail grade crossing.

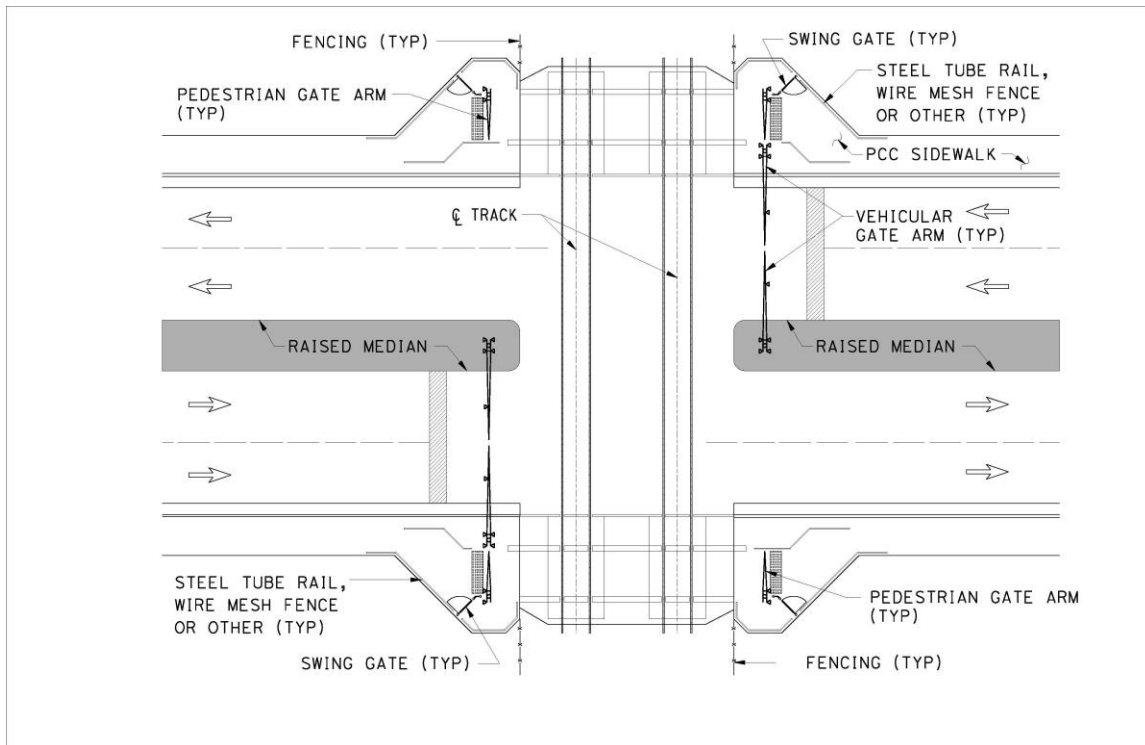


Figure 3-10. Raised Medians at a Highway-Rail Grade Crossing

Criteria for the design of islands is set forth in an AASHTO publication titled A Policy on Geometric Design of Highway and Streets.



Figure 3-11. Effective Use of Medians and Signage



To be effective, a raised median should be centered on the street between both directions of traffic. **On each approach to the highway-rail grade crossing the raised median shall begin 10 feet from the centerline of the nearest track. The end of the median adjacent to the highway-rail grade crossing shall be square, with a six (6) inch radius on the corners** to discourage motorists from making left or U-turns between the medians. Figure 3-11 shows an effective use of median islands.

3.6.2 Median Islands versus Exit Gates

Two mitigation methods can minimize the opportunities for motorists to violate gates:

- The use of a median of sufficient length and height, preferably 100 feet long (measured from the gate) and eight (8) inches high, to prevent motorists from driving around the lowered gate.
- The installation of exit gates, as discussed later in the Manual, at the crossing, blocking motorists from entering the highway-rail grade crossing when gates are lowered.

The preferred minimum length of the median as measured from the highway-rail grade crossing gate shall be 100 feet. A design deviation may be requested where the 100 feet is unobtainable, but in no case shall the median be less than 60 feet. The width of the median shall be nine (9) feet if a warning device is installed in the median and four (4) feet if no warning device is installed in the median. The minimum width of the median may be two (2) feet with the approval of SCRRRA and the local highway agency. Raised median curbs shall be eight (8) inches. The median island shall be continuous throughout its length without any breaks. However, there may be instances where an existing manhole or valve box must remain in its current location. In this case, the median shall be designed to accommodate access to these facilities. The lead Engineer shall consider the elimination of manholes, valve boxes, or other features requiring regular maintenance within the approaches to the highway-rail grade crossing

Table 3-2 can be used in the selection and design of medians:

Table 3-2. Standard SCRRRA Applications of Medians

Hazard	Option 1	Option 2	Notes
Adjacent driveways	Medians to extend past driveway	Medians extending past the driveway, and shaped to limit vehicular movements	The use of the median shall effectively control vehicular activity at the driveway
Multiple lanes	Install raised medians for additional highway-rail grade crossing gates	N/A	Medians are mandatory in instances where additional gates and lights are needed for proper lane coverage
Light traffic or rural area	Install raised medians		The use of the median shall effectively control vehicular activity



Limited highway right-of-way	Install raised medians	Install raised delineators	The installation of medians can require the acquisition of additional highway right-of-way
Insufficient truck turning radius	Extend median to the maximum length that still accommodates truck movements, and consider exit gates	N/A	Truck turning radius may be a defining component on the use of exit gates
Insufficient right-of-way for a raised median	Acquire additional right-of-way for the installation of the raised median	Consider the use of raised delineators, but only if right of way acquisition is not possible.	The installation of delineation between traffic directions may be needed if the acquisition of additional right-of-way is not an option

The primary median width requirement, per CPUC, is that there shall be a minimum horizontal clearance of two (2) feet between the flashing beacon backplate and the face of the curb. The lead Engineer shall plan for future highway uses when considering the ultimate width of the median. The position of the median gate counterweight, when the gate is in the horizontal position, must be considered.

3.6.3 Median Landscaping

In general, **trees, shrubbery, and similar view obstructing landscaping are not allowed on highway approaches within 100 feet of a highway-rail grade crossing. Low maintenance stamped concrete, pavers, or other hardscape materials shall be the standard landscape treatment for median islands and sidewalk approaches.**

3.7 DRIVEWAYS

The location of driveways, alleys, or similar facilities (with respect to the highway-rail grade crossing) can significantly affect the safety associated with highway-rail grade crossing operations. Driveways associated with railroad-highway crossings are defined as nearside or farside.

- A nearside driveway is defined as a driveway that is located on the crossing approach prior to, or upstream of, the crossing. An example of this type of driveway is shown in Figure 3-12.
- A farside driveway is defined as a driveway located beyond, or downstream of, the highway-rail grade crossing as shown in Figure 3-13.

Driveways (private or public) located within 100 feet of the nearest highway-rail grade crossing active warning gate are strongly discouraged. Driveways within 100 feet of highway-rail grade crossings shall be removed or appropriately reconfigured to achieve safety objectives.

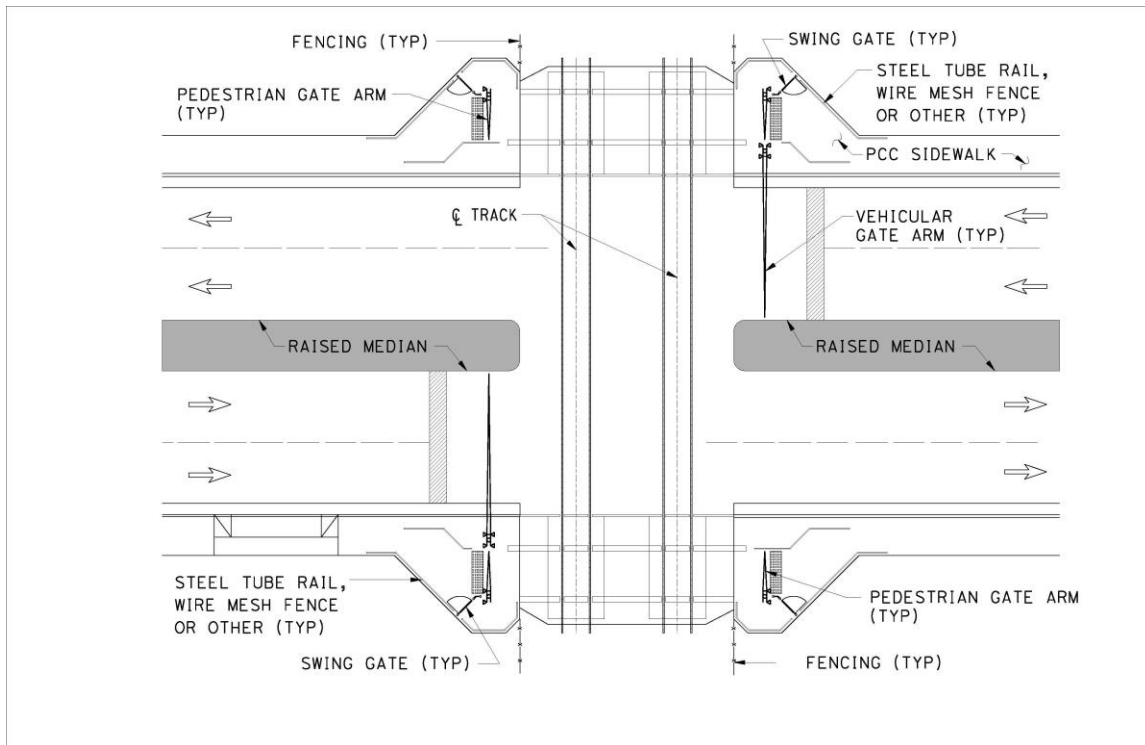


Figure 3-12. Nearside Driveway at Highway-Rail Grade Crossing

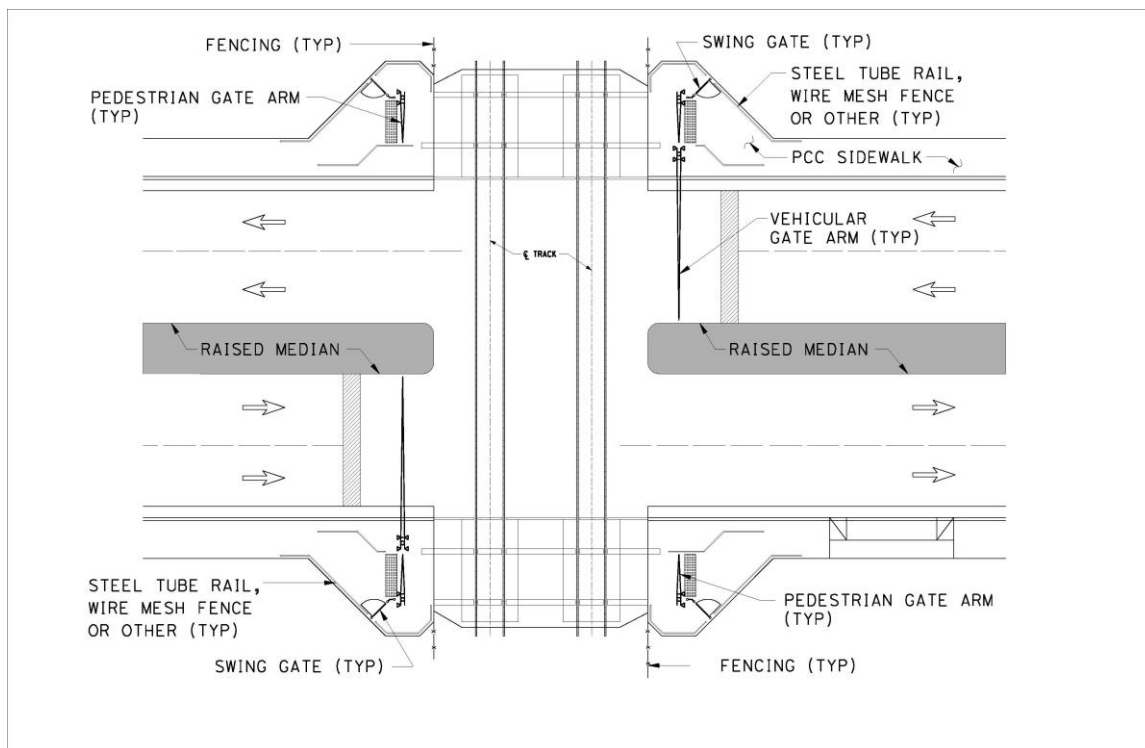


Figure 3-13. Farside Driveway at Highway-Rail Grade Crossing



In addition to preventing vehicles from driving around gates, well designed medians limit movements out of these driveways, thus minimizing vehicle queuing hazards associated with cross-traffic vehicle movements.

Vehicles entering and exiting a driveway immediately adjacent to a highway-rail grade crossing can affect the traffic flow over that crossing. In particular, vehicles making right or left turns into, or out of, the downstream driveway may force approaching traffic to slow or stop, which may result in queuing over the crossing. Where there is an existing nearside or farside driveway, the first choice is to eliminate the left turn into, and out of, the driveway by providing raised median islands, and using other measures coordinated between the highway agency and the property owner. This shall minimize the opportunity for vehicles to be stopped on the tracks by uncontrolled cross traffic.

Another solution for the mitigation of an existing driveway adjacent to a highway-rail grade crossing is the use of a shaped median that allows for a right turn out of the driveway while eliminating turning movements toward the highway-rail grade crossing. An example of this is shown in Figure 3-14, below:

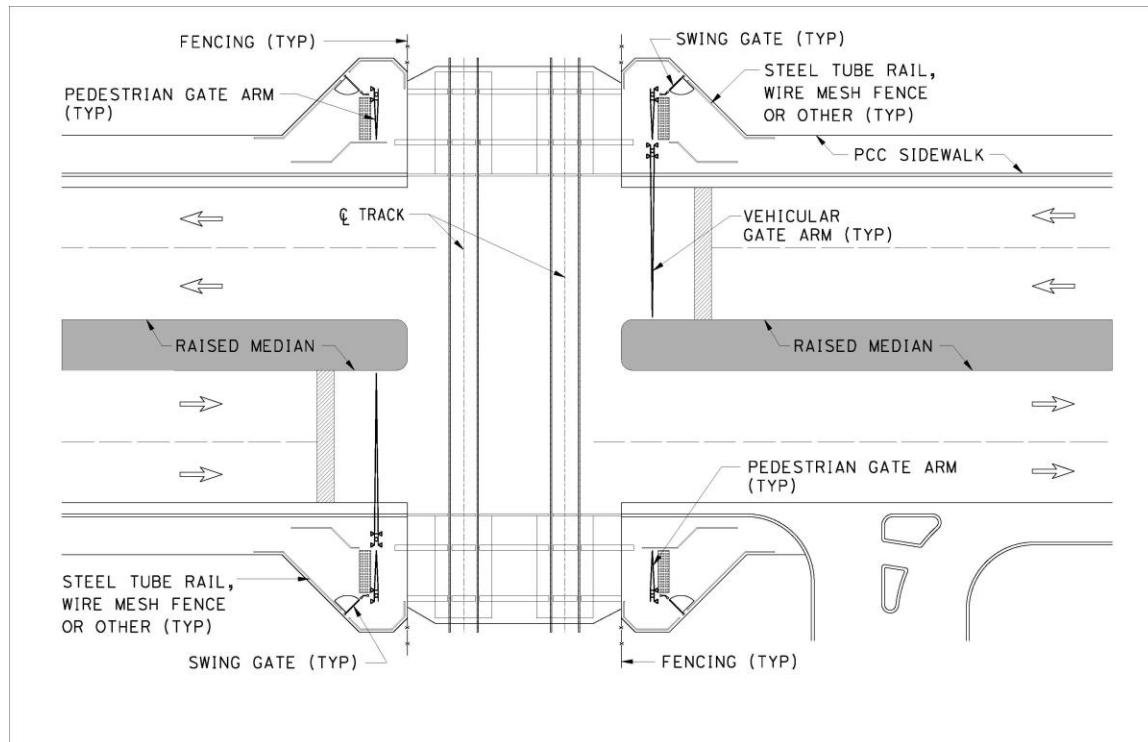


Figure 3-14. Use of a Shaped Median to Control Access

Table 3-3 below shall be consulted for the design of mitigations when driveways are located adjacent to the crossing:

**Table 3-3. Standard Mitigations for Driveways Adjacent to the Crossing**

Driveway Location	Medians	Signage	Warning Gates	Traffic Control
Nearside	<ul style="list-style-type: none">• Yes	R3-5 (RT) “Right Turn Only” sign	<ul style="list-style-type: none">• Installed at entrance quadrant	Consider traffic signals in cases of large driveway volumes
Farside	<ul style="list-style-type: none">• Yes• Install island at the driveway to prohibit left turns toward the tracks (see Figure 3-14)	R3-5 (RT) “Right Turn Only” sign	<ul style="list-style-type: none">• Installed at entrance quadrant• As a last option, consider exit gates if there is a possibility of unsafe access through the median	Consider traffic signals in cases of large traffic volumes

During the design of the crossing, consider the type of vehicle that will use the driveway and how the driveway will be used. The actions of vehicles and motorists using the highway-rail grade crossing should be observed during the diagnostics and field reviews, and findings incorporated into the design.

Driveways adjacent to a highway-rail grade crossing which require vehicle reversing (backing) movements shall not be allowed and the local highway agency shall prohibit the reversing moves. To clarify, if the driveway can only be accessed by a backing movement by the design vehicle, then this driveway will need to receive one of the following mitigations to eliminate this unsafe and illegal way to access the driveway:

- Relocate the driveway so as to provide sufficient turning capability for the design vehicle.
- Modify the loading/unloading area/location so as to provide sufficient turning capability for the design vehicle.
- Widen the highway so the design vehicle can exit the travelled way, and provide sufficient turning capability for the design vehicle.

In some instances, there may be a nearside driveway that leads to a truck loading dock (See Figure 3-15 for an example of this). In this case, the truck may drive past this nearside driveway, back over the tracks and, while backing up, turn into the nearside driveway to line up to access the loading dock. **The design and actual usage of the driveway shall preclude the movement of vehicles over the tracks while ingressing or egressing the driveway.**

In such instances, the agency shall endeavor to close the nearside driveway or work with the adjacent property owner to control this access or address the unsafe practices. **Special traffic signage shall be installed to control undesirable traffic movements, especially reverse or slow movements into or out of driveways near tracks.**

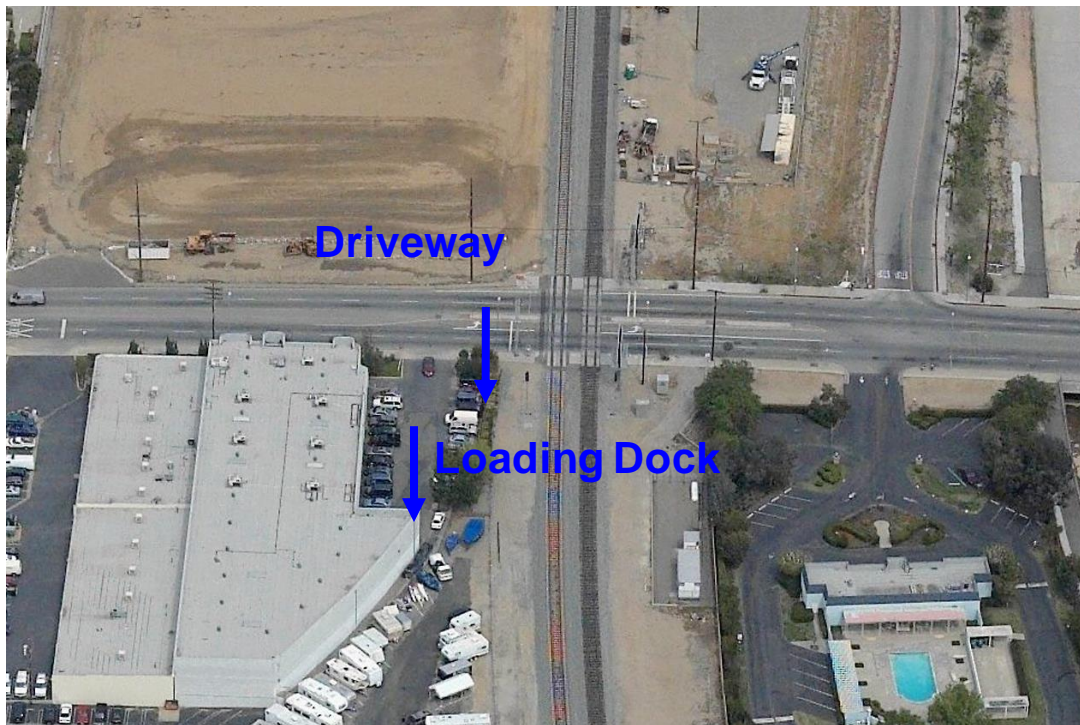


Figure 3-15. Loading Dock Adjacent to Right-of-Way

3.8 SIDEWALKS AND PAVEMENT APPROACHES

Sidewalks and pavement approaches to the highway-rail grade crossing shall be constructed using hot mix asphalt concrete between the zero curb line and the panels. Refer to SCRR Engineering Standards for the location of the zero curb line.

3.9 VISIBILITY

It is SCRR's policy to work jointly and responsibly with highway agencies, and other adjacent private property owners, to ensure that proper visibility is maintained. Buildings, fences, walls, billboards, highway geometry, trees, vegetation, natural or man-made embankments, or other man-made structures will play a significant role in the overall visibility at the highway-rail grade crossing, and these features will become important in the geometric design process. The vehicle operator should detect the presence of the highway-rail grade crossing, identify and react to the type of traffic control devices at the crossing, and determine whether a train is approaching or occupying the crossing. According to CA MUTCD, all advance warning signing, pavement markings, and highway-rail grade crossing warning devices should be clearly visible to the approaching motorist.

Horizontal and vertical curves within the highway near, or at, the crossing create additional concerns. In cases where the sight distance is not sufficient to allow adequate braking prior to the crossing, the lead Engineer should examine the need for advance warning devices.



Of particular concern is stopping sight distance near and across the highway-rail grade crossing. Refer to Sections 3.5.7 and 3.5.8 for highway geometry. The lead Engineer shall examine all aspects of the highway geometry and follow the Caltrans Highway Design Manual or AASHTO publication titled “A Policy on Geometric Design of Highways and Streets” for stopping sight distance requirements. The railroad right-of-way often abuts developments consisting of structures which prevent the motorist from clearly seeing down the tracks when approaching the crossing. During the design phase, the lead Engineer shall endeavor to investigate all measures for improving visibility at these crossings, and mitigate any detected hazards.

The following actions should be taken during the design of a grade crossing to preserve visibility:

- Prohibit new trees at highway-rail grade crossing approaches and medians, and ensure existing trees are trimmed for proper visibility.
- Prohibit new ground covers or shrubs exceeding 36 inches in height, and ensure the existing trees are trimmed for proper visibility.
- Investigate the possibility of mitigating the effects of adjacent development on overall visibility at the crossing.
- Ensure stopping sight distances are per the Caltrans Highway Design Manual or the AASHTO publication titled “A Policy on Geometric Design of Highways and Streets”.
- **Vehicle parking within 100 feet of the highway-rail grade crossing, as measured from the furthest automatic warning device from the tracks, shall be prohibited.**

Figure 3-16 is an example of how visibility can be impaired at a highway-rail grade crossing by highway geometry and landscaping. Note the following items:

- Advance signs are obscured by trees.

Mitigations: Avoid the planting of trees adjacent to advance signs.
 Work with the highway agency to adequately maintain trees and landscaping.

- Advance visibility of vehicles downstream of the highway-rail grade crossing is impeded by geometry. The vertical curve at the highway-rail grade crossing may prevent the motorist from seeing possible highway obstructions concealed by the highway profile.

Mitigations: To the extent possible, design highway geometry to eliminate these cases.
 Install advance warning to warn motorists.



Figure 3-16. Restricted Visibility at a Highway-Rail Grade Crossing Approach

Regular trimming of vegetation along the approaches to the highway-rail grade crossing is an important responsibility of the highway agency or private property owner.

3.10 SIGHT TRIANGLES

It is SCRRRA's policy to work jointly and responsibly with highway agencies, and other adjacent private property owners, to ensure that improvements to properties adjacent to the railroad corridor, and particularly at highway-rail grade crossing, are designed so as to mitigate the effects of the development on highway-rail grade crossing safety.

A sight triangle is the triangular area of visibility required to allow a driver to see an oncoming train (approaching from either direction) in advance of the crossing. The stopping sight distance is measured along the highway and is a function of the distance required for the design vehicle, traveling at the posted speed limit, to stop safely.

The use of the sight triangle for highway-rail grade crossing design is an effective tool for the development of the overall design, as well as to mitigate the effects of restricted visibility. The FHWA handbook shows a calculation used to determine sight triangle distances. Unfortunately, urban areas seldom have the proper site triangle (as shown in the FHWA handbook). In these cases, signal timing, and highway-rail grade crossing warning device timing, must provide adequate warning to enable the motorist to stop prior to the crossing.



The effects that commercial or residential development can have on the visibility at a highway-rail grade crossing are shown in Figure 3-17. The sight triangles for this highway-rail grade crossing show the effective visibility of the highway-rail grade crossing from the motorist's perspective. This figure demonstrates the effect on overall visibility when buildings are placed adjacent to the right-of-way. The solid green fill shows a constricted sight triangle resulting from the location of proposed buildings on a development site adjacent to the railroad right-of-way.

Figure 3-18 demonstrates the same building configuration relocated to the backside of the property, which results in much improved visibility of the track area. Although this realignment of the buildings does not alter or impair the overall use of the property, it is an effective way of improving visibility and places driveways away from the highway-rail grade crossing.



Figure 3-17. Sight Triangle Impeded by Adjacent Buildings



Figure 3-18. Sight Triangle Enhanced through Alternative Placement of Buildings

3.11 PASSIVE TRAFFIC CONTROL DEVICES

Passive warning devices are traffic control warning devices not activated by trains, vehicles, or pedestrians. Passive warning devices provide static messages of warning, guidance, and (in some instances) mandatory action for the driver. Their purpose is to identify and direct attention to the location of a highway-rail grade crossing in order to permit motorists, bicyclists, and pedestrians to take appropriate action. Passive warning devices consist of regulatory, warning, and guide signs, along with supplemental pavement markings. These basic devices are incorporated into the design of active traffic warning devices. The application of passive devices is defined in Part 8 of the CA MUTCD.

3.11.1 Signage

The application of signage at highway-rail grade crossings is defined in Part 8 of the CA MUTCD. The lead Engineer shall follow the requirements within this section for the proper application of highway signs at the crossing.

In addition to highway signs to be installed at the highway-rail grade crossing, there may be additional signs required, such as, “No Trespassing”. Installation of “No Trespassing” signs on the SCRRA member-owned right-of-way shall be installed per SCRRA Standards.

The highway agency is responsible for approving the use of highway signs, and coordination between highway agency and the lead Engineer is required.



3.11.2 Pavement Markings

Striping and pavement marking are defined within Part 8 of the CA MUTCD. SCRRA has defined additional striping and delineation requirements that apply to highway-rail grade crossings. These measures include the following:

- Striping along edge of travel way: (SCRRA Engineering Standards 4004)
- Striping between medians: (SCRRA Engineering Standards 4004)
- Possible use of “Keep Clear” pavement markings: (Caltrans)

Maintenance responsibilities for striping and pavement markings are to be defined in the C&M. Also, refer to CPUC GO 75. Generally, the highway agency maintains the highway striping. The lead Engineer is to refer to the configuration and location of striping shown in Chapter 8 of the CA MUTCD. In addition, the lead Engineer is directed to SCRRA Engineering Standards for pavement markings within the limits of the crossing.

The highway agency is responsible for approving the use of highway pavement markings, and coordination between highway agency and the Engineer is required.

3.12 ACTIVE TRAFFIC CONTROL DEVICES

All SCRRA “main track” highway-rail grade crossings should be equipped with active warning devices used to warn vehicles and pedestrians of potential hazards at the crossing, in accordance with the GO 75 of the CPUC, this Manual, and the CA MUTCD. Furthermore, it is SCRRA’s policy to require that any new SCRRA “main track” private highway-rail grade crossing shall be so equipped with standard equipment at the private owner’s expense. (Refer to Appendix B for the definition of SCRRA “main track”).

Each of these types of devices is designed to fill a need at the highway-rail grade crossing to effectively warn of approaching trains. The placement of these devices is an important factor in the development of the highway-rail grade crossing, and must be considered during design. It should be noted that these devices may be installed at locations other than at highway-rail grade crossings to ensure proper advance warning of oncoming trains.

Each warning device is constructed on a substantial foundation required for the safe support of the device. These foundations may take up a broad area and must be considered in the placement of the device. The utilities and drainage associated with the highway-rail grade crossing shall be considered when developing the overall layout of the devices. Additionally, the position of present and future foundations must be taken into account when considering utility encroachment—it may be necessary to relocate utilities and other facilities that could interfere with these foundations.

The placement of active warning devices is an important factor in the overall design process. Baseline criteria have been developed to use for guidance in the placement of the highway-rail grade crossing devices.

Warning gates are physical barriers that obstruct the entrance to the highway-rail grade crossing upon activation by an approaching train. The railroad signaling system activating these devices is further defined within the SCRRA’s signal and communication standards. Standard applications of warning gates and flashing signals (Automatic



Warning Devices) are shown in Figure 3-19 through Figure 3-22. In addition, a cross-buck, and a sign indicating the presence of multiple tracks at the crossing, would be mounted on each gate to indicate the presence of multiple tracks at the crossing.

Flashing signals are mounted on the mast or on an overhead cantilever to provide a visual warning of an oncoming train. These lights are directed toward the approach. In some cases (such as with adjacent driveways and highway), additional auxiliary lights are necessary to provide visual warning for each approach to the crossing.

Some applications of flashing signals include backlights mounted on the mast in addition to the standard flashing signal configuration. *SCRRA's policy is to discourage the use of backlights on exit gates to avoid motorist confusion.* The use of backlights shall be evaluated to determine the necessity of their use and the possibility for motorist confusion.

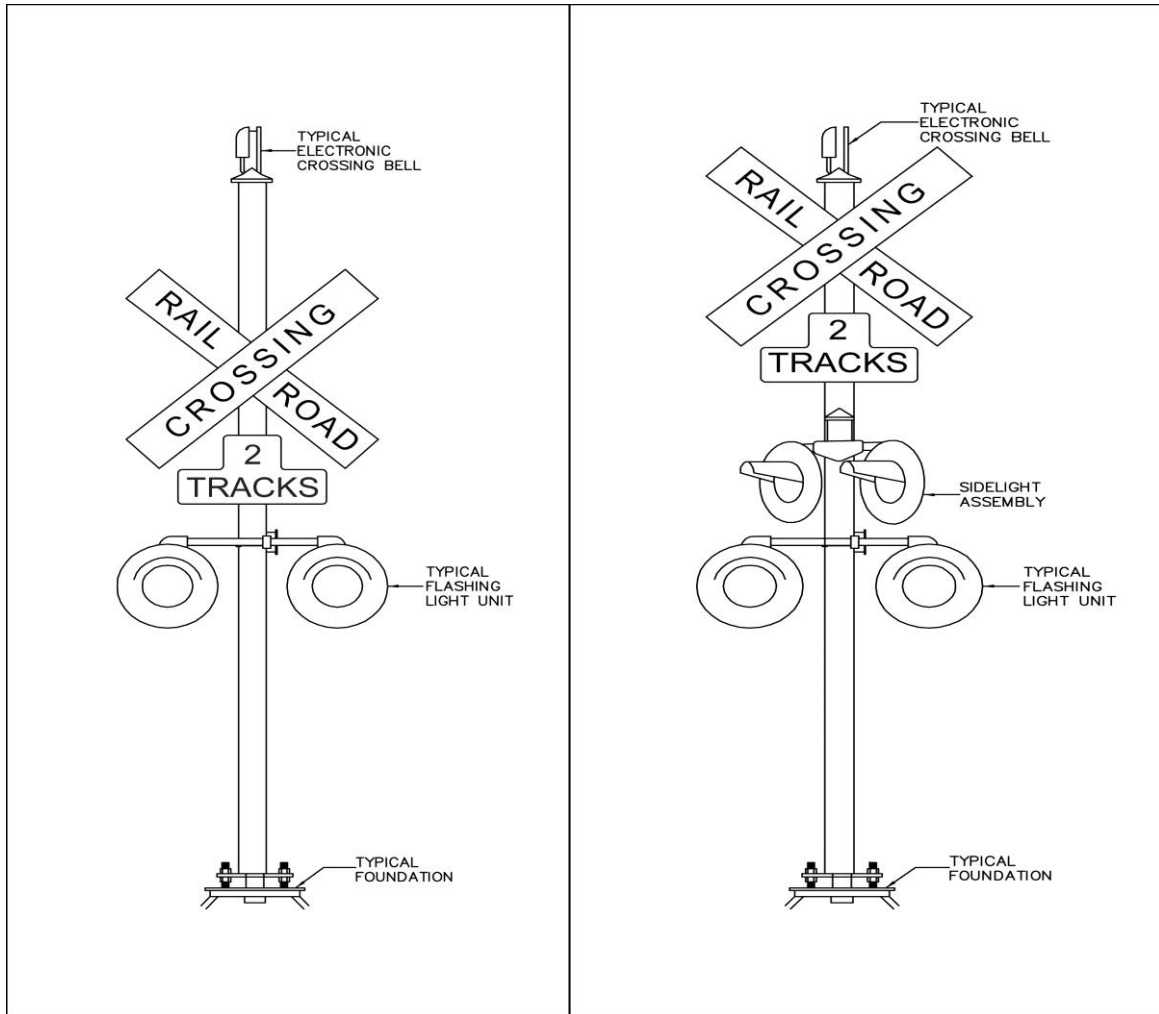


Figure 3-19. Active Warning Device Mechanisms – Standard No. 8 (Left) and Standard No. 8 with Additional Sidelights (Right)

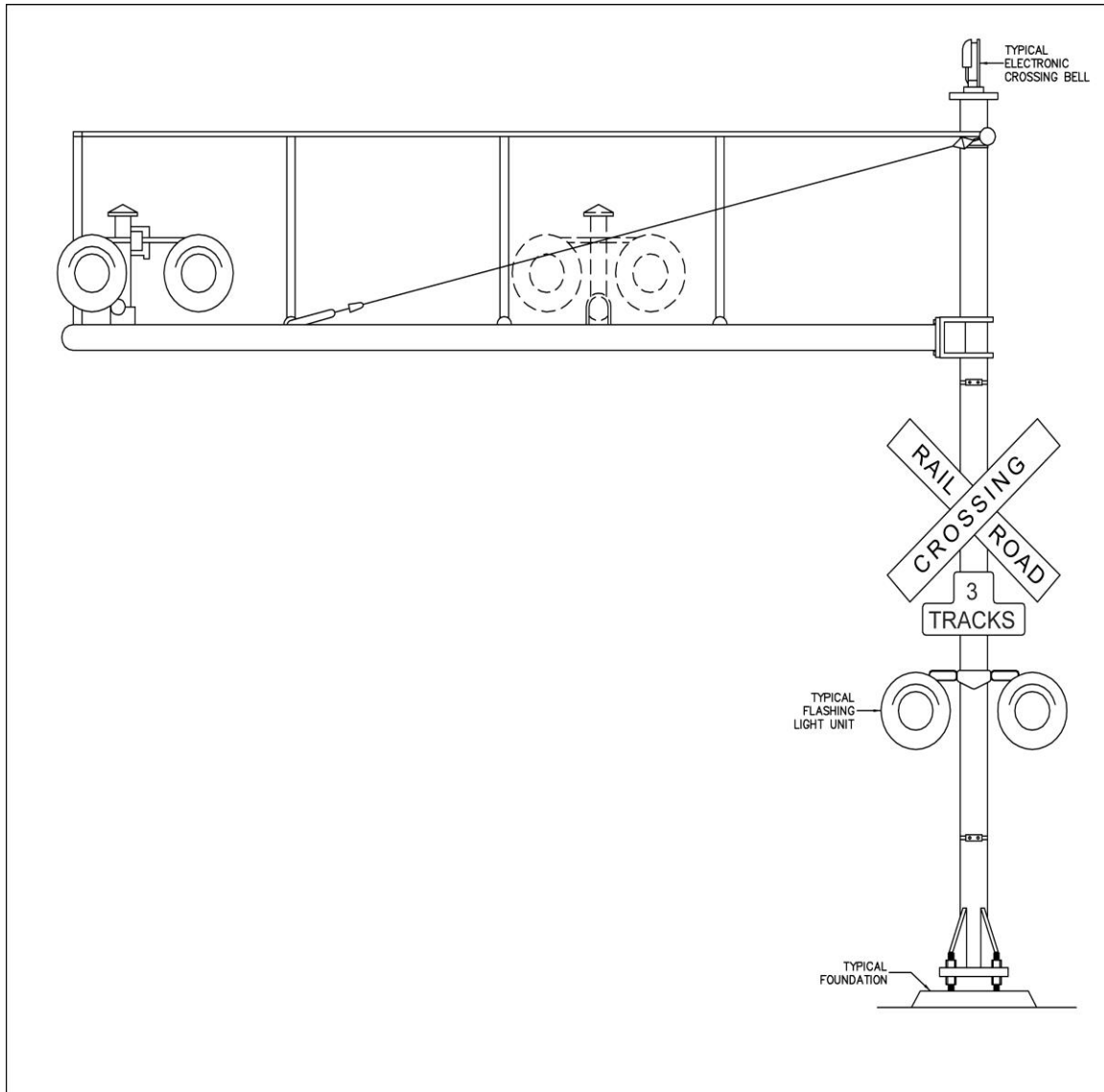


Figure 3-20. Active Warning Device Mechanisms – Standard No. 8-A

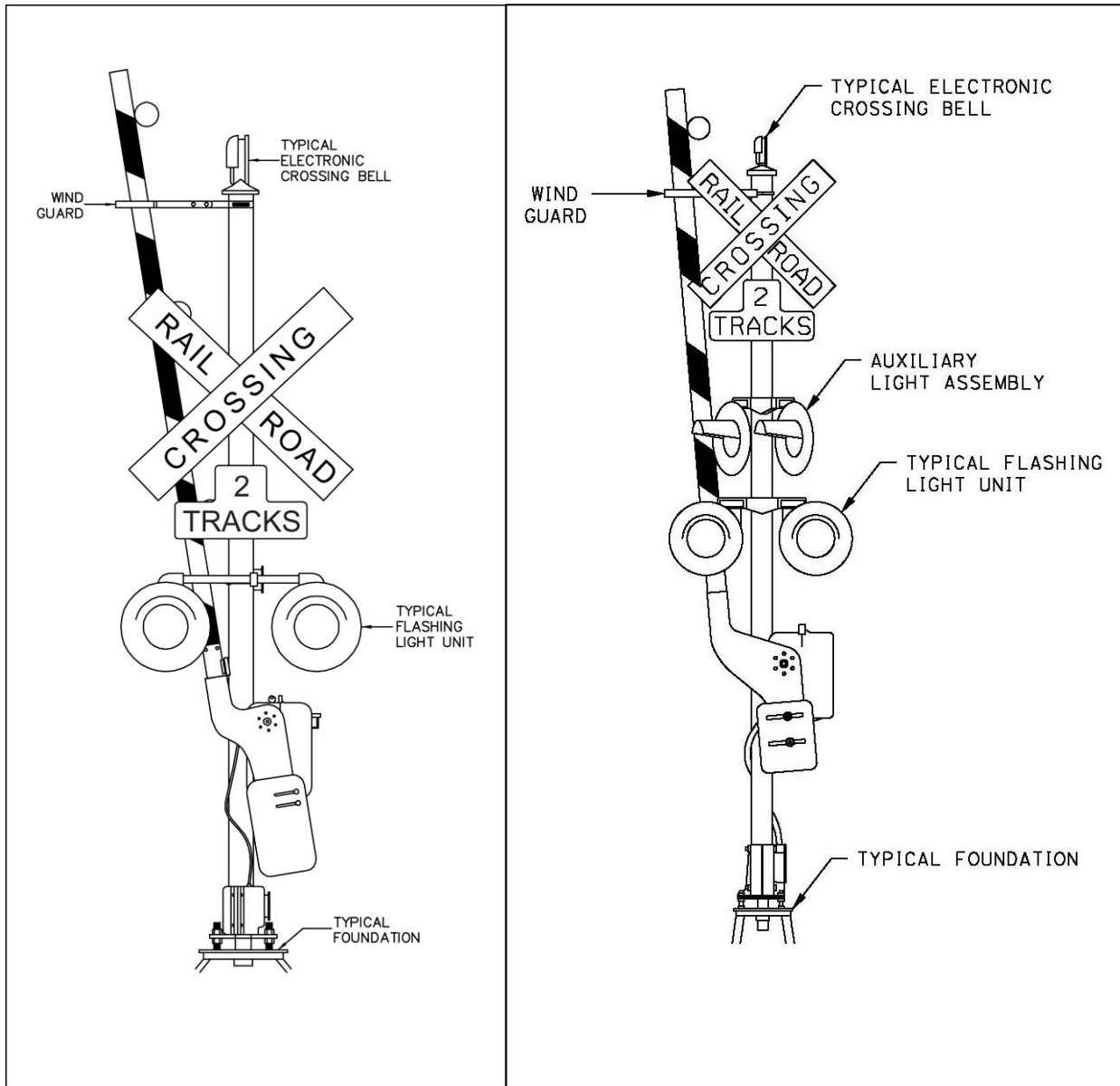


Figure 3-21. Active Warning Device Mechanisms – Standard No. 9 (Left) and Standard No. 9 with Additional Auxiliary Lights (Right)

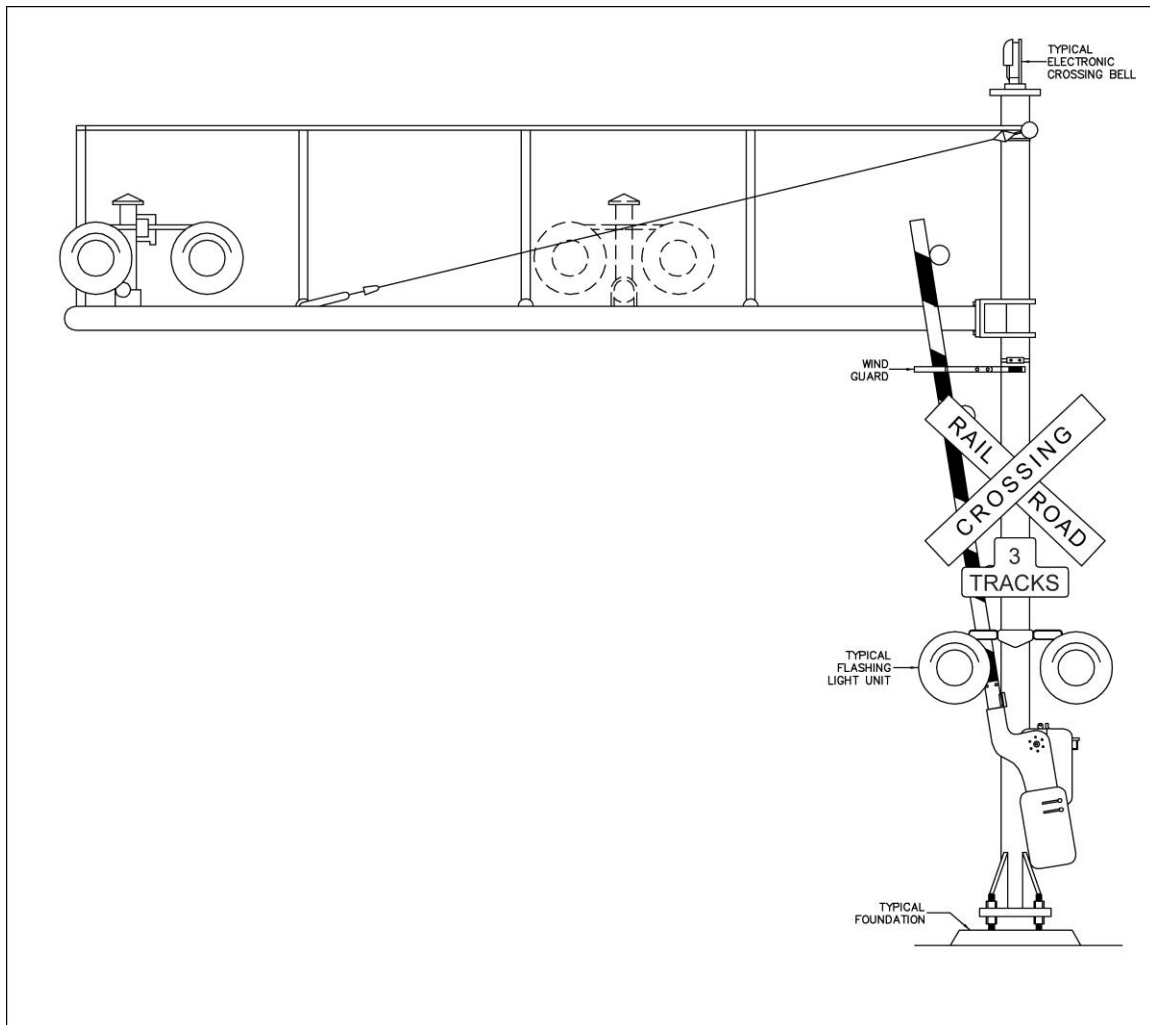


Figure 3-22. Active Warning Device Mechanisms – Standard No. 9-A

For additional information on the various types of warning devices, refer to CPUC General Order No. 75.

As mentioned previously, it is SCRRRA standard to provide flashing lights for each traffic lane approaching the highway-rail grade crossing. For more detailed information on the location, dimensions, and selection of warning devices, refer to SCRRRA's Engineering Standards for signals and communications.

When the use of a No. 9 Gate (see Figure 3-21) is defined by SCRRRA's Engineering Standards, the flashing light mounted on the mast shall provide warning for the curb and the traffic lane. If there is more than one lane, and highway width is greater than the maximum length of the single gate arm, an additional device will be required adjacent to the second lane. A No. 9-A cantilever signal (see Figure 3-22) may be used in order to place the light over the traffic lane.

Where pre-signals are installed, the lead Engineer and the diagnostic team shall evaluate the locations of both the railroad and traffic signaling to ensure the combination



of traffic lights and highway-rail grade crossing warning lights is coordinated and do not conflict with one another, thus mitigating possible confusion for motorists approaching the tracks.

3.12.1 Two-Quadrant Gate Systems

Standard gate systems utilize gates installed in the entrance, or upstream, quadrant of the highway-rail grade crossing. These gates are intended to prevent the motorist from proceeding into the path of the train when the gate is in the horizontal position. See Figure 3-23 below.

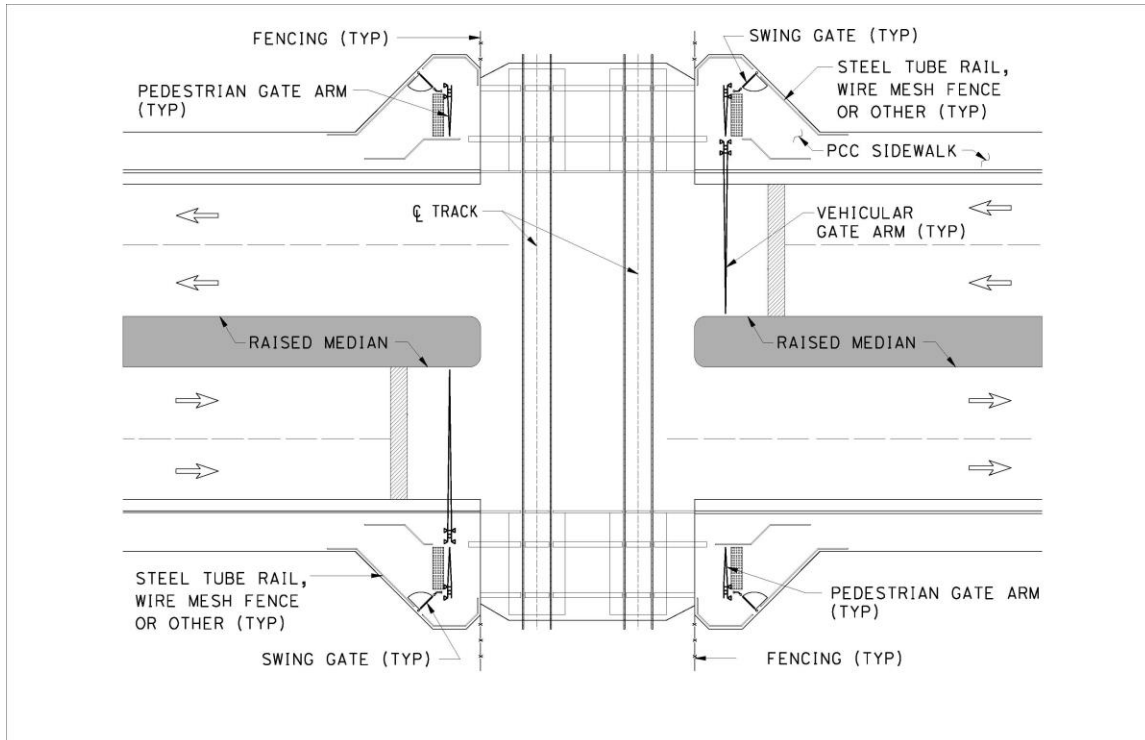


Figure 3-23. Two-Quadrant Gate System

3.12.2 Exit Gate Systems

SCRRRA standards call for a raised median (refer to Section 3.6 for additional discussion) instead of an exit gate (with the exception of a highway-rail grade crossing within 100 feet of an intersection with a parallel highway, as discussed below). However, in some applications a raised median may not be possible due to the conditions at the highway-rail grade crossing. In cases such as these, an exit gate may be used as a last resort, but will require a request for a deviation then approval from SCRRRA.

Exit gates are seldom used with raised medians of substantial length unless there are extenuating circumstances. Even so, they are discouraged by the SCRRRA. This is primarily due to the redundancy in the systems and the long term life-cycle costs of repairing, maintaining, and replacing exit gates as compared to medians. For example, a raised median with exit gates may be utilized where there is an adjacent driveway to the



crossing. This will prevent an illegal turn out of the driveway and onto the crossing. An example of an exit gate system is shown in Figure 3-24.

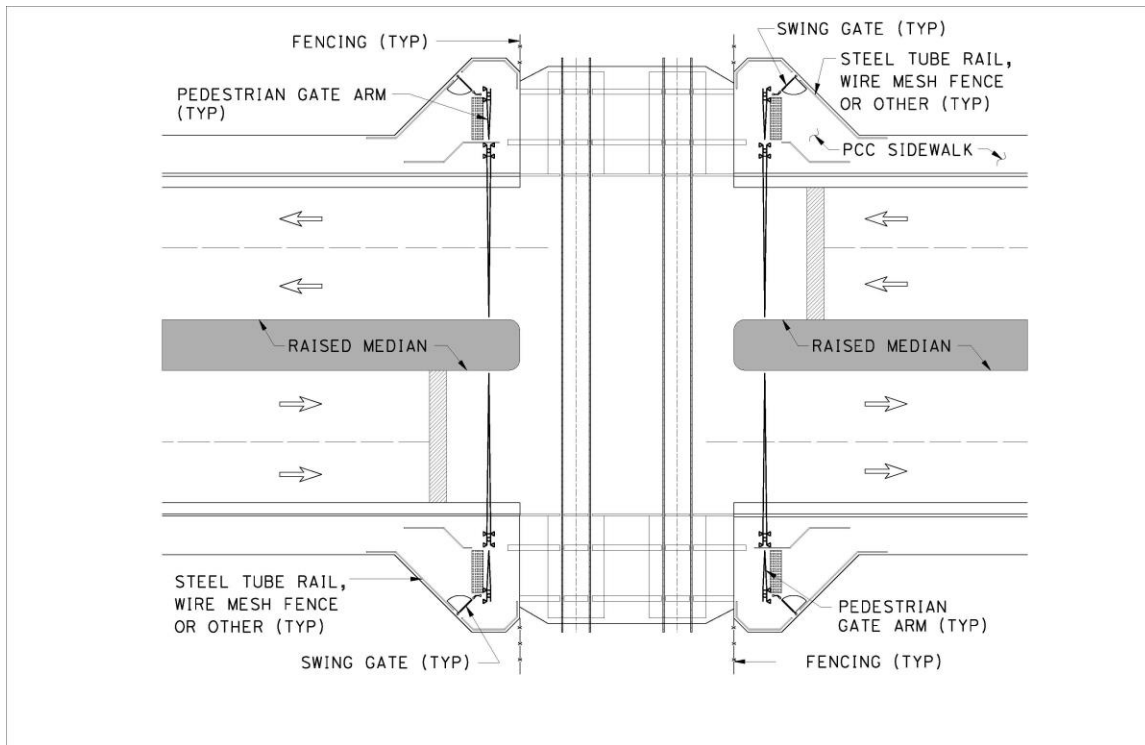


Figure 3-24. Exit Gate Systems

Highways parallel to the tracks present a unique challenge. At an intersection with a highway, access to the track area by traffic turning toward the tracks, particularly a left turn, creates safety situations that should be addressed in design. **For intersections within 100 feet of the highway-rail grade crossing with multiple main tracks, an exit gate shall be installed to prevent left turn movements accessing the track area.** This is shown in Figure 3-25.

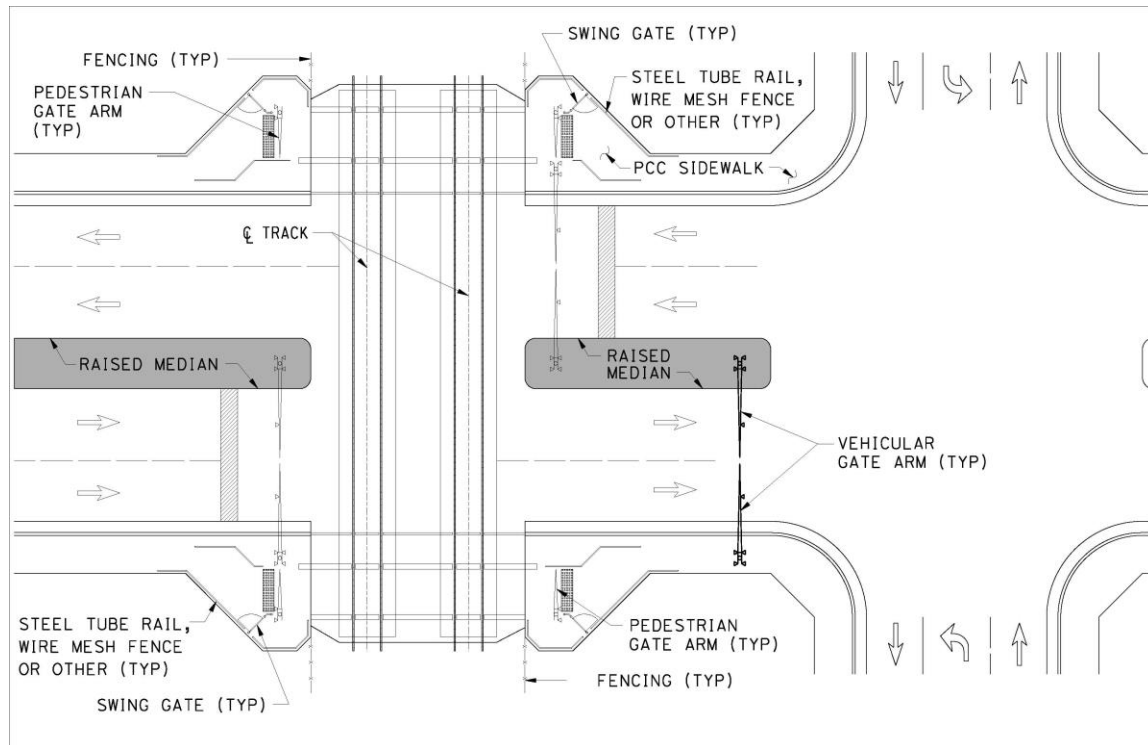


Figure 3-25. Exit Gate Installation near an Intersection

The inclusion of exit gates requires the installation of induction loops that are part of the vital crossing signal system within the pavement. *It is SCRRA's policy to maintain these loops when they are integrated into the vital railroad signal system.* It is important to factor the maintenance of these into the overall C&M Agreement for the highway-rail grade crossing. Refer to SCRRA Engineering Standards for further discussion on the use of induction loops.

The following protocols shall be observed during the engineering and construction of these induction loops:

- The lead Engineer shall refer to SCRRA Engineering Standards for placement of induction loops through the crossing.
- The lead Engineer shall refer to SCRRA Engineering Standards as a minimum standard for the pavement structure through the crossing; shall verify the pavement section through appropriate engineering analysis; and enhance the specifications as necessary to meet the needs of the design. Low maintenance high quality pavement sections shall be installed within 50 feet of the highway-rail grade crossing.
- The lead Engineer shall include within the construction specifications a mandate that the contractor shall not install pavement within the limits of the highway-rail grade crossing and the induction loops without the review and approval of the SCRRA.
- The highway agency having jurisdiction over the highway shall execute a C&M Agreement defining the induction loops, as well as the division allocation of maintenance responsibilities and costs regarding the crossing.



Table 3-4 below can be used as a reference for the installation of gates.

Table 3-4. SCRRRA Standard for Gate Installations

Number of Approach Lanes	Raised Median	Option 1	Option 2	Option 3
1	No	Two No. 9 devices	N/A	N/A
1	Yes	Two No. 9 devices	N/A	N/A
2	No	Two No. 9-A devices	N/A	N/A
2	Yes	Two No. 9-A devices	Four No. 9 devices	Two No. 9 devices with a cantilever
3	Yes	Two No. 9-A devices Two No. 9 devices	N/A	N/A
4	Yes	Four No. 9-A devices	N/A	N/A

3.12.3 Measures to Counter Potential Gate Violations

When analyzing a highway-rail grade crossing for gate placement, it is important to assess the opportunities that motorists will have to drive around the lowered gate. Many conditions exist that promote such opportunities. Three of these are listed below:

- Higher traffic counts, and the resulting delays at the gates.
- In locations, or at times when there is light traffic, presenting less restrictions to gate violation.
- In locations where the vehicle crossing is adjacent to a station where dwell times within the station cause longer gate down time.
- The proximity of driveways or intersections that provide opportunities for gate violations.

The lead Engineer, along with diagnostic team, shall analyze the project location to assess the need to install median islands, lengthen existing median island(s), or to include exit gate(s) in order to counter potential or observed gate violations.

3.13 ADJACENT CROSSWALKS

Pedestrian crosswalks parallel and adjacent to highway-rail grade crossings are strongly discouraged. Pedestrians using these crosswalks may cause vehicles to queue over the highway-rail grade crossing without an avenue of escape. Active measures should be taken to prohibit access using signage and barricades. A request



for a deviation from the recommended design practices and standards must be submitted

Figure 3-26 below is an example of how the presence of pedestrians can inhibit vehicular traffic from clearing the track area.



Figure 3-26. Pedestrian Crosswalk Parallel and Adjacent to a Highway-Rail Grade Crossing

3.14 ADJACENT HIGHWAY-RAIL GRADE CROSSINGS

The location of adjacent highway-rail grade crossings should generally be noted and analyzed with the operation of the subject highway-rail grade crossing. Separate railroad operations on the adjacent highway-rail grade crossing may cause vehicles waiting behind lowered gates to queue back over the adjacent highway-rail grade crossing. In these situations, the location and proximity of the operations will have a large impact on the overall design.

At locations where there is a possibility of vehicles queuing over a highway-rail grade crossing, the lead Engineer shall coordinate the design with the owners and operators of both highway-rail grade crossings to develop a solution to avoid vehicles being trapped



between the highway-rail grade crossings or over the adjacent highway-rail grade crossing.

3.15 TRAFFIC SIGNALS

The placement of traffic signals depends upon the proximity of the highway intersection to the highway-rail grade crossing, alley intersections, driveway intersections, vehicle queuing, and the impact of adjacent traffic control devices on the operation of the highway-rail grade crossing. The lead Engineer shall consider several factors when deciding on the inclusion of a traffic signal into highway-rail grade crossing system, some of which are listed below. In addition, the lead Engineer should conduct queuing studies during traffic peak-hours to accurately assess actual traffic conditions at the project site.

- Traffic congestion should be minimized along the highway that crosses the railroad tracks. Various factors affect the operation of traffic at the highway-rail grade crossing and tend to cause traffic to queue over the tracks.
- The presence of a traffic signal downstream, or upstream, of the highway-rail grade crossing may tend to generate long traffic queues that could back up over the tracks.
- CA MUTCD Part 8 Section 8D.07 recommends the preemption of traffic signals located within 200 feet of the highway-rail grade crossing. In addition, Section 8D.07 suggests preemption may be appropriate for longer distances, depending upon vehicle queuing. Refer to Section 3-16 of this Manual for additional information on preemption.
- The location of a nearby stop-controlled intersection may tend to cause traffic to back up into the highway-rail grade crossing, especially during peak traffic hours.

Some commonly used mitigation measures are as follows:

- Traffic signal coordination, including the installation of queue-cutter signals, pre-signals, and/or turning movement prohibitions.
- Replace the stop control with a preempted traffic signal.

3.15.1 Adjacent Stop Controlled Intersections

Adjacent stop controlled intersections should generally be avoided in all instances. Vehicles traversing the highway-rail grade crossing should have a clear path over the crossing that is unimpeded by vehicular cross traffic. The existence of a stop sign controlling vehicular movements over the crossing may force vehicles to wait for cross traffic to clear before proceeding. In cases where there is limited distance between the highway-rail grade crossing and the adjacent intersection, or significant vehicular traffic over the highway-rail grade crossing, vehicles can queue over the highway-rail grade crossing without a means of escape.

3.15.2 Design Scope

This section establishes the basic traffic engineering criteria to be used in the design of traffic signal systems affected by SCRRRA's operations.



The design shall specify all traffic signal equipment, including: traffic signal controller assemblies, the railroad interconnection system, lighting systems, sign illumination systems, communication systems electrical equipment, and provisions for future systems, and any combinations thereof. *The design shall incorporate equipment that has been proven to be reliable, durable, and effective on the SCRRA or other major Class 1 inter-city passenger or commuter railroad systems, and already is or can be readily incorporated in current SCRRA System active warning devices.* In order to provide this, the lead Engineer shall coordinate with SCRRA forces for advice/direction regarding this matter.

The design shall incorporate features and equipment that are familiar to the SCRRA Engineering, Construction and Maintenance staff and contractors and that will contribute to the inspection, testing, repair operations, and maintenance of the traffic signal system. Any new testing procedures, or methods required by new equipment, must be identified and submitted to SCRRA and the highway agency for consideration and approval before implementing the new equipment and procedures.

All designs shall be submitted for SCRRA approval in accordance with Section 7.9 “Submittals” of this Manual. The local highway agency shall also approve the design of the traffic signal system.

3.15.3 Traffic Signal Standards

Traffic signal systems shall be designed in accordance with the standards and practices of the stakeholder having jurisdiction over the specific traffic signal system. The most current version of the applicable standards in effect at the time of proposal submission shall be used.

The design shall adhere to the latest version of CA MUTCD and the local jurisdiction's design criteria for traffic signals, or to a separate criterion specifically established by the local jurisdiction. Any new or modified traffic signal system shall be coordinated and integrated into the civil and track design to provide a seamless interface between the design disciplines.

3.15.4 Traffic Signal Design

As per the CA MUTCD, if preemption is provided at a signalized intersection, the normal sequence of traffic control signal operation shall be interrupted by the railroad (preempted upon the approach of a train). The sequence of traffic signal and railroad warning system operations during the interruption shall avoid entrapment of vehicles on the highway-rail grade crossing (entrapments that might result from conflicting displays in which the traffic control signals are green, even while the railroad active warning flashing-light signals are active). **During the preemption hold interval, the traffic signal indications shall prevent vehicles from moving toward the track area.** All turning movements toward the highway-rail grade crossing that are currently permitted shall be prohibited during the signal preemption sequences. **A blank-out, changeable message sign, appropriate highway signal indication, or other similar control shall be used to prohibit turning movements toward the highway-rail grade crossing during preemption.** The R3-1 and R3-2 blank-out signs that are to be used as appropriate for turn prohibition are shown in Figures 3-27 and Figure 3-28. Turn prohibition blank-out signs that are associated with preemption shall be visible only when



the highway-rail grade crossing restriction is in effect. For signalized intersections that display a red indication, during preemption, to restrict all movements across the tracks, an R10-11 blank-out sign may be used.

The R3-1, R3-2, and R5-1 blank-out signs are typically placed where they may most easily be seen by the motorist intending to make a turn. The R3-1 should be placed over the highway in line with the right-turn lane, or at the right corner of the intersection. The R3-2 should be placed over the highway in line with the left-turn lane adjacent to the left-turn signal indication, or on the median (in line with the left-turn lane). The R5-1 should be placed appropriately for the movement being restricted.



Figure 3-27. Turning Movement Blank-Out and Associated Signs



Figure 3-28. Turning Movement Blank-Out Sign



As per the CA MUTCD, whenever a traffic signal is provided with emergency vehicle preemption and railroad preemption, the railroad preemption shall have priority. In the event of a demand for emergency vehicle preemption during the time the intersection is operating on railroad preemption, the railroad preemption sequence shall continue unaffected until completion. In the event of a demand for railroad preemption during emergency vehicle preemption operation, the railroad preemption function shall immediately assume control of intersection operations. However, traffic signals may be used to enhance the control of highway users at highway-rail grade crossings.

A detailed analysis shall be conducted for any planned signalized intersection to properly define the lane geometry and configuration. The objective is to efficiently control the signalized intersection and maintain a reliable railroad operating system.

Traffic signal system design shall incorporate input from the stakeholders having jurisdiction over the signal system. A traffic signal system plan shall be prepared for each new or revised traffic signal system. The traffic signal system plan shall be in a format acceptable to the stakeholder having jurisdiction over the signal system, and shall be prepared by a professional traffic Engineer registered in the State of California.

The following general criteria shall apply:

- Traffic signals, pedestrian signals, and any special signs and signals required shall be designed and installed in accordance with the local jurisdiction's specifications.
- Where there are existing conductors, interconnecting traffic signals, and railroad signals, they may be used if in good condition and adequate for the desired type of interconnection. See Section 6.10 for information on interconnection circuitry. New traffic signals shall be integrated into the existing or modified system, as appropriate, in accordance with the local jurisdiction's standards and specifications, and SCRRA requirements.
- The traffic signal lead Engineer shall be responsible for coordinating with the appropriate local utility company to determine the source of power and the utility company's requirements for each new or revised traffic signal and safety lighting system.
- The design and placement of vehicle induction loops near the tracks shall be coordinated with SCRRA railroad signal engineers.
- *Where the traffic signal system design requires the removal of existing traffic signal equipment, the existing traffic signal system shall be kept operable until the new equipment has been installed, tested, and ready for activation.* During periods when the existing traffic signal is inoperable, the intersection shall be flagged in accordance with the requirements of the local jurisdiction. In cases where this occurs within 200 feet of a highway-rail grade crossing, SCRRA shall control the highway-rail grade crossing with flagging.

3.15.5 Left-Turning Movements

A traffic study shall be conducted to determine the need and length for left-turn pockets and protected left movements at existing signalized intersections that are preempted by trains which, under the original conditions, do not have left-turn pockets or protected left-turn signal indications (green arrows). All legs of the intersection should be evaluated to



determine the appropriateness of the left turn protection. In addition, the length of the left-turn lane should be evaluated for proper application according to traffic demands. The left-turn protection (green arrow) shall provide the following criterion during the preemption sequence:

- Provide sufficient green time for the left-turning motorists traveling away from the highway-rail grade crossing to clear any vehicles from the railroad tracks.
- Restrict conflicting left-turn movements toward the tracks.
- Allow non-conflicting left-turn movements away from the tracks during the preemption hold interval.
- **In case there is an existing left-turn lane and it is not provided with a signal head equipped with protected left-turn arrow, the traffic signal shall be modified to provide protected left-turn arrow, or a blank-out sign.**

The lead Engineer shall analyze the length of left-turn lanes in association with the overall crossing. **A left-turn lane pocket configuration extending across the tracks is not allowed** unless countermeasures such as traffic signals, striping, and signing are also used to warn motorists not to stop on the tracks. A deviation from the Manual must be requested for this configuration. Several concerns arise with this configuration:

- Vehicles waiting to turn are impeded from turning by cross-traffic, since the turn onto the cross street is not controlled by a traffic signal
- Vehicles queuing in this left-turn lane over the track will not have an unimpeded egress should a train arrive.

In such cases, the design shall provide appropriate mitigations to avoid the trapping of vehicles across the highway-rail grade crossing.

- Install a preempted traffic signal at the cross street to allow the clearance of the left-turn lane on the arrival of a train
- Install a queue-cutter signal or pre-signal to control vehicles stopping on the tracks.

It must be noted that the addition of a left-turn lane, as well as changing the length of the left-turn lane, should only be considered after a proper engineering study regarding the traffic movements associated with that lane are known. The left-turn lane shall be of sufficient length to avoid vehicles waiting for the left turn to impede approaching traffic.

3.15.6 Pre-Signals

Refer to Part 8 of the CA MUTCD for requirements associated with pre-signals. Whereas existing traffic signal preemption is mandated to clear queued vehicles from the crossings upon arrival of trains, a pre-signal is intended to preclude, or minimize, and queuing across the highway-rail grade crossings during each traffic signal cycle, regardless of the presence of a train on the approach. A pre-signal does not eliminate the need for preemption, but it does significantly reduce the likelihood that vehicles are within the minimum track clearance distance, and clear storage distance, at the onset of the clear track green interval (see Section 3.15 for an explanation of these terms). See Figure 3-29 for a typical pre-signal.

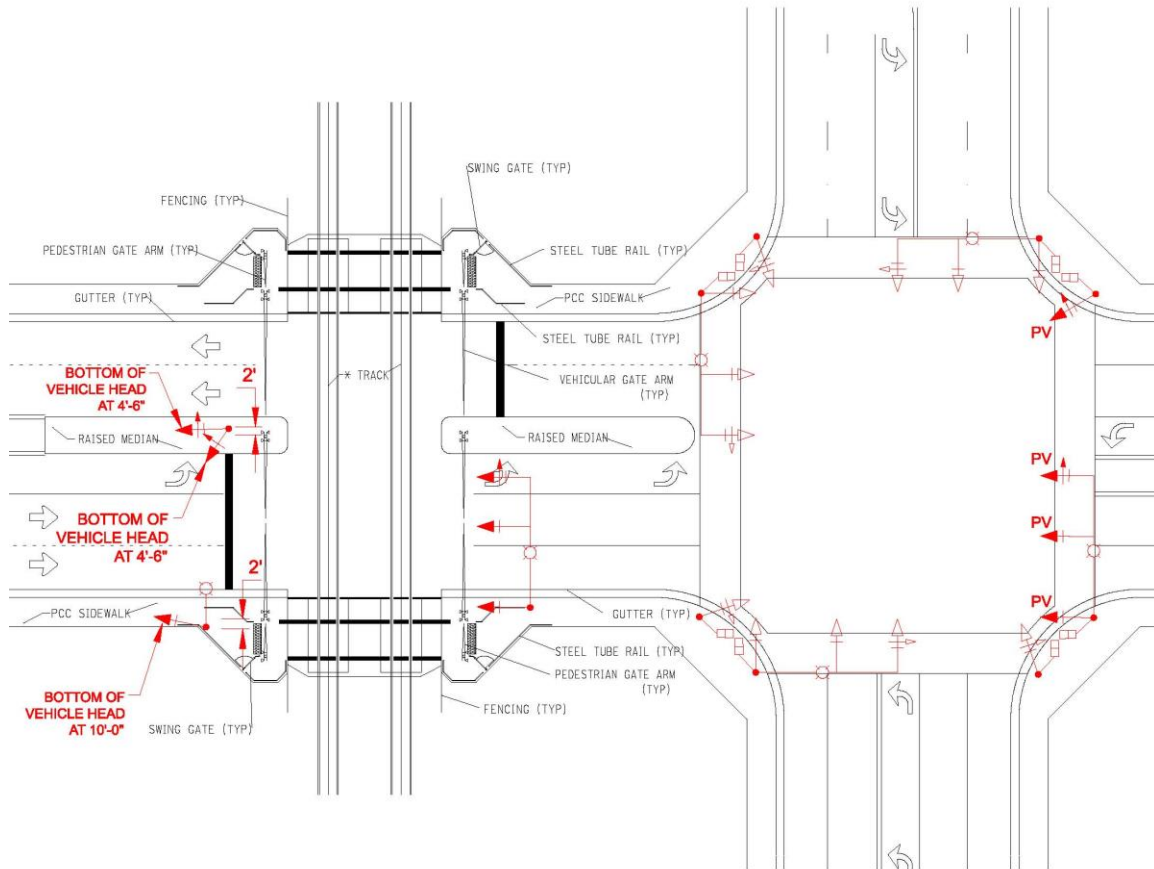


Figure 3-29. Typical Pre-Signal Layout

The lead Engineer should be aware that the installation of pre-signals, in coordination with railroad warning signals, can create instances where the motorist may become confused by conflicting signal directions. This can be a particular problem when the traffic signals on an overhead mast flash red as the railroad signal lights on a cantilever flash red. These send conflicting messages to the motorist: a flashing red traffic light indicates stop and proceed, while a flashing railroad warning light indicates stop. **The use of a Standard No. 9-A cantilever for a pre-signal is not allowed.** In locations where both a pre-signal and a cantilever are already present or are typically required, the lead Engineer should consider installation of the pre-signal and omit the installation of the Standard No 9-A device. This installation allows the railroad warning gates and lights to operate in conjunction with the traffic pre-signals to send the appropriate message to the motorist.

If the pre-signals are on separate masts, they must be positioned so as to avoid interference to the visibility of the railroad flashing-light signals or other traffic control signals.

A pre-signal should be considered in the following cases:

- Where the clear storage distance [measured between six (6) feet from the rail nearest the intersection to the intersection stop line, or the normal stopping point on the highway] is 50 feet or less.



- At approaches where high percentages of multi-unit vehicles are evident, the distance should be 75 feet. A vehicle classification study should be conducted to determine the types of vehicles using the crossing.
- Where the clear storage distance is greater than 50 feet or 75 feet (depending on the highway vehicle design length), but less than 120 feet, and an engineering study determines that the queue extends into the track area.

An engineering study should be made to evaluate the various elements involved in a pre-signal, addressing the following as a minimum:

- Site conditions of the highway-rail grade crossing and intersection, including minimum track clearance distance and clear storage distance.
- Traffic patterns, including queuing at the crossing.
- Type of vehicles that use the highway-rail grade crossing (to determine timing parameters).
- Highway-rail grade crossing and road intersection geometry, including grades, horizontal and vertical curves, and obstructions as well as the lateral and vertical angles of sight toward a signal face, to determine the vertical, longitudinal, and lateral position of the signal face.

Pre-signals can be used for stopping vehicular traffic before the highway-rail grade crossing where the clear storage distance is 200 feet or less. Pre-signals shall be considered when the clear storage distance is less than 120 feet. An engineering study shall confirm the correct application of pre-signals.

3.15.7 Pre-Signal Location

There are two primary alternative locations for placement of traffic signal heads at the crossing. Pre-signals on poles can be placed on the near side of the highway-rail grade crossing and on mast-arm poles placed ahead of the highway-rail grade crossing (upstream), or between the highway-rail grade crossing and the intersection (downstream). *Downstream placement is the preferred position, so the stopping position of the vehicular traffic is close to the crossing.* Where the pre-signal pole is mounted in advance of the highway-rail grade crossing with multiple approach lanes, a unit shall be placed on the sidewalk and on an inside median. **In all cases, pre-signal poles shall be positioned so as to maintain visibility of the railroad flashing lights.**

As per CA MUTCD (Section 4D-15 standard), a minimum of two signal faces shall be provided for the major movement on the approach to an intersection. At least one and preferably both of the signal faces shall be located as follows:

- Not less than 40 feet beyond the stop line, unless a supplemental nearside signal face is provided.
- Not more than 150 feet beyond the stop line, unless a supplemental nearside signal face is provided.
- As near as practical to the line of the driver's normal view, if mounted over the highway.

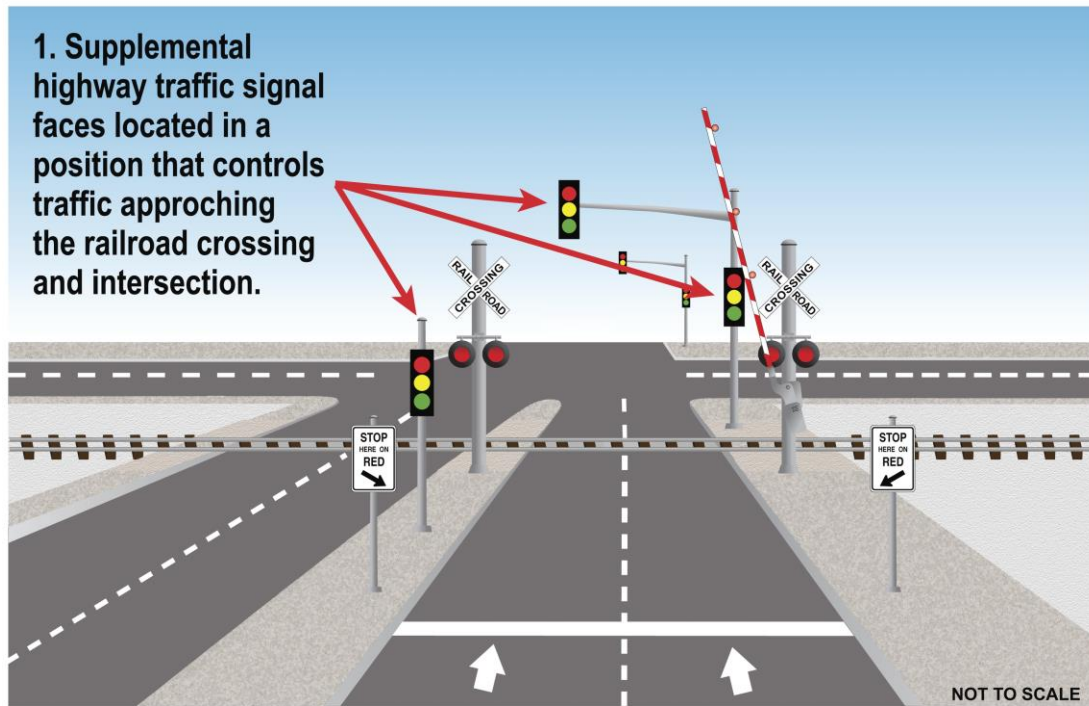


Figure 3-30. Pre-Signal Placement

3.15.8 Downstream Pre-Signals

Figure 3-30 shows a typical downstream installation, which includes a supplemental nearside signal face in the median. As specified in CA MUTCD, the stop line should be placed no closer than 15 feet from the nearest rail, and eight (8) feet from the railroad gates (if present). It is desirable to utilize this same stop line for the pre-signal indications, if possible. Placement of the traffic signal stop line at the same location as the railroad warning gate stop line has two advantages:

- Transit vehicles and trucks required to stop at crossings would not be subject to a double stop
- Heavy vehicles will be closer to the crossing, and therefore more able to clear the minimum track clearance distance during preemption

If clear storage distance is 50 feet or less, and if it is possible to use the nearside intersection signal heads as a pre-signal, the stop line of the pre-signal should be at the same location as the railroad warning gate stop line. **The farside intersection signal heads shall be equipped with programmed-visibility heads or louvers to restrict visibility of the intersection signal displays to drivers at the pre-signal stop line.**

If the clear storage distance is more than 50 feet, and if it is possible to locate a pre-signal between the highway-rail grade crossing and the intersection, the pre-signal faces should be located such that the stop line of the pre-signal is at the same location as the railroad warning gate stop line.



3.15.9 Upstream Pre-Signals

In order to meet CA MUTCD requirements, when traffic signal faces are located near the railroad warning devices, the stop line must be located a minimum of 40 feet ahead of (upstream) the signal faces. If the stop line distance is shortened, a low mount pre-signal head and a “STOP HERE ON RED” (R10-6) sign shall be installed to warn approaching traffic of the traffic control signal. The intersection signal heads should be equipped with programmed-visibility heads or louvers to restrict visibility of the intersection signal displays to the drivers at the pre-signal stop line.

3.15.10 Pre-Signal Operations

The pre-signal intervals should be progressively timed with the downstream intersection signal intervals, providing adequate time for vehicles to clear the minimum track clearance distance and continue through the clear storage distance area and downstream intersection. Vehicles that are required to make mandatory stops (such as school buses and vehicles hauling hazardous materials) should be considered when determining the preemption timing design parameters.

Unless otherwise defined, the design vehicle shall be for purpose of the Manual the AASHTO WB-65 semi-tractor-trailer.

Where the clear storage distance is inadequate to store the design vehicle clear of the minimum track clearance distance, consideration should be given to the installation of vehicle detection loops within the clear storage distance. This could prevent vehicles from being trapped within the minimum track clearance distance by extending the clear track green interval.

Pre-signals shall display a red signal indication during the transition into the preemption control portion of a signal preemption sequence. This shall prohibit additional vehicles from highway-rail grade crossing the railroad tracks.

3.15.11 Signs and Markings for Pre-Signals

Figure 3-31 shows typical placement of signs and markings for a pre-signal. If a pre-signal is installed at an interconnected highway-rail grade crossing near a signalized intersection, an R10-6 (“STOP HERE ON RED”) sign shall be installed at the stop line. If there is a nearby, signalized intersection with insufficient clear storage distance for a design vehicle, or if the highway-rail grade crossing does not have gates, an R10-11 (“NO TURN ON RED”) sign shall be installed for the approach that crosses the railroad track.

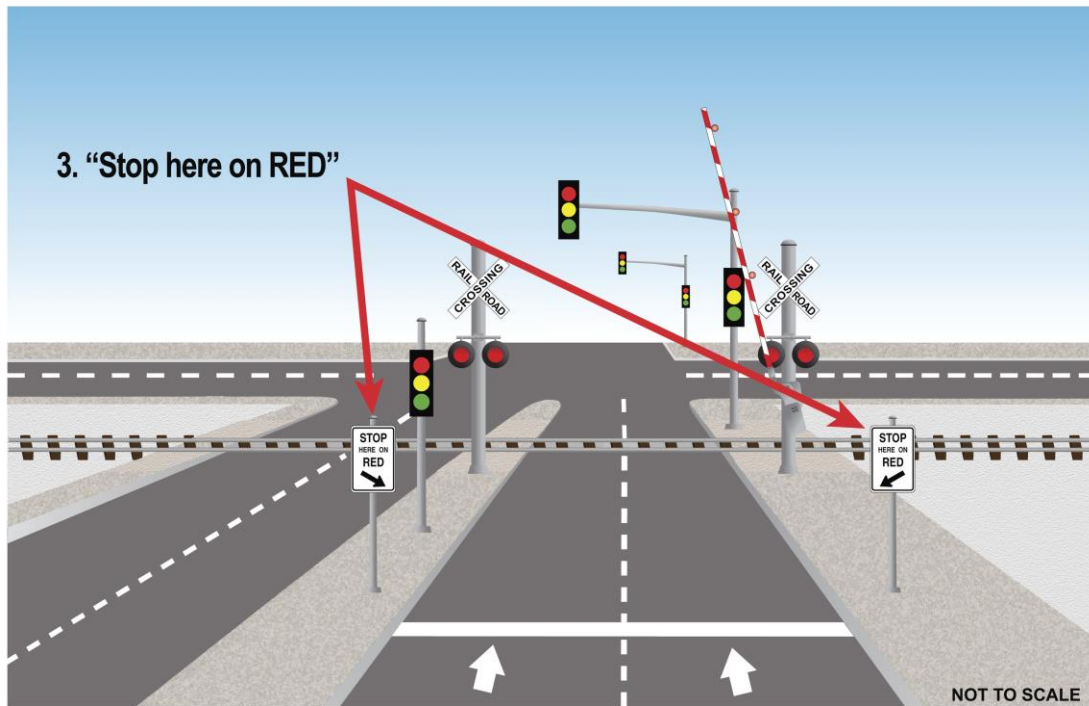


Figure 3-31. Pre-Signal Signs and Markings

3.15.12 Queue-Cutter Signals

Another solution to traffic queuing onto the tracks, and an alternative to a pre-signal, is the use of an automated queue-cutter traffic signal upstream of the highway-rail grade crossing. A queue-cutter signal differs from a pre-signal in that if the clear storage distance is greater than 200 feet; any traffic signal heads located at a highway-rail grade crossing should be considered to be a separate, mid-block highway-rail grade crossing (a “queue-cutter” signal), and not a pre-signal. The queue-cutter signal can be utilized in conjunction with R8-8 signs (“DO NOT STOP ON TRACKS”), as per CA MUTCD requirements. The queue-cutter traffic signal can be activated by vehicle detection (typically induction loops) on the departure side of the highway-rail grade crossing to detect a growing queue between the highway-rail grade crossing and the downstream highway intersection. Figure 3-32 indicates the use of a queue-cutter signal.

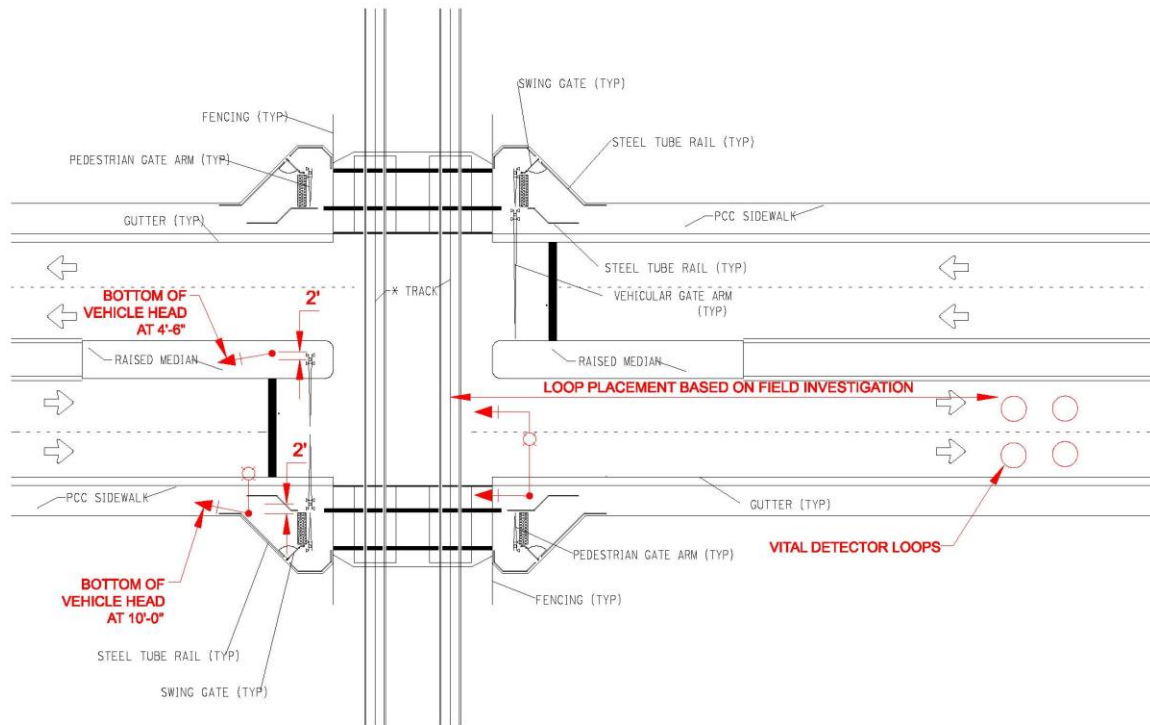


Figure 3-32. Queue-Cutter Signal Placement Layout

3.15.13 Traffic Signal Controller Units

There are two types of traffic signal controller units: those that are designed to NEMA specifications and those that are Type 170/2070 Controller Units (discussed below). Traffic signal controller units manufactured according to older NEMA TS 1 standards do not have internal preemption. These units are generally not capable of accommodating preemption without special external control processes. The current industry standard for both pretimed and actuated traffic signal controller units—the NEMA TS 2 standard—includes provisions for internal preemption.

The Model 2070 Controller Unit includes various provisions for internal preemption; these depend on the specific software packages being run by the microprocessor. The Model 2070 is an open platform advanced transportation controller (ATC) that completely separates hardware from application software by defining a common controller unit hardware on which multiple applications from multiple developers can operate.

The preemption capabilities of traffic signal controller units vary from manufacturer to manufacturer. It is very important to be familiar with the preemption operation provided in each controller unit being used in the field.



The IEEE 1570 standard for the interface between the railroad active warning system and the traffic signal controller unit is a digital communications interface. Designed according to both fail-safe and closed-loop principles, it provides equivalent functions while maintaining the required safety attributes at the highway-rail grade crossings. Application of the IEEE 1570 interface shall be explored for all new highway-rail construction and modifications. For more information on the IEEE 1570 standard, consult the IEEE Standard for the Interface Between the Rail Subsystem and the Highway Subsystem at a Highway Rail Intersection (IEEE publication no. 1570-2002).

The traffic signal controller unit shall be able to meet the following functions and requirements:

- Receive multiple preemption inputs and provide multiple routines on a priority basis, at least one of which shall be assigned to railroad preemption. Per CA MUTCD, the railroad preemption shall have priority at a traffic signal provided with emergency vehicle preemption and railroad preemption.
- The preemption feature shall have either an electrical circuit based upon the closed-circuit principle, or a supervised interconnect circuit (preferable) between the control circuits of the railroad active warning system and the traffic signal controller unit.
- Detect broken wires/cables and respond as programmed. One possible programming alternative is to first clear the tracks and then display all-way flashing red signal indications.
- Remotely notify the responsible highway agency as soon as a detectable problem is known to exist at the highway-rail grade crossing.
- Provide an indication, via health check circuit, to the railroad active warning system cabinet when the traffic signals are in flashing mode or “dark” condition for advance preemption.
- Provide a backup power system for the traffic signal controller in the event of a commercial power outage, and remote notification to the highway agency responsible for maintenance of the controller.

3.15.14 Standby Power

In accordance with FRA rules and requirements, railroads install backup power systems to provide power to flashing light signals during commercial power failures. This practice for back-up power is different from traffic signals that are generally dark when the commercial power is off. When traffic signals are dark, motorists in most jurisdictions are expected to know traffic signals are ahead; they are supposed to stop their vehicle at the stop line, and proceed with caution through the intersection as if the dark signal were a stop sign. Since dark traffic signals cannot provide preemption, **backup or standby power systems shall be required at all traffic signals interconnected with railroad signals.**

When traffic signals malfunction, which may cause an all-red flash, the advance preemption time becomes ineffective in helping clear vehicles from the crossing. As a result, vehicles may have less time to clear the crossing. The incorporation of a health check circuit can serve to convert some or all advance preemption time to warning time when this occurs.



3.16 PREEMPTION

The design of preemption for a highway-rail grade crossing owned or maintained by an agency other than the SCRRA shall be in accordance with the standards used by that agency. The resulting design must be consistent with, or more stringent than, the recommended design practices and standards in this Manual or other applicable SCRAA Standards.

In establishing preemption operations at highway-rail grade crossings adjacent to signalized highway intersections, the highway agency shall coordinate with the SCRRA and the CPUC. The need for preemption, type of preemption, preemption time, right-of-way transfer time, queue clearance time, clear track green interval, etc., for preemption shall be determined by the highway agency and must be agreed to by SCRRA.

3.16.1 Abbreviations and Formulas

The following abbreviations are provided to assist the lead Engineer in preparing the appropriate preemption timing parameters for the highway-rail grade crossing interface. These are also shown in Appendix B.

APT	Advance Preemption Time
BT	Buffer Time
CT	Clearance Time
CSD	Clear Storage Distance
ERT	Equipment Response Time
MHTSPT	Maximum Highway Traffic Signal Preemption Time (MPT)
MT	Minimum Time
MTCB	Minimum Track Clearance Distance
MWT	Minimum Warning Time
QCT	Queue Clearance Time
RWTT	Right-of-Way Transfer Time
ST	Separation Time
TAT	Total Approach Time
TWT	Total Warning Time

$MHTSPT (MPT) = RWTT + QCT + ST \text{ or } CT \text{ (whichever is greater)}$

$TAT = MWT + BT + ERT + APT$

$TAT = TWT + ERT + APT$

$MWT = MT + CT$

$TWT = MWT + BT$

$APT = RWTT + QCT - MWT$

$RWTT = \text{Minimum green interval, or pedestrian change/walk and pedestrian clearance time (whichever is higher) + yellow change + red clearance}$

3.16.2 Highway-Rail Grade Crossing Elements that Affect Preemption

The following highway-rail grade crossing and intersection elements affect preemption timing calculations and should be evaluated carefully to determine their impact:



- Intersection geometry.
- Highway-rail grade crossing geometry
 - Track clearance distance (track clear zone).
 - Clear storage distance; distance from clear track zone to intersection.
- Approaches to the highway-rail grade crossing during preemption calculations.
- Travel times to clear the intersection or crossing.
- Vehicle volumes.
- Frequency of train movements.
- Train stops within the approach to the highway-rail grade crossing (especially for sidings and stations).
- Vehicle queue lengths and dissipation rates.
- Design vehicles and special classes of vehicles, and their operating abilities through the intersection.
- Types of active warning devices.
- Pedestrian activity.

Intersection Geometry

No traffic movements toward the highway-rail grade crossing shall be allowed during preemption. Therefore, the lane configuration and traffic signal operation of the intersection must be evaluated to determine the need for additional lanes and traffic signal modifications to properly control the intersection movements. For example, if the highway parallel with the tracks has a shared through and left lane, and operates with a permissive green ball that allows left turns, the intersection would need to be reconfigured with a left-turn pocket with protected operation so the through movement can operate during preemption, while the left-turn movement toward the tracks is restricted. Alternatively, an R3-2 blankout sign can be installed to prohibit left turns. This must be evaluated first to help define what the advance preemption time needed to provide the appropriate transit from conflicting movements to the preempt sequence.

Minimum Track Clearance Distance

The minimum track clearance distance (MTCD) is measured along the highway from either the highway stop line; warning device; or 12 feet perpendicular to the track centerline; to six (6) feet beyond the furthest track, measured perpendicular to the far rail. The measurement is taken along the centerline or edge line of the highway, as appropriate, to obtain the longer distance. This measurement is used to determine the “clear track green interval”, and is also used to determine the “clearance time.”

Geometric features, such as elevation differences of the tracks or the skewed angle of the crossing, should also be considered when evaluating the effects the track clearance distance has on timing parameters.

Clear Storage Distance

Clear storage distance is the distance available for vehicle storage. It is measured between 6 feet from the rail nearest the intersection to the intersection stop line, or to the normal stopping point on the highway. At skewed crossings and intersections, the 6-foot distance shall be measured perpendicular to the nearest rail, either along the centerline



or along the edge line of the highway (as appropriate to obtain the shorter clear distance).

Jurisdictions shall often use this distance when calculating the “queue clearance time.” Typically, the queue clearance time only includes the area between the MTCD and the intersection if there is not enough room to store a design vehicle. The lead Engineer must work with the local jurisdiction to determine the most appropriate method.

The operating abilities of the design vehicle must be considered when evaluating the queue clearance time; e.g., start-up for a heavy truck loaded down is much slower than for a normal vehicle. The movement the truck makes at the intersection also determines the time required to clear the vehicle.

3.16.3 Railroad Parameters for Preemption

Minimum Time

As per CA MUTCD requirements (Part 8 of Section 8D.06), the minimum time (MT) flashing-light signals shall operate is 20 seconds before the arrival of any train. The exception to this requirement is on tracks where all trains operate at less than 20 mph, and where flagging is performed by an employee. The FRA regulations in Title 49, Code of Federal Regulations (CFR), Part 234.225, state that a highway-rail grade crossing warning system shall be maintained so as to activate in accordance with the design of the warning system, but in no event shall it provide less than 20 seconds of warning time before the highway-rail grade crossing is occupied by train traffic. CPUC General Order No. 75 states that highway-rail grade crossing signals at main or branch line crossings shall be actuated by trains approaching on main tracks through track circuits or by electronic controls for approximately 25 seconds, with limits of 20 to 30 seconds in advance of the fastest train that is normally operated over the highway-rail grade crossing being protected.

Clearance Time

Additional time clearance time (CT) is often provided in excess of the minimum time to account for track clearance distances (track clear zone) that are wider because of a skewed highway-rail grade crossing or because of other specific features (i.e., one track being considerably higher than the other tracks, causing vehicles to slow down in the crossing). Clearance time should also consider the large number of slow vehicles that utilize the crossing; vehicles that take more time to cross than a normal vehicle.

Clearance time is added to the minimum time at a rate of one (1) second for each 10 feet (or fraction thereof) of minimum track clearance distance exceeding 35 feet.

Minimum Warning Time

CA MUTCD mandated minimum time of 20 seconds, and any additional clearance time is known as the “minimum warning time.” This is the time between when the railroad warning system is activated and when the train enters the crossing. Refer to SCRRRA Signal Standards for SCRRRA’s standard for MWT.

$$\text{MWT} = \text{MT} + \text{CT}$$



Equipment Response Time

Equipment response time (ERT) is the additional time provided to account for delays in railroad circuitry before the railroad warning devices are activated. This is typically set at 5 seconds, and is used to establish the approach time for train detection placement.

Buffer Time

Buffer time (BT) is discretionary time determined by the railroad. It is added to the required minimum 20-second time. The railroads add this buffer time for train handling to ensure that a required minimum warning time for track clearance is provided. Refer to SCRRRA Signal Standards for SCRRRA's standard for BT.

Total Warning Time

The total warning time (TWT) is a combination of each element defined above. Although the equipment response time is never reflected in the total warning time calculation, it should be figured into the approach time and distance for train detection.

$$\text{TWT} = \text{MWT} + \text{BT}$$

3.16.4 Preemption Operational Sequence

FHWA and ITE publications (see Appendix C for references) have tables and charts that help identify different paths that preemption can take during phased operation. These tables and charts indicate the displays that would be shown, depending on what phase was active when preemption input was received. Each highway-rail grade crossing is unique; an engineering study should be conducted for each signalized intersection near a highway-rail grade crossing to determine the most appropriate preempt operational sequence and the preemption parameters to be implemented.

The traffic signal controller unit shall enter into preemption operation as soon as the interconnect circuit from the railroad active warning system is activated. Some controller units may incorporate a delay time to verify the continuity of the preemption call.

Railroad preemption results in a special traffic signal operation, depending on the relationship of the railroad tracks to the intersection, the number of phases in the traffic signal, and site-specific traffic conditions. Preemption ensures that the actions of the traffic control devices complement, rather than conflict, with the railroad warning system devices. There are three basic elements to railroad preemption:

1. Right-of-way transfer into preempt control
 - a. Termination of normal operation
2. Preempt control
 - a. Track clear/clear storage interval
 - b. Hold/dwell interval
3. Transition to normal operation
 - a. Exit phases
 - b. Transition to coordination



Right-of-Way Transfer into Preemption Control

There are many possible transition scenarios, depending upon which interval in the traffic signal control cycle is operational when preempt is initiated. Upon receiving a preempt call, right-of-way transfer of the traffic signal should provide the following basic sequence of operation:

- The length of yellow change and red clearance intervals shall not be altered by preempt for any signal phase that is green or yellow when preempt is initiated.
- Phases that are in the green interval when preempt is initiated, and which shall be green during the track clearance interval, shall remain green, unless doing so creates a left-turn trap. In that case, they must be terminated normally and then restarted after a brief all-red period.

There are two basic scenarios that could occur with the pedestrian walk interval or the pedestrian clearance time, depending on the local jurisdiction's requirements:

- Immediate termination of the pedestrian walk or clearance intervals, with all pedestrian signals faces displaying a steady upraised hand during the track clearance green interval.
- Shortening of the pedestrian walk interval, while allowing the pedestrian clearance interval to follow the normal time.

The signal phase (or phases) controlling traffic, as it approaches the intersection after crossing over the railroad tracks, should be green during the track clearance interval. A yellow change interval shall be provided if a green signal indication was provided during the track clearance interval.

In cases where the approach has a phase that conflicts with the clear track green interval (queue clearance), the right-of-way transfer time (RWTT) shall be maximized when the preempt call is received at the traffic signal controller just after the onset of green. The maximum traffic signal timing required for the transition can vary, depending on the programmed phasing of the controller when the preempt call is established. The maximum RWTT used in the calculation of preempt time establishes the upper limit of the preempt time. This set of circumstances is sometimes referred to as "worst case" scenario.

The RWTT shall be nonexistent or zero if the preempt call is received when the traffic signal controller is already in the phase that is used as the clear track green interval (queue clearance phase). This scenario is usually known as the "best case" scenario. These variations in traffic signal operations can be unsafe if not properly recognized in the timing and design of simultaneous and advance preemptions. The "worst case" scenario shall be used in the determination of maximum preempt time, while both the "best case" and "worst case" scenarios shall be used in the design of any preempt sequence. A "gate-down" circuit should be used when there is a substantial difference between the minimum and maximum RWTT. Some traffic signal controllers are capable of dynamically calculating the maximum RWTT, adding extra time to the track clearance green when the actual RWTT is below maximum. The use of the "not to exceed" timing



circuit can also be used to control the advance preemption time; however, this type of circuit cannot prevent shorter advance preemption times.

Preemption Hold/Dwell

Limited Service shall be used for traffic signals interconnected to SCRRRA active warning devices. The transition into preemption hold occurs after the queue clearance time and separation time (track clearance interval) have been completed, and continues while the train is occupying the crossing. Preemption hold shall remain in effect until the preemption input to the controller unit is removed. The purpose of the preemption hold interval is to allow those movements that do not conflict with the train to proceed through the intersection.

Depending on traffic requirements and the phasing of the traffic signal controller unit, the traffic signal may do the following:

Limited Service (standard)

- Revert to limited operation with those signal indications controlling through and left-turn movements toward the railroad tracks displaying steady red.
- Limited operation shall allow through and left-turn movements away from the railroad tracks to operate.
- With slow-moving trains and long interruption times, the preempt dwell may allow the traffic signal controller to rotate through various defined non-conflicting traffic phases.
- Permitted pedestrian signal phases shall operate normally.
- This operation shall be used only if the highway-rail grade crossing warning equipment includes gates.

Flashing All Red (only with SCRRRA approval of standard deviation)

- Go into flashing operation, with flashing red or yellow indications for the approaches parallel to the railroad tracks, and flashing red indications for all other approaches.
- Pedestrian signals shall be extinguished.
- If flashing red is used for all approaches, an all-red or other clearance interval shall be provided prior to returning to normal operation.
- Blank out signs shall be used to prohibit turn movements across the tracks.

Transition to Normal Operation

There are many possible scenarios for the transition from preempt to normal operation; they depend on the type of intersection control that was in effect at the time of preempt (e.g., running free, actuated [semi or full], recalls, coordinated, etc.). The user can define the exit phases that shall operate after the preempt call has been released. Most controllers shall run the normal split time for the exit phases, and then, depending on user-programmed parameters, the controller shall attempt to resynchronize with the defined offset. There are basically three types of resynchronization capabilities (dwell, short way, add only) that control the transition back to normal operation.



Some controller software has the capability to monitor the coordinated cycle during preemptions so that upon release of preempt, the transition to normal operation is right in step with the coordinated background cycle. The lead Engineer should be aware of the local jurisdiction's preferred operation.

3.16.5 Preemption Timing Parameters

The highway-rail grade crossing elements that affect railroad preemption (as defined in Section 3.16.2) help calculate the timing parameters defined in this section. The narrative below presents preemption timing parameters that should be evaluated carefully and calculated for each appropriate sequence of preemption operation.

- Maximum RWTT
- Minimum RWTT
- Queue clearance time
- Separation time
- Maximum highway traffic signal preemption time
- Advance preemption time
- Total approach time

Maximum RWTT

The maximum RWTT is the “worst case” scenario and consists of the following timing parameters:

- Minimum traffic signal green time or minimum pedestrian walk time, whichever is longest
- Pedestrian clearance time
- Yellow change interval
- All-red clearance interval for opposing traffic

Minimum Green Interval

Two components are necessary to establish the minimum green interval for transition phases:

- Vehicle timing requirements
- Pedestrian timing requirements

If pedestrian timings cannot be truncated, then the vehicle timing requirements must be compared to the pedestrian timing requirements; the greater of the two shall set the minimum green interval. The minimum green time is the shortest green time allowed for each phase. The vehicle timing requirements shall consider both directions of travel, and the time required to clear the intersection if there is not sufficient clear storage distance for the design vehicle. This is very important for simultaneous preempt, where a design vehicle approaching the highway-rail grade crossing from the intersection does not have sufficient storage between the intersection and the crossing. Additional time may be necessary to allow the vehicle to cross the intersection, the insufficient storage area, and the minimum track clear area.



Pedestrian Clearance Time

The pedestrian clearance time shall adhere to CA MUTCD, Part 4, which addresses the shortening or omission of pedestrian walk and clearance intervals. The application of permitted pedestrian control during the transition into preemption control requires the agreement of the highway agency. The walk interval, if provided, should be at least seven (7) seconds long so that pedestrians will have adequate opportunity to leave the curb or shoulder before the pedestrian clearance time begins. For pedestrians in the crosswalk who left the curb or shoulder during the WALK signal indication, and who are traveling at a normal speed of 4.0 feet per second, the pedestrian clearance time, if provided, should be sufficient to allow them to reach at least the edge of the lane, or a median of sufficient width that they can wait safely. Where older or disabled pedestrians routinely use the crosswalk, a walking speed less than 4.0 feet per second and as low as 2.8 feet per second may be used in determining the pedestrian clearance time.

The “worst case” pedestrian interval is not restricted to pedestrian phases that run concurrently with vehicle phases serving traffic parallel to the tracks (or the track clearance phase). The “worst case” pedestrian interval may be associated with the vehicle phase approaching the highway-rail grade crossing. All pedestrian intervals that are required to time out must be evaluated to determine the maximum right-of-way transfer time.

Minimum RWTT

The minimum RWTT is the “best case” scenario in which all movements away from the tracks are being served when the preempt call is received by the traffic signal controller. If the intersection phasing operates with a permissive left turn for the approach that opposes the movement away from the track, then both movements must be terminated and the clear track interval may be reestablished without serving any other movements. This would consist of the following timing parameters, in sequence:

- Minimum traffic signal green time
- Yellow change interval
- All-Red clearance interval
- Re-establish clear track green

Some traffic signal controllers have the functional capability to lengthen the track clear green interval based on preprogrammed, required maximum right-of-way transfer times. This shall prevent the track clear green interval from terminating before the railroad warning system has been activated.

Queue Clearance Time

The queue clearance time (QCT) of the preempt sequence must be displayed long enough to clear all vehicles that might be stopped within the limits of the highway-rail grade crossing (minimum track clearance distance). Design vehicle characteristics, geometry of the highway-rail grade crossing, and the clear storage distance affect the queue clearance interval.



There are two possible scenarios that determine the queue clearance interval:

- If there is significant clear storage distance for the design vehicle, the queue clearance time provided must be sufficient to clear the minimum track clearance distance, but it is not required to clear every vehicle from the clear storage area.
- Although it is recommended that the queue clearance time provide enough time to remove all vehicles from the clear storage area, this is a jurisdictionally defined parameter that depends greatly on how long the clear storage distance might be.

The green for the queue clearance time should be displayed until the gates block the path of approaching vehicles, especially if the clear storage distance is insufficient for the design vehicle. The preempt calculations shall ensure that the gates start to descend before the queue clearance green interval terminates. This operation can be achieved through the use of a “gate down” circuit. (Refer to Section 6.1.2 for more information on “gate down” circuits). The queue clearance time should account for the following:

- Minimum track clearance distance
- Clear storage distance
- Start-up time of first vehicle in the queue and subsequent vehicles within the clear storage distance, and the minimum track clearance distance to travel through the intersection

If the clear storage distance has sufficient space for the design vehicle, the queue clearance time need only be sufficient to allow the design vehicle to start up and travel from the highway-rail grade crossing stop line to a point clear of the minimum track clearance distance.

The Los Angeles Department of Transportation “(LADOT) Railroad Preemption Worksheet” should be used to calculate the duration of the queue clearance interval.

Clear Track Green Time

One factor that some highway agencies take into consideration is the design vehicle’s ability to clear the railroad gate on the approaching side of the highway-rail grade crossing when given a green indication to proceed. The concern is with the height of the semi tractor-trailer. If the travel lane is close to the railroad gate, there is a good possibility that the gate will start to descend before the design vehicle (a large semi tractor-trailer) has moved far enough forward to prevent the railroad gate from getting trapped between the cab of the semi’s tractor and its trailer, thereby snapping the gate from the mechanism. This is a leading cause of broken gates.

Therefore an evaluation/calculation should be conducted to determine if additional time must be added to the queue clearance time to prevent this from occurring. A term used for this calculation is “clear track green interval.” The clear track green interval should account for the following:

- Everything defined in the queue clearance interval
- Distance from the vehicle to the railroad mechanism



- Time required for the design vehicle to start up at the highway-rail grade crossing stop line and move forward, such that the railroad gate will not get trapped between the cab of the semi tractor and the trailer

The time for the design vehicle to start up at the highway-rail grade crossing stop line and travel to a point clear of the minimum track clearance distance is known as the clear track green time (CTG).

The CTG should be compared to the queue clearance time, and the larger of the two should be used in the preemption calculations. The “LADOT Railroad Preemption Worksheet” shall be used to calculate the duration of the queue clearance time and the clear track green time.

Separation Time

Separation time (ST) is the time during which the minimum track clearance distance is clear of vehicle traffic prior to the arrival of the train. The separation time is important under the following conditions:

- High-speed trains are present
- The passing traffic includes a high percentage of trucks and buses

The separation time should be a defined value (typically four to eight seconds) that is based on an engineering evaluation of the highway-rail grade crossing. Variations in traffic signal operation may affect the actual separation time experienced at the crossing. The lead Engineer shall consider the separation time to be at its minimum when the right-of-way transfer time and the maximum highway traffic signal preemption time are the largest. The “worst case” (maximum right-of-way transfer time) and “best case” (minimum right-of-way transfer time) scenarios shall be explored in the determination of maximum highway-rail traffic signal preemption time and separation time.

Maximum Highway Traffic Signal Preemption Time

To provide sufficient queue clearance or clear track green time for a highway-rail grade crossing, the controlling traffic signal must be notified in advance of a train’s arrival. The total time required for this function—the advance notification time—is called the maximum highway traffic signal preemption time (MHTSPT). The MHTSPT is the maximum RWTT plus the QCT and the ST.

$$\text{MHTSPT} = \text{Max RWTT} + \text{QCT} + \text{ST}$$

Advance Preemption Time

Advance preemption time (APT) is the time above and beyond the MWT that is required to provide sufficient RWTT, QCT, or CTG, and ST. The minimum warning time includes any CT that is necessary for the highway-rail grade crossing.



The formulas shall be used to determine how much time is needed for the traffic signal system to appropriately accommodate an arriving train, and how much time is needed for the rail equipment. These design procedures and the “LADOT Railroad Preemption Worksheet” shall be used to determine the preemption time.

$$\text{APT} = \text{MHTSPT} - \text{MWT}$$

Total Approach Time

The total approach time (TAT) is not necessary for calculation of the required preemption time, but it is very useful for the rail operator when determining where to place the detection equipment. The total approach time includes the total warning time, the advance preemption time, and the equipment response time. The total warning time includes the minimum warning time plus the buffer time.

$$\text{TAT} = \text{TWT} + \text{APT} + \text{ERT}$$

$$\text{TWT} = \text{MWT} + \text{BT}$$

3.16.6 Types of Preemptions

Simultaneous Preemption

Under simultaneous preemption, the railroad flashing lights start to flash at the same time the preempt notification is received by the traffic signal controller. Simultaneous preemption is easier to apply and minimizes the variables that might otherwise come into play between the railroad warning system and traffic signal system. However, simultaneous preemption provides limited total warning times and may result in excessive gate down time if additional warning times are included.

To discourage unsafe behavior by impatient motorists, the railroad flashing-light signals shall start to flash and the gate arm shall descend to its horizontal position in a minimal amount of time. The traffic signals shall complete the RWTT and queue clearance time while the railroad warning system is activated. Actual railroad warning times can vary depending on the variable times provided by railroads for each train movement and the phasing of the traffic signal controller when the preempt signal is established.

Advance Preemption

Under advance preemption, the traffic signal controller unit receives the preempt notification from the railroad warning equipment before the railroad warning system is activated. The difference between the MHTSPT and the minimum warning time is called the advance preemption time.

Advance preemption has the following benefits:

- Provides additional track clearance and separation time, which clears the intersection prior to lowering the gates
- Gives vehicles stopped under the gates time to start up and clear the gates before they descend
- Provides adequate queue clearance time



- Facilitates a smooth transition from conflicting movements to the track clearance phase

3.16.7 Preempt Trap and Potential Solutions

Preempt trap is the condition wherein the queue clearance or the clear track green interval ends before the railroad flashing-light signals start to flash and the gates start to descend. Vehicles will continue to cross the tracks until the railroad gates actually begin to descend. Some vehicles will even try to squeeze under the descending gate. Therefore, the downstream traffic signals must display a queue clearance green indication until the gates have descended. The condition is exacerbated if the traffic signal controller that is used does not have the ability to expand the queue clearance interval time based on the green time already allocated to the conflicting movement. To properly define the preemption parameters, the lead Engineer must thoroughly understand the capabilities of the traffic signal controller that is to be used.

The following factors can also create a preempt trap:

- Any warning time variation that is different from the value used in the initial preemption calculation and programming of the traffic signal controller (if it is implemented without adjustments to the other preempt parameters).
- A longer advance preemption time that is different from the value used in the initial preemption calculation and programming of the traffic signal controller (if implemented without adjustments to the traffic signal controller parameters).

These variations in time create a preempt trap.

Under simultaneous preemption, the railroad warning lights start to flash at the same time the preempt notification is received by the traffic signal controller. Therefore, the queue clearance green interval cannot end before the lights start to flash.

The main cause of the preempt trap is the “uncoupling” of the preempt notification from the warning light activation in the preempt calculations. This results in two separate processes, with no fixed time relationship between them.

The evaluation of the maximum highway traffic signal preemption time should evaluate all possible approaches to determine the maximum right-of-way transfer time. Potential solutions for the preempt trap shall be considered and implemented. The following are some of the methods that may be used to avoid preempt traps:

- Increase the queue clearance green interval in the traffic signal controller unit. The queue clearance green interval should be displayed at least until the gates start to descend, and ideally until the gates block the path of approaching vehicles. The use of older traffic signal controllers cannot guarantee that the gates will be down when the queue clearance green interval terminates. Increasing the clear track green interval may not be the best option, because an increased overall delay to the signalized intersection can cause other congestion-related problems, especially if train volumes are high.



- Use a controller that is capable of dynamically calculating the RWTT and adding the difference to the QCT to account for the variations in allocated (versus used) green time for the conflicting movements.
- Use a “gate down” circuit to guarantee that the queue clearance phase terminates only after the gates are down. This is the preferred method. Refer to Section 6.1.2 for more information on “gate down” circuits.
- Use the “not to exceed” timing circuit. A not-to-exceed timer may be able to control the maximum advance preemption time, but it will not be able to prevent shorter advance preemption times.
- Use the preempt delay function in the traffic signal controller unit to adjust the actual implementation of the preempt sequence so it more closely coincides with the railroad gate’s descent.
- The highway agency should consider changing its traffic signal controller unit specifications, selecting a unit that has the ability to adjust the queue clearance green interval based on variations in the time allocated versus the green time used for the conflicting movements.
- The traffic signal controller should also have the functional ability to recognize a second preempt call during the initial preempt sequence, and either maintain the preempt hold state or reserve the queue clearance interval before the railroad gates begin to descend for the second train.
- Consider the potential of conditional service solutions to prevent the preempt trap. Conditional service allows a signal phase to be served twice during the same cycle.

3.16.8 Preemption Timing Scenarios

The highway agency shall complete the “LADOT Railroad Preemption Worksheet” for both “worst case” and “best case” scenarios (see Section 3.16.4) for simultaneous and advance preemption scenarios, and submit it for SCRRRA review. The evaluation shall consider all feasible approaches to the highway-rail grade crossing.

3.16.9 Other Preemption Considerations

Multiple Tracks

Multiple tracks at highway-rail intersections introduce two problems that must be considered when designing a preemption timing plan:

- Additional clearance distance is required during the queue clearance interval. The additional clearance distance increases the clear track green interval and thus increases the total approach time required for preemption.
- The possibility that a second preemption call could be sent to the controller unit immediately after the first preemption input is removed. This occurs when a train traveling on the second track approaches a crossing right after a train on the first track has left the highway-rail grade crossing area.

Older traffic signal controllers units could not recognize a second preempt call that was received while the first preempt was being serviced; the first preempt sequence had to time out first. Typically, the older traffic signal control units would then continue in the hold state even though the railroad gates had risen. If the railroad gates were to rise



before the control unit recognized the second preempt call, it could lead to skipping the clear track interval and potentially trapping vehicles on the tracks.

Provisions to avoid this problem may include use of an “extended hold” to keep the highway-rail grade crossing gates down until the second train has arrived, as well as use of traffic signal control logic that ensures that a second track clearance can be provided in the event the gates have been raised prior to the arrival of a second train.

When pedestrian clearance time becomes a driving factor for long preemption times and affects levels of service at an intersection, consideration should be given to providing a separate pedestrian input to the traffic signal controller. This is particularly true when there is a station stop in the approach to the highway-rail grade crossing.

The determination whether or not to use the vehicle gate interaction time shall be determined jointly by the railroad and agency. Among the factors to be considered are whether the highway-rail grade crossing has a history of broken gates and the impact on the additional preemption to the level of service.

Multiple Intersections

Where a highway-rail grade highway-rail grade crossing is located between two closely spaced signalized intersections, the two highway traffic signals must be interconnected. Further, their preemptions must be coordinated to permit the tracks to be cleared in both directions.

When the railroad diagonally crosses two interconnected highway intersections, it is normally necessary to clear out traffic on both highways prior to the arrival of the train, requiring approximately twice the preemption time computed for a single approach. It is also normally required to have both railroad warning systems designed to operate concurrently to prevent the traffic signals and railroad warning systems from falling out of coordination with each other. When the railroad warning system is activated, traffic leaving the intersection and approaching either highway-rail grade crossing may queue back into the intersection and block traffic if there is not adequate storage for those vehicles between the highway-rail grade crossing and the intersection. Traffic turning at the intersection toward the other highway-rail grade crossing may also be unable to proceed due to stopped traffic. When this occurs, the following recommended solutions could be used:

- Utilization of advance preemption
- Activating one highway-rail grade crossing before the other
- Extension of gate delay time and minimum warning time
- Use of blank-out turn restriction signs

3.16.10 Preemption Form with Gate Interaction

It is SCRRRA's policy for traffic engineers to use the “LADOT Railroad Preemption Worksheet” spreadsheet to determine the amount of advance preemption and green track clearance time needed at preempted traffic signals near highway-rail grade crossings. This form is included in Appendix E, while an electronic version is available to the lead Engineer from SCRRRA upon request.



This tool also provides a graphical depiction of the timeline of events occurring prior to train arrival at the highway-rail grade crossing to help the user visualize the effects of changes in preemption timing. It was designed to simplify the process of determining specific preemption timing values, and to enable the user to experiment with different scenarios based upon engineering judgment. The form computes the necessary times based upon input data regarding specific geometric, signal timing, and railroad equipment parameters. As data is entered into the form, a timeline is updated to show the effect of each entry. Once all the entries are completed, the timelines can be reviewed to determine whether the settings are appropriate for the crossing. This gives the user the ability to experiment with different timings and immediately see the result of those changes.

3.17 RAILROAD FEATURES

Gate Operations Near Stations

Most stations function as both nearside and farside stations (relative to the highway-rail grade crossing and the travel direction of the trains). Figure 3-33 shows a station adjacent to a highway-rail grade crossing. A station functions as a nearside station when a passenger train stops at the station before proceeding through the highway-rail grade crossing. In cases where the station is within the highway-rail grade crossing detection circuitry, but not directly adjacent to the crossing, it is desirable to have the highway-rail grade crossing gates remain raised until the train is ready to depart (assuming there is sufficient distance between the highway-rail grade crossing and the station to allow this protocol). *When stations are very near vehicular crossings, it may be preferable to have the gates remain down while the train is waiting in the station to depart.* This is particularly important at a multiple-track station adjacent to a crossing, where the train stopped at the station may block the view of a second oncoming or overtaking train in the far track.



Figure 3-33. Stations near a Highway-Rail Grade Crossing



Stations function as farside stations when passenger trains proceed through the highway-rail grade crossing before stopping at the station. The highway-rail grade crossing gates should recover immediately after the train proceeds through the highway-rail grade crossing unless a second train is approaching on the opposite track (in the case of multiple-track stations only), in which case the gates shall react and remain down as required. The station scenarios described above are ideal; however, each situation is unique and should be carefully examined during the diagnostic analysis and design in order to address the challenges at the highway-rail grade crossing and station interface.

Track Structure

The track structure within the highway-rail grade crossing is defined from the subgrade up through the highway surface. All components of the track structure shall be in accordance with SCRRRA Engineering Standards. The track structure shall be designed to: minimize maintenance; minimize opportunities for vehicles to become trapped on the tracks due to an uneven surface or failing pavement; and maximize the lifetime of the track structure.

Within the limits of the highway-rail grade crossing, the track structure works in concert with the highway structure to provide a smooth, safe, and efficient means for vehicles to cross the tracks. It is important for the lead Engineer to note that the track structure—designed for maintenance and sustainability—is a significantly stiffer structure than the highway structure on the approaches. With the addition of concrete crossing panels and asphalt overlays, the track modulus is significantly increased. The effects of this increase are mitigated within the structure to maintain an effective highway-rail grade crossing design.

In the design of the track structure, the lead Engineer shall pay close attention to the conditions existing at the highway-rail grade crossing to detect any indications of failure of the surface or structure. The track structure at highway-rail grade crossings shall follow SCRRRA design standards and meet the following criteria:

- No exothermic rail welds, insulated joints, or bonds shall be placed in highway-rail grade crossings or within 10 feet of a crossing.
- No turnouts or crossovers shall be located within a crossing.
- The highway-rail grade crossing structure shall be designed to permit the maximum amount of drainage of the track structure. Therefore, it may be necessary to construct underdrains within the vicinity of the highway-rail grade crossing to maximize the highway-rail grade crossing life. Under no circumstances shall street surface or gutter runoff be permitted to flow into the track structure.

Multiple Tracks

Multiple, parallel tracks within the highway-rail grade crossing create additional concerns for the lead engineer. Specifically, the lead Engineer shall mitigate the following concerns during the design of the crossing:



- The curvature of the railroad tracks and the resulting superelevation of the tracks shall be evaluated and addressed within the design. Refer to Section 3.5 for additional details on geometry.
- The additional time necessary for a pedestrian to traverse the highway-rail grade crossing shall be minimized. This is especially important with skewed crossings.
- Visibility of the second track and the potential for trains approaching on that track shall be considered.
- Visibility of the second track, where a train may be temporarily stopped or spotted on the adjacent track, shall be considered. This is especially important when the second track is a siding or industrial lead where locomotive and railroad cars may be stored for long durations.

Geometry

Horizontal curves on mainline tracks are superelevated to account for vehicle dynamics. This superelevation is accomplished through maintaining the profile of the low rail (the inside rail) and lifting the outside rail to superelevate the track. Traditionally, the railroad profile shown in drawings and track charts refer to the low rail as the profile grade. The horizontal geometry will define the superelevation.

Where highway-rail grade crossings are located within a superelevated curve, the surface of the highway plane should be in the same plane as the top of rails of the superelevated curve.

This minimizes undulations in the highway surface that can cause a vehicle to become stranded on the tracks. Figure 3-34 is an example of superelevated curves within a highway-rail grade crossing that are not on an even plane.

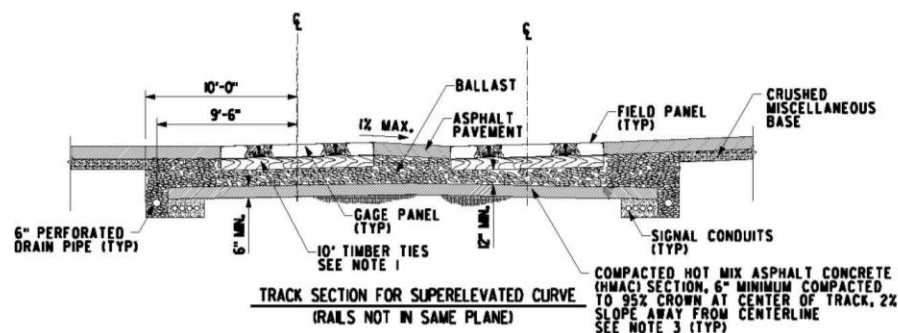


Figure 3-34 Uneven Highway Surface Created by Superelevation

At multiple-track crossings involving concentric superelevated curves, the inside rails for each track may be at equal elevations, while the outside rails are also at equal elevations. The elevations of the four individual rails create an uneven surface through the highway-rail grade crossing.

To avoid this situation, multiple tracks shall be brought to the same plane to provide a smooth and level highway-rail grade crossing plane for the highway (see Figure 3-35 for



an example). This may not be possible due to railroad vertical profile constraints; therefore, highway vertical profiles should be designed on either side of the highway-rail grade crossing to provide as smooth a transition as feasible, and to provide the proper clearance for the lowest vertical clearance design vehicle. Additional warning signs (such as W10-5) are required to alert motorists of a low-clearance situation.

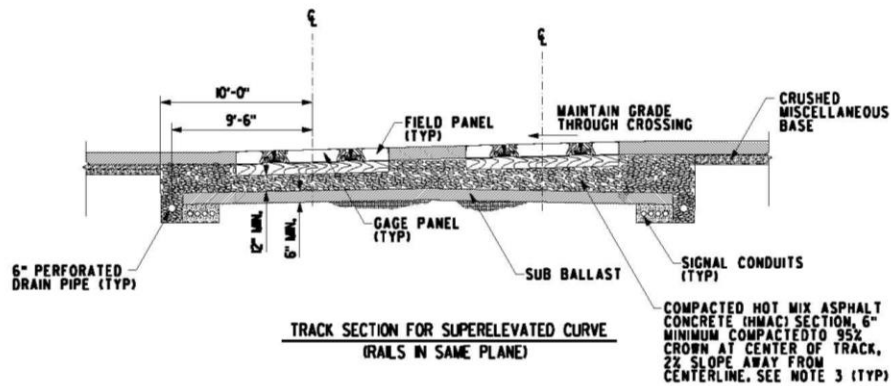


Figure 3-35. Superelevation with Rails in the Same Plane

Special Trackwork

Highway-rail grade crossings located in close proximity to special trackwork are discouraged. The main concerns about the proximity of special trackwork to a highway-rail grade crossing are as follows:

- Additional train movements with switching movements.
- Exothermic welds and insulated joints generally cannot be located within the limits of the grade crossing.
- Signal design concerns related to adjacent railroad signals associated with the special trackwork.
- Additional prolonged railroad activity within the highway-rail grade crossing limits related to industry lead service.



Figure 3-36. Location of Adjacent Turnouts and Crossovers

The point of switch for turnouts and crossovers should be located a minimum of 60 feet outside of the limits of the crossing. Figure 3-36 shows such an application. When turnouts and crossovers are close to the highway-rail grade crossing, the lead Engineer shall consult SCRRRA about the railroad's need for special trackwork. The lead Engineer shall refer to SCRRRA communications and signal Engineering Standards.

Utilities

The term "utilities" includes electric power, cable TV, and lines for: telephone, water, sewer, gas, communications, street lighting, traffic signals, waste water, fuel, and oil.

Railroad right-of-way typically contains a wide variety of utilities that are related to the operations of the railroad and other public or private uses. The design shall address the location of each affected utility and mitigate the impacts on these utilities. The lead Engineer shall obtain the necessary right-of-way information regarding the license/easement agreements related to the utility, and address any modifications that may be required. This includes potential limitations on access as a result of the construction of the crossing, the preservation of access for the utility for maintenance purposes, and safety impacts of the highway-rail grade crossing related to the utility.

After the acceptance of plans by SCRRRA and other stakeholders, the lead Engineer shall submit and obtain written approval of design from all utilities within the construction area. This includes all utilities that have established prior use of the right-of-way under easement or license agreements.



For a new highway-rail grade crossing, existing underground and aboveground utilities shall be identified prior to any construction. The appropriate regional notification center [Underground Service Alert (DIGALERT) at (800) 227-2600], railway companies, and utility companies shall be notified prior to performing any excavation close to any underground pipeline, conduit, duct, wire, or other structure. Refer to SCRRA's website <http://www.metrolinktrains.com> to ensure proper contract information and phone numbers. SCRRA is not a member of DIGALERT. It is, therefore necessary to call SCRRA's signal department phone number (refer to SCRRA's website) to mark, at the highway agency's or contractor's expense, signal and communication cables and conduits. In case of signal emergencies or highway-rail grade crossing problems, the contractor shall call SCRRA's 24-hour signal emergency number. When the new crossings involve gates, the minimum required clearance from existing overhead wires (as specified in CPUC GO-95) shall be maintained, and gate foundations checked for utilities.

The lead Engineer shall locate and note all utilities in place at the crossing. These utilities shall be confirmed by potholing or other method to determine location and depth. This is especially important where additional highway-rail grade crossing devices are to be installed or existing devices relocated. The lead Engineer shall address the location of any utilities in relation to any device foundations or other structural considerations.

The installation of conduits or encasements under the railroad shall be in accordance with SCRRA Engineering Standards for utility crossings. In addition, the lead Engineer shall comply with the SCRRA standards for details on jacking pipes or conduits under SCRRA tracks.

Signs and Billboards

Advertising billboards are often located along the open spaces of the railroad right-of-way. These are to be treated as individual right-of-way items that shall be addressed early in the design phase. The lease agreements between the two parties often create special and time-consuming circumstances that must be addressed early to avoid delays if the billboards or signs must be relocated. The removal or relocation of a billboard shall be coordinated with the right-of-way departments of SCRRA member agencies.

Billboards and sign structures can create visibility problems and distract the motor vehicle operator's attention from the warning devices located near or at the highway-rail grade crossing. Figure 3-37 illustrates how billboards and signs can block the view of a crossing.

In many cases these billboards are mounted on substantial columns, impeding the view down the railroad right-of-way. Signage placed within or adjacent to the right-of-way for traffic control or other purposes must also be addressed during design. When developing the overall design of the crossing, the lead Engineer shall consider the current locations of existing signs and billboards, and the ultimate effect that this placement will have on the operation of the crossing. Signs that could impede visibility should be noted during the diagnostic review and, if necessary, recommendations should be made regarding the treatment of these signs.



Figure 3-37. Billboard within the Right-of-Way

Enhancements to highway-rail grade crossings that involve improved pedestrian access, additional warning devices, widened highways, and additional traffic signal equipment may be affected by billboards located adjacent to the crossing. It may be necessary to remove or relocate the billboard prior to construction.

3.18 FUTURE IMPROVEMENTS

Enhancements to the highway-rail grade crossings, such as median islands, traffic signal system, preemption, widening, pedestrian and vehicular facilities, should be designed and constructed, such that future railroad improvements [second or more track(s)] and/or other railroad improvements can be accommodated without the need to completely modify the current elements of the crossing. *The lead Engineer or designer should be cognizant of the potential to improve the highway-rail grade crossing system for future SCRRRA tracks and other facilities, and should incorporate into the design the necessary accommodation of future railroad improvements.*



4.0 PEDESTRIAN-RAIL GRADE CROSSINGS

4.1 GENERAL

Pedestrian treatments shall be installed at pedestrian-rail grade crossings in accordance with the Pedestrian-Rail Grade Crossing Design Consideration Flowchart in Figure 4-2. Pedestrians at highway-rail grade crossings present unique challenges to the lead engineer. Many of the same considerations given to motor vehicles—such as channelization, signs, and warning lights—also apply to pedestrians. This section of the Manual will discuss and define the components and treatments that together, all or in part, comprise a pedestrian-rail grade crossing and then will describe the applications at the different types of pedestrian-rail grade crossings. Pedestrian-rail grade crossings can be placed in four different categories:

- Pedestrian-rail grade crossings adjacent to a motor vehicle crossing
- Pedestrian-rail grade crossings at stations adjacent to motor vehicle crossings
- Pedestrian-rail grade crossings at stations
- Pedestrian-rail only crossings

Each of these types of pedestrian-rail grade crossings generates unique challenges that need to be addressed during the design phase. In general, pedestrian-rail grade crossing design should facilitate efficient and safe travel across the railroad right-of-way, and shall be in accordance with SCRRRA's Engineering Standards. It is desirable that the pedestrian-rail grade crossing have the following features:

- A smooth, easily traversed surface that does not impede individuals with disabilities, strollers, or carts, incorporated into the adjacent sidewalk topography.
- Clear striping and signage that avoids confusing directions or features, a relatively straight path that is clearly marked and easily accessible throughout the footprint of the crossing and a readily accessible means of exiting the crossing.
- Deterrents such as fending and gates that minimize trespassing into prohibited areas of the railroad right-of-way.

4.2 PEDESTRIAN-RAIL GRADE CROSSINGS AND GRADE SEPARATIONS (AT STATIONS)

Pedestrian-rail grade crossings at stations shall be evaluated for grade separation per the following criterion, along with an analysis of the train volumes and pedestrian volumes. The lead Engineer will work and coordinate with SCRRRA for the determination of the need for grade separation:

- | | |
|--------------------------------------|---|
| • One main track plus a platform | Pedestrian–rail grade crossing acceptable |
| • Two main tracks plus two platforms | Pedestrian-rail crossing acceptable consider |
| | Pedestrian grade separation > 50 daily trains |
| • Three or more main tracks | Grade separation recommended |

4.3 TEN-MINUTE WALK RULE

In order to determine if a crossing has, or has the potential for, pedestrian activity, pedestrian-rail grade crossings shall be evaluated using the 10-minute walk rule. This



rule is based upon research conclusions that pedestrians will walk ten minutes to reach their destination. This equates to a one-third to one-half mile walk. Therefore, if the crossing is located within this radius of schools, hospitals, substantial pedestrian generators or other facilities, then the lead Engineer should consider features pedestrian traffic features over the crossing.

4.4 PEDESTRIAN AND TRACK STRUCTURE INTERFACE

The track structure is made up of many components. The component that most affects the pedestrian-rail grade crossing is the flangeway. The flangeway is the inside edge of the rail and the crossing surface and allows the flange of the train wheel to ride along the rail.

The ADA limits the width of the flangeway gap to a maximum of two and a half (2½) inches (ADAAG 10.3.1). The surface of the crossing shall be level and flush with the top of the rail at the outer edge and between the rails. Freight railroads require a three (3) inch flangeway gap at installation. This allows for a wear of about one (1) inch in regular use. SCRRRA standards call for a rubber flangeway filler for all new or improved crossings that accommodates the ADA requirement while allowing the free movement of rolling stock over the crossing.

4.4.1 Visibility

Visibility between trains and pedestrians shall be considered during the diagnostic analysis and design of the crossing. The design should provide the pedestrian reasonable visibility of a train upon its approach and departure. This is important when dealing with a multi-track crossing, when the view of an approaching train may be blocked by an additional train. In general, the installation of active warning devices including automatic gates and appropriate fencing will mitigate for the lack of visibility. During the initial site assessment, the lead Engineer shall examine all features in and around the crossing that could impede pedestrian visibility.

Many features present at a highway-rail grade crossing can hinder visibility for the pedestrian. These features may include the following:

- Buildings and/or walls
- Billboards, signs, and utilities
- Trees and other vegetation
- Traffic patterns of motor vehicles at the crossing
- An adjacent bus stop shelter and bus operations associated with that shelter
- Trains stopped at multiple-track crossings
- Adjacent developments such as housing units, buildings, and industrial parks
- Railroad features such as shelters

The lead Engineer shall consider the overall visibility at the crossing from the pedestrian's perspective, and endeavor to mitigate deficiencies that could diminish the intrinsic safety of the crossing. During the diagnostic analysis and inventory, the diagnostic team shall consider the following and take appropriate action:



- Diagram the crossing to show the obstructions to pedestrian visibility, and incorporate solutions into the design of the crossing.
- Examine each of the features at the crossing, and thoroughly explore the risk arising from those features, and may include recommendations to remove a feature that is severely impeding pedestrian visibility.
- Additional devices or signage may be necessary to offset the lack of visibility created by the obstructions; however, placement of each of these devices should be carefully examined for compatibility with existing features.

4.5 AMERICANS WITH DISABILITIES ACT

The Americans with Disabilities Act Guidelines (ADAAG) govern the design and construction of any features associated with pedestrian crossings. **ADA guidelines must be incorporated into the overall design for pedestrian-rail grade crossings.**

Detectable warning strips shall be applied to the sidewalk ahead of the warning device in order to show pedestrians where to stop when a train is approaching.

The placement of the detectable warning strip shall follow the standards outlined in SCRRRA's Engineering Standards.

4.6 WARNING DEVICES

Pedestrian-rail grade crossing active warning devices shall be installed 15 feet from the centerline of the track, as measured from the center of the mast at new or existing crossings. A design deviation may be requested for active warning devices installed less than 15 feet, but in no case shall an active warning device be installed less than 12 feet from the centerline of track.

4.7 CHANNELIZATION

The design of pedestrian-rail grade crossings shall provide clear, well-defined travelways throughout the crossing and should discourage improper pedestrian behavior, such as circumventing the gates, walking onto the railroad right-of-way, or walking onto the highway. Fencing or railing should be provided along the sidewalk to direct pedestrians along the proper path, but coordination with the SCRRRA Signal Department is recommended to ensure this railing, to the extent possible, does not block or impede maintenance access to railroad signal devices, and does not interfere with the location of the devices used for sealing the corridor. This can be tubular steel railing, ornamental fencing, or welded wire mesh fencing. The type of fencing to be used shall be discussed with the stakeholders.

Additional controls used to identify the pedestrian travelway include striping and raised markers. Bold, white striping, with reflectorized markers, is used to delineate the pedestrian's safest path across the crossing. Refer to SCRRRA Engineering Standards for examples of these treatments.

The channelization of pedestrians is particularly effective when attention can be directed along a given line of sight. By controlling the direction taken by pedestrians approaching a crossing, the lead Engineer may be able to induce pedestrians to look in a given direction. For example, the creation of a zigzag pedestrian path forces the pedestrian to



look along both approaches of the crossing, maximizing the likelihood that the pedestrian will see trains approaching from either direction. Figure 4-1 illustrates this type of channelization on the approach to the pedestrian-rail grade crossing.

Pedestrians sometimes trespass into prohibited areas of the railroad right-of-way. This problem requires special consideration. Traditional designs have often used fencing to keep pedestrians out of protected areas. “No Trespassing” signs, complete with warnings about enforcement and prosecution, have also been used. During the diagnostic review, the team should review pedestrian access to the railroad right-of-way and develop safe and effective solutions to preventing unwanted trespassing.



Figure 4-1. Pedestrian Channelization

4.7.1 Center Fence (Inter-Track Fence)

At stations, track centers shall be a minimum of 18 feet but not more than 25 feet to accommodate a center track fence. Such fences must have a 9'-0" minimum (on tangent) clearance from each track center. The fence shall encompass the platform and channel the passengers to crossings at the end of the platforms. Where tracks cannot be widened to accommodate a center fence, proper signage should be installed to deter pedestrians from crossing the tracks except at the proper and designated locations.

4.7.2 Refuge Areas

SCRRRA standards for pedestrian applications include an area where pedestrians crossing the track can seek refuge. SCRRRA standard pedestrian channelization concepts include a refuge area where the pedestrian can wait as a train approaches. This refuge area is not intended as a location where a pedestrian can wait for the train, but rather as a safe harbor should the pedestrian hesitate between the down gates and the track. Refer to Engineering Standards for examples of these refuge areas. The



refuge area shall incorporate a swing gate (see Section 4.8.3 for additional information) to allow pedestrians to exit the refuge area away from the tracks.

4.8 PASSIVE DEVICES

4.8.1 Signage

Signage is utilized throughout a crossing to guide pedestrians safely through it. Of particular note are the signs warning pedestrians of multiple tracks, and the possibility of multiple trains at the crossing. These signs should be used at the approaches to the crossing. The potential presence of a second train is an important consideration when applying signage to the crossing.

4.8.2 Pavement Markings

Pavement markings should generally consist of white striping with reflectorized indicators. Refer to the Engineering Standards for details on pavement markings.

4.8.3 Swing Gates

Pedestrian swing gates have two distinct functions: they can serve as an entry/exit swing gate, or strictly as an emergency exit gate, as explained in further detail below:

- As an entry/exit swing gate, the swing gate is intended, when not used with a pedestrian-rail grade crossing gate, to slow pedestrians and encourage them to stop, look both ways down the track for approaching trains, and then pull the swing gate open to safely cross the tracks. A “LOOK” sign, as detailed in the Engineering Standards, shall be mounted on the approach side on the swing gate or on a separate post next to the swing gate. Particularly at pedestrian-only crossings without active warning devices and automatic gates, the pedestrian must determine if there is sufficient time to cross the tracks in front of an approaching train. The diagnostic team should provide the pedestrian with adequate visibility. Appropriate “Push Gate To Open” signs on the track side and “Pull Gate To Open” signs on the approach side shall be mounted on the entry/exit swing gates.
- As an emergency exit gate, the swing gate is incorporated with an active warning device, so pedestrians shall have an escape route in the event of occupying the crossing during the time when a crossing gate is activated. The gate shall only swing away from the crossing, with clearly marked “Push Gate To Open” signage on the track side. The approach side of the swing gate shall have signage marked as “Exit Only” to deter pedestrians from using the gates and entering the crossing while the active warning gates are activated.

Refer to SCRRRA Engineering Standards for details on the swing gates and signs. The responsibility for the installation and maintenance of swing gates shall be covered in a C&M Agreement.

4.9 ACTIVE DEVICES

Active warning devices applicable for pedestrian-rail grade crossings are usually similar to those for vehicles. Active pedestrian warning devices include pedestrian gates. Refer



to Engineering Standards for pedestrian warning devices.

Active warning devices that are used to aid pedestrians take on a variety of configurations. Refer to Engineering Standards for examples of these configurations.

4.10 PEDESTRIAN-RAIL GRADE CROSSING TYPES

The design of a pedestrian-rail grade crossing should provide an environment that provides ample opportunities for pedestrians to observe and comply with the warning devices and stay clear of any approaching train traffic. The option to select passive and active warning devices depends upon the four types of crossing listed at the beginning of this section. With each type, the following factors need to be considered:

- The number of and type of tracks (i.e. main, siding, industry lead)
- The proximity to rail passenger stations
- The proximity to other rail facilities such as sidings, yards, industry spurs
- The skew and vertical profile across the crossing
- Visibility restrictions
- The volume and pattern of pedestrian activity
- Current and future development in and around the crossing
- Right-of-way constraints

4.10.1 Pedestrian-Rail Grade Crossings at Highway-Rail Grade Crossings

Most pedestrian-rail grade crossings on SCRRA's system are of the type where the pedestrian-rail grade crossing is a part of the highway-rail grade crossing and is located on one or both sides of the highway and the highway-rail grade crossing.

When beginning the design for modifications to a highway-rail grade crossing, the lead Engineer should determine whether or not the local highway agency allows pedestrians along the highway and to what degree pedestrian facilities are already in existence. A flowchart detailing the decision process for determining the type of pedestrian treatments warranted for a highway-rail grade crossing is provided in Section 4.11.

4.10.2 Pedestrian-Rail Grade Crossings at Highway-Rail Grade Crossings and Adjacent to Rail Passenger Stations

Combined pedestrian-rail grade and highway-rail grade crossings near rail stations are considerably more complex than pedestrian crossings not near a rail station and represent a special case of pedestrian-rail grade crossings. Some of the complicating factors are as follows:

- These pedestrian-rail crossings may be used by large groups of commuter rail patrons accessing the platforms and by pedestrians crossing the tracks.
- The level of pedestrian activity at a station crossing is directly associated with the departure and arrival of passenger trains and other transit such as buses and shuttles; it is also associated with the presence of parking lots.
- The stopping patterns and dwell times of trains affect the performance of the active warning devices.



The lead Engineer shall follow the same design process used for a pedestrian-rail grade crossing adjacent to a highway-rail grade, and determine the appropriate pedestrian treatments as provided in Section 4.11.

4.10.3 Pedestrian-Rail Grade Crossings at Stations (not located at Highway-Rail Grade Crossings)

Pedestrian-rail grade crossings at stations are primarily used by pedestrians accessing the platforms; however, in some circumstances they may also be used by pedestrians to cross the rail corridor.

In general, the level of pedestrian activity at a station crossing is directly associated with the departure and arrival of passenger trains. Because of this, **station pedestrian-rail grade crossings shall provide “full pedestrian treatments” (signage, channelization, active pedestrian warning devices with gates, and swing gates) and fencing, and shall not cross more than two tracks.**

There are two types of pedestrian-rail grade crossings at stations: (1) pedestrian-rail crossings grade crossings located past the ends of platforms (the new recommended design practice and standard); and (2) existing pedestrian-rail crossings in the middle of the platform (this design practice will no longer be allowed).

- **Station pedestrian-rail grade crossings shall be installed approximately 60 feet from the platform, and include full pedestrian treatments.** It is desirable to have the gates recover during normal station dwell time. Fencing should properly channelize pedestrians across the tracks at the pedestrian-rail grade crossing and deter the public from taking a “short cut” and trespassing across the tracks in prohibited areas.
- **New pedestrian-rail grade crossings in the middle of platforms shall not be allowed.** At existing stations that have a pedestrian-rail grade crossing in the middle of platform, the crossing shall be relocated at the end of the platform, or an underpass shall be constructed during major modifications to the station.

4.10.4 Pedestrian-Rail Grade Crossings (for Pedestrians Only)

New pedestrian-rail grade crossings shall not be allowed unless one or more existing pedestrian-rail or highway-rail grade crossings are closed.

Pedestrian-rail grade crossings shall follow the same design process as a pedestrian-rail grade crossing adjacent to a highway.

Pedestrian-rail grade crossings are typically associated with walking paths and bike trails adjacent to the railroad right-of-way. Pedestrians may be tempted to take shortcuts and trespass rather than use the designated pedestrian crossings. The lead Engineer shall pay careful attention to this hazard, and place the proper fencing and channelization to address this undesirable behavior. Where the right-of-way permits, the use of zigzag channelization, referred to in Section 4.7, should also be considered by the diagnostic team.



4.11 DESIGN PROCESS AND CONSIDERATION TABLE

Pedestrian-rail grade crossings should, in combination with the horns on locomotives, provide adequate warning devices which allow pedestrians and bicyclists to be warned of approaching trains and take appropriate action. During the design of the pedestrian-rail crossing, the lead Engineer shall consider these factors: 1) existing and future pedestrian and bicycle activity; 2) type of path (pedestrian only or combined pedestrian and bicycle); 3) number of tracks, track speeds, and number of trains; 4) proximity of rail passenger stations; 5) establishment of quiet zones; 6) travel distance across tracks to reach a location well outside of train dynamic envelope; 7) skew and vertical profile across the rail crossing; 8) visibility restrictions; 9) volume of pedestrian activity; 10) type of pedestrian activity (i.e., school, transit, hospital); 11) current and future development (including transit service and transit oriented development) in close proximity to the pedestrian-rail crossing; and 12) right-of-way constraints.

In the discussion of the design considerations, the term **“full pedestrian treatments”** shall include signage, markings, channelization, fencing, active warning devices with gates, and swing gates. *SCRRRA’s policy and practice is to apply full pedestrian treatments to highway-rail grade crossings consistent with the Pedestrian-Rail Grade Crossing Design Flowchart in Figure 4-2.*

The process in Section 4.11 and Figure 4-2 shall be used to determine the designs of pedestrian-rail grade crossings and appropriate warning treatments. This process shall be similar for any type of pedestrian-rail grade crossing, and defines the SCRRRA recommended approach to the application of pedestrian treatments at pedestrian-rail grade crossings.

Decision Point 1

The existence of pedestrian activity shall be determined. This includes sidewalks leading up to the right-of-way, or evidence of pedestrians crossing at that location. The lead Engineer shall determine from the Highway Agency the existing and desired future status of any pedestrian related facilities in the highway and railroad rights-of-way, including easements, licenses, and C&M Agreements. SCRRRA-recommended design practices and standards call for the addition of pedestrian treatments if the highway agency and the SCRRRA are in agreement, and the highway agency legally allows pedestrians to utilize the highway right-of-way for crossing the track(s). The lead Engineer shall take the following actions when evidence of activity exists without pedestrian facilities:

- Determine the level of pedestrian activity and if the pedestrian activity is legal and supported by the local highway agency.
- Work with the local highway agency to modify sidewalks and bring in compliance with ADA requirements.
- If warranted, the design shall provide sidewalks over the railroad right-of-way and tracks.
- If warranted, take steps to prevent possible trespassing.

Decision Point 2

If the pedestrian-rail grade crossing is to be included in a quiet zone, then full pedestrian treatments for safety enhancements and quiet zone signage shall be applied.



Decision Point 3

The type of pedestrian-rail grade crossing is analyzed at this step. A station pedestrian-rail grade crossing or a pedestrian-rail grade crossing combined with a highway-rail grade crossing adjacent to the station (including any light rail stations located on within a common rail corridor) require full pedestrian treatments.

Decision Point 4

Is the pedestrian-rail grade crossing located within a 10-minute walking distance of a school, hospital, or other facility that can be expected to support disabled people? If the answer is yes to any of the listed facilities, then full pedestrian treatment shall be applied. If the answer is no, then is there significant pedestrian activity?

In order to answer no to whether there is significant pedestrian activity, the lead Engineer shall conduct a study to determine: the volume of pedestrian use, both on-peak and off-peak hours; the types of pedestrians (i.e., school children, elderly, disabled, bike riders, etc.); and pedestrians' behavior patterns (i.e., are pedestrians behaving in a safe manner when using the crossing and cognizant of potential train activity?). The lead Engineer will then discuss the results of this study with SCRRA and CPUC for clear consensus with the Safety Review Team as to the presence or absence of significant pedestrian activity. Full pedestrian treatments shall be applied for a yes answer to any of these questions.

Decision Point 5

Does the crossing have three or more main tracks? If the answer is yes, the pedestrian-rail grade crossing shall be grade separated. The grade separation can be an overhead or an underpass.

Decision Point 6

Does the crossing have two main tracks? This decision point is arranged so that a yes answer for this question accounts for two tracks in rural areas that see few pedestrians. In this case, it may not be appropriate to install full pedestrian treatments, but a request for a deviation not to do so must be submitted to the SCRRA. In an urban/metropolitan environment, full pedestrian treatments shall be applied when multiple tracks are in a location with limited visibility.

Decision Point 7

Does the crossing location have restricted visibility? Full pedestrian treatments shall be applied where there is limited visibility at crossings.

Decision Point 8

Is the right-of-way necessary to comply with the Manual unobtainable? If not, then full pedestrian treatments are required. SCRRA Standard Drawings include variations to the standard configuration, depending on the available right-of-way. In cases where the right-of-way required for the use of one of these standard applications cannot be acquired due to existing property uses, or because of other conditions, the lead Engineer shall request a deviation from standard and design a non-standard application.

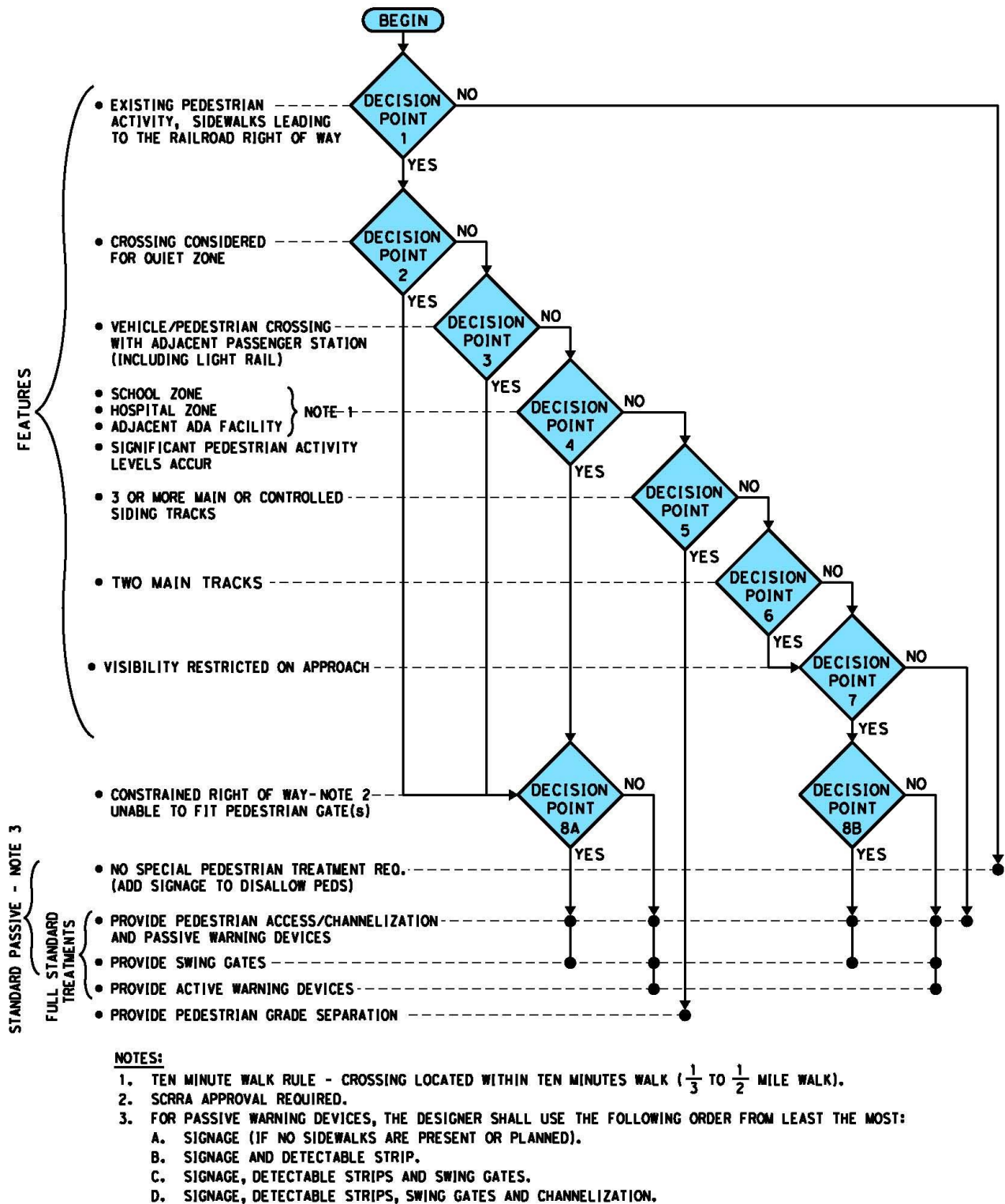


Figure 4-2. Pedestrian-Rail Grade Crossing Design Consideration Flowchart



5.0 GRADE SEPARATIONS

A “grade separation” is a means of separating the highway or pedestrians from the railroad tracks. Pedestrian grade separations are discussed briefly in Section 4 of the Manual. These may be accomplished with an underpass (the highway or pedestrian pathway passes under the railroad) or an overhead (the highway or pedestrian pathway crosses over the railroad). Outside of full highway-rail grade crossing closure, this is the most effective means of eliminating hazards related to these types of crossings. Refer to SCRRA’s Grade Separation Guidelines, located on the SCRRA website: <http://www.metrolinktrains.com>, for additional information on grade separations within SCRRA’s system.



6.0 RAILROAD ACTIVE WARNING AND TRAFFIC SIGNAL SYSTEM INTERCONNECTION CIRCUITS

6.1 INTERCONNECTION DESIGN

6.1.1 Background

Knowledge in the field of traffic signal preemption continues to evolve. Before designing a traffic signal preemption circuit, the lead Engineer should review the latest guidelines regarding traffic signal preemption as prepared by the Institute of Transportation Engineers, AREMA, CAMUTCD, CPUC, and other knowledgeable parties. Circuits described below are based on fail-safe closed loop methodology. A vital serial data circuit in accordance with IEEE Standard 1570-2002 may be used in lieu of the referenced circuits. Design and testing of traffic signal preemption interconnection circuits must be coordinated with the railroad and the agency having jurisdiction.

6.1.2 Interconnection Circuits

Older, widely-used traffic signal controller units use interconnection circuits between the railroad active warning system cabinet and the traffic control signal cabinet for preemption. This interconnection circuit consists of two wires/cables buried in the ground between the above two points. The approach of a train to a highway-rail grade crossing activates the electrical circuit, which in turn notifies or issues a call to the traffic signal controller preemptor. This establishes and maintains the preemption condition during the time the highway-rail grade crossing warning system is activated.

If there is a break in either or both wires or cables of the interconnection circuit (as, for example, when an excavation contractor inadvertently breaks the wires or cables), the traffic signal controller unit would respond as if a train were approaching and clear vehicles off the tracks—even though a train may not be approaching. The traffic signals remain in the preemption mode as long as the circuit remains open. If a train approaches during this scenario, the railroad active warning devices shall activate, yet the traffic signal preemption cannot be reinitiated to clear vehicles off the tracks.

One potential problem with the two wire/cables interconnection is a short in the circuits. If the wires/cables between the traffic signal control cabinet and the railroad active warning system cabinet became shorted together, the preemption relay in the traffic control signal cabinet could be falsely energized, even if the relay contact opened. In this case, the active warning devices would operate, but the traffic signal controller unit would not receive the preemption input. To address these potential problems, a supervised double-break, double-wire circuit shall be installed between the railroad and the traffic signal control system.

Supervisory Circuits

In order to detect a shorted or open interconnection circuit, two additional wires are used to provide a supervised circuit. The energy source originates at the traffic signal controller: two wires provide a return path, verifying the railroad preemption control relay is energized and there is no call for preemption. The two additional wires verify circuit integrity when the railroad issues a call for preemption. The circuit logic is “Exclusive OR.” One circuit must be energized and the other de-energized. If both circuits are



shown to be energized and both appear de-energized, it indicates a problem with the interconnect circuit. In that case, the traffic signal controller should assume a state known to be safe and issue a notification that there is a circuit deficiency.

Table 6-1 below identifies the number of wires and functions for the supervised interconnection circuit for simultaneous and advance preemptions:

Table 6-1. Interconnect Wire Assignments

Wires	Simultaneous Preemption	Advance Preemption
1	Source energy positive	Source energy positive
2	Source energy negative	Source energy negative
3	Preempt relay positive	Preempt relay positive
4	Preempt relay negative	Preempt relay negative
5	Supervision relay positive	Supervision relay positive
6	Supervision relay negative	Supervision relay negative
7		Gate down relay positive
8		Gate down relay negative
9		Traffic signal health positive
10		Traffic signal health negative

Gate-Down Circuits

A preempt trap condition occurs when the clear track green interval ends before the flashing-light signals start to flash and gates start to descend. It can occur with advance preemption.

One of the solutions to avoid preempt trap is to use a “gate down” circuit. The purpose of the “gate down” circuit is to prevent the traffic signal from leaving clear track green interval until it is determined that the gates controlling access over the tracks are fully lowered. The “gate down” circuit notifies the traffic signal controller unit when the gates controlling access over the tracks on the approach to the intersection have either fully lowered or the train has occupied the crossing. At the beginning of preemption, the traffic signal controller unit shall change to the clear track green interval as usual, but shall dwell in the clear track green interval until the “gate down” confirmation is received, or until a user-defined maximum time has expired.

Traffic Signal Health Check Circuits

A health check circuit provides an indication to the railroad active warning system cabinet when the traffic signals are in flashing mode or dark, such as when the controller is in failure. This health check circuit requires additional wires/cables between the traffic control signal cabinet and the railroad active warning system cabinet. Consideration should be given to a fail-safe design for the health check circuit so that there shall be no case in which the circuit shall remain energized while the traffic signals are flashing or dark.

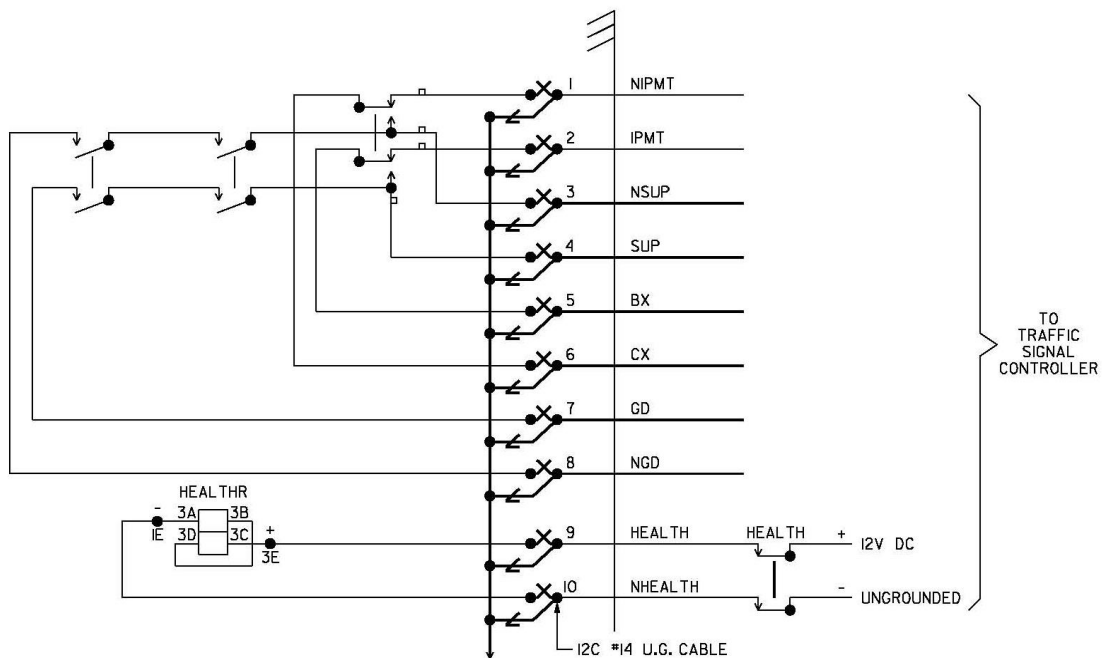


Figure 6-1. Interconnection Circuits with Supervision, Gate-Down Circuitry, and Health Circuit

Interconnection Circuits

In Figure 6-1 above, energy (BX, CX) is supplied to the railroad from the traffic signal controller. The TCPR is the relay that provides the call to preempt. This relay is normally energized and returns energy to the inputs of the traffic signal controller. When a train is detected and the call for preemption is generated, the TCPR is de-energized and the energy is returned to the traffic signal controller on the wires labeled SUP and NSUP. This is the supervisory circuit. The supervisory circuit must be de-energized and the preemption circuit energized, or vice versa. This indicates the integrity of the interconnection circuitry to the traffic signal controller. If both are energized, or both are de-energized, that is indicative of a fault in the interconnection.

The wires labeled GD and NGD are energized when the gates approaching the signalized intersection are down after a call to preempt. Upon receipt of these inputs, the traffic signal controller can terminate track clearance green (TCG) and transition to the phases allowed during preemption. These gate-down contacts may be bypassed by contacts of the island circuit so that TCG can terminate when the island is occupied in the event of a gate that does not fully lower.

The health of the traffic signal controller is communicated to the railroad via the health relay. If the traffic signal controller is not functioning or in all-flash mode, the health relay shall be de-energized; thus the highway-rail grade crossing warning system may cause the gates to be down longer for an approaching train, since the traffic signals shall not be able to clear out traffic as designed.



When a serial connection is used, this information and more can be conveyed between the railroad control devices and the traffic signal control devices. This enhances the operation of both systems.

6.1.3 Not-to-Exceed Timing Circuits

Railroads sometimes use the “not-to-exceed” timing circuits to control the maximum advance preemption time. This helps in eliminating a preempt trap.

6.1.3 Second Train Logic

Where there is more than one track, a second train can approach at any time. If there is an advanced preemption interconnection between the traffic signals and the railroad, the appearance of a second train can hold the traffic signals in preemption and have the gates rise momentarily, allowing vehicles to pull up onto the tracks. Where second train logic is employed, if a second train is detected on the outer approach, the gates shall remain down until after the second train passes. Second train logic may be employed where no traffic signals are present if circumstances warrant.



7.0 HIGHWAY-RAIL GRADE CROSSING PROJECT IMPLEMENTATION

7.1 HIGHWAY-RAIL GRADE CROSSING DESIGN PROCESS

The process for the proper analysis and design of highway-rail grade crossing improvements involves several different engineering disciplines, as well as the highway agency, the SCRRA, and the CPUC in regulatory roles. A typical highway-rail grade crossing design considers motorist behavior, pedestrian behavior, civil design, railroad design, railroad signal design, and traffic engineering plus application of CPUC, FRA and MUTCD regulations and standards. This design process involves all engineers involved in the ultimate configuration of the crossing, from the onset of design. The process is outlined in Figure 3-2.

The design of the highway-rail grade crossing is a dynamic iterative process, with the design evolving as different levels of design are reached. The ultimate configuration of the highway-rail grade crossing may be significantly different from the initial concept.

Modifications of a highway-rail grade crossing must go through the CPUC approval process. Because of this, the lead Engineer should allow time in the design process for diagnostic reviews by the engineering team (see Section 7-3). At these diagnostic reviews, the ultimate scope of the project, and ultimately the design, shall be determined. These diagnostics are an important part of the design process, and provide the necessary input from stakeholders to determine the effectiveness of the proposed changes. The lead Engineer shall take note and record the results of the diagnostic meetings and attempt to incorporate the appropriate recommendations and changes into the design.

The design of the highway-rail grade crossing shall include the input received from the different departments within SCRRA. The overall functionality and effectiveness of a highway-rail grade crossing shall be determined by operational and maintenance needs as well as engineering design needs. The input from these departments early in the engineering process shall provide important information that shall affect the overall design of the crossing. Designs that do not give adequate attention to SCRRA inter-departmental input often fall short of meeting the overall goals of the project, and often require substantial rework in order to accommodate those needs. The lead Engineer shall include SCRRA as an active participant in the design process in order to ensure that the recommendations in this Manual and the input of the SCRRA are adequately addressed.

7.2 DESIGN GOALS

The purpose of, and need for, the modifications should be set forth at the start of design. This will form the basis for the overall design of the project, and set the ultimate goals for the improvements. The evolving diagnostic process will define changes in those ultimate goals, changes that shall ultimately decide the outcome of the final design.

The initial efforts in the design should include meetings and field surveys with SCRRA staff to determine other factors that could affect the construction of the proposed improvements. During the development of the overall scope of the improvements, the lead Engineer should know the extent of work that will be necessary to implement the improvements. For example, the addition of a lane shall require the widening of the



overall crossing. It may be necessary to recommend a complete reconstruction of the highway-rail grade crossing to ensure that the ultimate construction does not create other impacts or maintenance concerns.

The overall schedule of the crossing construction should be compared with SCRRA maintenance plans in the area. During this comparison, a plan of construction can be incorporated into a regular maintenance cycle so as meet the operational needs of the railroad. This is especially important in areas where heavy rail traffic minimizes the opportunities to remove tracks from service in order to perform construction and maintenance.

7.3 DIAGNOSTICS

7.3.1 Introduction

To make improvements to a crossing, construct a new crossing, or close a crossing, a series of diagnostic reviews shall be performed. As shown in Figure 3-1, before commencement of design, a conceptual diagnostic site meeting shall be completed with the purpose of understanding the existing conditions of the crossing. After the 30% Design, but before the Pre-Final 90% designs can be approved, a second diagnostic site meeting shall be completed to predict how the proposed changes would affect and improve the crossing.

The second diagnostic meeting will have the benefit of having all of the site survey and investigation work done and much of the design completed. During the second diagnostic meeting, any significant changes from the assumptions or recommendations in the first diagnostic meeting and any proposed requests for waivers from the Manual should be discussed. After completion of the design and construction, a final diagnostic site meeting shall be completed to verify that the new improvements allow the highway-rail grade crossing to function as intended. Information from SCRRA, FRA, inventories, and accident summaries—as well as information from local highway traffic departments—can help to create a clearer picture of how a highway-rail grade crossing functions and what problems need to be addressed. The diagnostic processes use a simple survey procedure, utilizing individuals in various areas of expertise to analyze the crossing.

The diagnostic team consists of knowledgeable representatives of stakeholders in a highway-rail grade crossing. Using highway-rail grade crossing safety management principles, the team evaluates conditions at a highway-rail grade crossing to make determinations or recommendations concerning safety needs. At a minimum, this diagnostic team needs to include: representatives of the highway agency or authority with jurisdiction over the highway; the SCRRA; and the CPUC (reference: CA MUTCD Part 8). Other participants in the diagnostic team may include the BNSF or UPRR railroads, and representatives of SCRRA member agencies.

The diagnostic team needs to be interdisciplinary to ensure that all factors relating to the operational and physical characteristics of the highway-rail grade crossing are properly identified, analyzed, and mitigated as necessary. The team shall have the expertise to provide a thorough engineering analysis of the physical and operational aspects of the highway-rail grade crossing, and provide input into the overall effectiveness and safety of the proposed design of the crossing.



Consultation with all stakeholders is required to ensure that the design of the highway-rail grade crossing shall, to the extent possible, comply with the recommended design practices and standards in this Manual.

In addition to the engineering expertise that should be included in the diagnostic, any stakeholder with an interest in the highway-rail grade crossing, or with information regarding the highway-rail grade crossing, should be included. The diagnostic team is responsible for bringing all factors affecting the design and ultimate operation of the highway-rail grade crossing into the discussion of the overall design.

7.3.2 Diagnostic Process

The diagnostic process necessary to begin and complete the design of the highway-rail grade crossing is a several-step process that is outlined in Figure 7-1. The diagnostic team should analyze the highway-rail grade crossing at various steps along the way to assess the progress of the overall design. Before starting the diagnostic process, the following should be addressed:

- Purpose of and need for improvements
- Existing conditions
- Existing deficiencies from the recommendations in the Manual
- Funding
- Lead agency
- Roles and responsibilities

Defining the purpose of, and need for, the improvements will set the stage for the overall diagnostic process. The engineering team, working on an established purpose and need, shall analyze the reasons for the proposed improvements and develop the overall strategy on the design of the improvements and the development of engineering solutions.

While funding is not a determining factor in developing the overall safety improvements at a crossing, it does affect the overall approach to the design, construction, and maintenance of the crossing. In many cases, the purpose of the modifications is directly related to funding sources and requirements that define the process. These responsibilities and funding sources for the project should be determined at the onset of the design process.

The roles and responsibilities of each organization represented at the diagnostic review shall be established prior to the commencement of the diagnostic process.

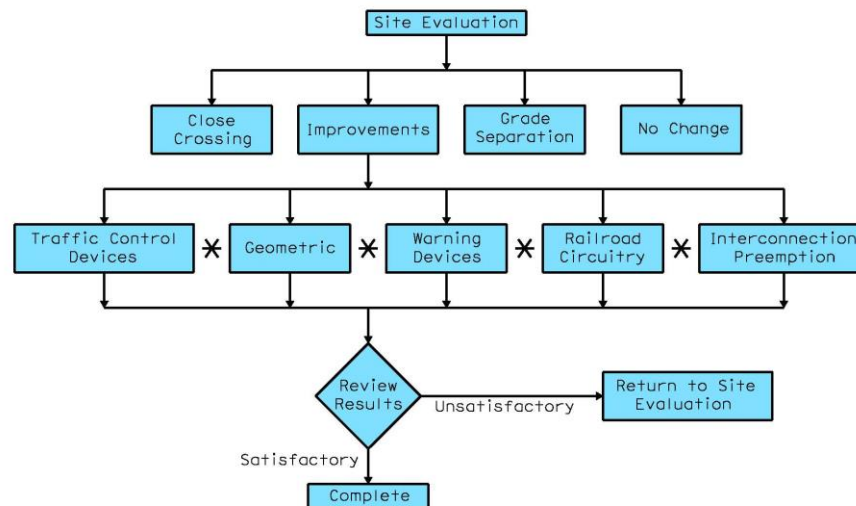


Figure 7-1. Diagnostic Meeting Process

Once the above-mentioned issues have been addressed, the team begins the diagnostic process in accordance with the above Figure. As shown, the first steps are deciding upon the first level: namely, whether the highway-rail grade crossing can be closed, or should be grade separated (usually this has been determined by the lead agency, or the project proponent, prior to commencing the diagnostic process); whether no changes should be made; or whether improvements are to be proposed. In general, the proposed improvements should bring the highway-grade rail crossing in compliance with the recommendations in the Manual. Once the team decides improvements are needed at the crossing, each of the elements (comprising the second level of the figure) is discussed, and improvements, if any, are proposed. Upon completion of the first diagnostic site meeting, the conceptual scope of the improvements is agreed upon between the stakeholders and the design phase of the project can begin.

In order to incorporate current conditions at an existing, or proposed, highway-rail grade crossing into the conceptual design of a highway-rail grade crossing, field observations are needed to record key factors that may affect the capabilities and success of the design. At this stage of the project general observations should be recorded, including but not limited to factors such as types of warning devices, vehicle and pedestrian conditions, vehicle-train and pedestrian-train conflict points, highway-rail grade crossing surface conditions, adjacent intersection and driveway conflicts, train speed, train density, train operating patterns, school bus volumes, location of schools in the vicinity, location of stations, illegal/risky vehicle and pedestrian maneuvers, sight distances, and pavement striping.

The next level of the figure, “review results”, represents the design diagnostic stage, and builds on the information gathered in the concept diagnostic by facilitating a more in-



depth analysis, from which final design recommendations for highway-rail grade crossing betterment are achieved. This diagnostic occurs after design has begun, usually following the completion of the 90% Design but sometimes as early as the 65% Design, but only after unique information regarding the conditions at the highway-rail grade crossing has been determined. This information may include, but is not limited to, factors such as additional traffic behavior, utility information, drainage information, or other civil-related information that will affect the overall design and operation of the crossing.

At this stage in the design, additional detailed data regarding design vehicles, current preemption phasing, current intersection phasing, annual average daily traffic (AADT), train speeds, train types, number of trains per day, train detection type, and the percent of trucks using the highway-rail grade crossing may be necessary.

The design diagnostic gives the design team a foundation to proceed with their highway-rail grade crossing improvement design.

The post-construction diagnostic site meeting also is representative of the “review results” level of the diagnostic process figure, in that the project is not satisfactorily completed until this process is completed and all the stakeholders agree on the results of the improvements.

7.3.3 Diagnostic Form

The diagnostic form is used by the diagnostic team as a representative checklist of existing highway-rail grade crossing conditions, noticeable conflicts, necessary changes required, etc. Appendix D and D-1 show the SCRRRA diagnostic form and instructions for its effective use. The diagnostic form is structured to allow users to easily gather pertinent information about the crossing. The form also accommodates extra notes and diagrams that help to clarify the current conditions at the crossing.

7.4 NEW HIGHWAY-RAIL GRADE CROSSINGS

Refer to Appendix H for SCRRRA's Board adopted policy on new crossings. *Before considering a new highway-rail grade crossing, the first alternative that should always be considered is a grade-separated crossing. It is SCRRRA's policy, as well as State and National policy, to discourage the construction of new at-grade highway-rail grade crossings.* However, there are instances where the additional highway-rail grade crossings are in the public's best interest, and where the construction of a grade separation is not feasible for a variety of reasons. In most cases, the construction of a new highway-rail grade crossing must be offset by the closure of one or more existing crossings.

A proposed new highway-rail grade crossing shall only be permitted if there is a clear public need, funding is sufficient, and the appropriate measures have been taken to mitigate the hazards associated with the new crossing. The CPUC will ultimately determine whether a new grade crossing is warranted; they should be contacted very early in the process to consider any new highway-rail grade crossing. A new highway-rail grade crossing must go through an environmental study (either a negative declaration, or environmental impact report), proper diagnostics, engineering, and a regulatory process for approval. Prior to beginning the planning for a new crossing, a Letter Agreement to reimburse the SCRRRA for its review and participation in the



conceptual planning process should be developed; if design is required, a Design Services Agreement with the SCRRRA should be developed. The agency initiating the highway-rail grade crossing shall have in place a fully executed C&M Agreement with SCRRRA before any construction begins. Refer to Section 2.5 for further information regarding Letter and Services Agreements, C&M Agreements, rights-of-entry, and right-of-way procedures related to the construction of new crossings or the modification of existing highway-rail grade crossings.

All costs related to the construction of the new crossing, including those borne by SCRRRA for design or programming, shall be the responsibility of the initiating agency. When no highway-rail grade crossing closures are included in the project, the involved parties must agree on the assignment of responsibility for providing financing for ongoing maintenance of the highway-rail grade crossing surface and traffic control devices. Closing one or more adjacent crossings shall be considered whenever a new highway-rail grade crossing is initiated.

7.5 HIGHWAY-RAIL GRADE CROSSING ENHANCEMENTS

An existing highway-rail grade crossing may be modified through the engineering of improvements that enhance the overall safety and operation of the crossing. Enhancing the safety of a crossing will be best achieved by incorporating the recommended design practices and standards in this Manual.

7.6 HIGHWAY-RAIL GRADE CROSSING CLOSURE

Closure of a highway-rail grade crossing is accomplished by eliminating highway access to the crossing. Because a highway-rail grade crossing closure is a method of eliminating hazards at a highway-rail grade crossing, closures costs may qualify for funding through the Section 130 Program. Refer to Section 7.10.2 for additional information regarding the Section 130 Program. Closure of a highway-rail grade crossing shall always be considered as an alternative to the modification of an existing crossing.

Closure of an existing highway-rail grade crossing will typically require a public process, an environmental process, and “street vacation” to address the property rights.

A highway-rail grade crossing closure may be the result of a corridor highway-rail grade crossing consolidation project. In this case, several crossings may be consolidated into fewer crossings, thereby minimizing the relative hazards within the corridor.

7.7 SEALED CORRIDORS

The SCRRRA Sealed Corridor Program is a comprehensive strategy to minimize access to the railroad corridor. Some examples of sealed corridor enhancements are as follows:

7.7.1 Sealed Corridor Safety Enhancements

- Exit gates
- Median separators and raised islands
- New signs and pavement markings
- Advanced highway-rail grade crossing signal analyzers



- Locked right-of-way gates and fencing
- Highway-rail grade crossing geometry improvements
- Grade separation or closing of crossings
- Advanced traffic signal technology
- Advanced pedestrian treatments

Where applied at multiple crossings, a system of prioritization shall be adopted in order to equitably apply sealed corridor technology within the design.

7.8 QUIET ZONES

A “quiet zone” is an area that qualifies under the FRA final rule, “The Use of Locomotive Horns at Highway-rail grade crossings,” on the use of locomotive horns at highway-rail grade crossings. This rule is intended to maintain public safety while responding to concerns of communities that have sought relief from unwanted train horn noise. Areas that may qualify for quiet zones are those in which the placement of traffic warning devices has been approved as providing enough safety protection so that sounding of a locomotive horn is unnecessary. A quiet zone is created upon notification of establishment by the requesting agency, usually the local municipality. The process of creating and authorizing a quiet zone is defined in CFR 49 Part 222.43. The FRA shall determine that a quiet zone exists after they have reviewed, qualified, and approved the highway-rail grade crossing improvements. Local public authorities are the only entities that can designate or apply for quiet zone status. *The highway agency who owns the highway shall also bear the initial and recurring costs if SCRRRA is required to install and maintain additional equipment.* SCRRRA has adopted procedures for the pursuit of a quiet zone within the SCRRRA system. Also, additional information regarding the creation of quiet zones can be found on the FRA website at <http://www.fra.dot.gov>.

Outside quiet zones, locomotives must sound their horns 15-20 seconds prior to entering the highway-rail grade crossing, but not if the train is more than a quarter-mile away from the crossing. Most state laws and railroad rules require that locomotives sound their horn a quarter-mile prior to entering the crossing, and continue until the highway-rail grade crossing is occupied by the locomotive.

7.9 SUBMITTALS

7.9.1 Engineering Drawings and Specifications

The lead Engineer shall submit to SCRRRA project plans, specifications, and estimates at each submittal stage, in accordance with SCRRRA Engineering Standards. The approved size for documents shall be 11" x 17" scaled for contract drawings, originally submitted plans for shop drawings, high-resolution color electronic files on read-only compact discs, and for photographs; all other documents should be 8½" x 11".

7.9.2 Traffic Preemption Calculations and Drawings

Traffic signal design, drawings, installation procedures, preemption timing calculations, and preemption sequences shall be signed and stamped by a registered professional Engineer (civil or traffic) licensed to practice in the State of California. The design drawings shall show intersection plan and details, phase diagrams, signal standard



schedules, conductor schedules, estimated material, and construction notes, as per Caltrans's standard drawing format. The highway agency shall also complete and submit the following:

- The completed "LADOT Railroad Preemption Worksheet" (see Appendix E) showing calculations for each approach to the crossing.
- A study of the variation in total warning time and advance preemption time as a result of railroad operations and variation in traffic signal operation. Both the "worst case" (maximum right-of-way transfer time) scenario and the "best case" (minimum right-of-way transfer time) scenario shall be considered for the determination of the maximum highway traffic signal preemption time and the design of preemption sequences.

If advance preemption is designed, a design, signed and stamped by a registered professional Engineer (civil or traffic) licensed to practice in the State of California, shall be submitted to SCRRRA for review and approval.

7.9.3 Design Phase

The highway agency shall submit Preliminary Design (30% Design), Interim Design (60% Design), 90% Design, and Final Design (100% Design) documents to SCRRRA.

Five (5) 11"x17" sets of plans and specifications shall be submitted to SCRRRA during the design phase. Four weeks will be allowed for each review. If a consultant is used for the review process, the consultant and the lead Engineer shall be free to communicate and resolve all design issues.

Any deviations or design exception from this Manual shall be considered by the SCRRRA through the submittal of a Design Exception Form, attached as Appendix F.

7.9.4 Construction Phase

For any project that infringes on SCRRRA or member agency property, the initiating agency shall submit two sets of drawings showing details of construction affecting the tracks and property; specifications; and plans and procedures for excavation, demolition, falsework, sheeting and shoring, drainage, and temporary traffic control.

7.9.5 As-Built Phase

The highway agency shall submit five (5) hardcopy sets, and one (1) electronic set using MicroStation CAD software, of As-Built documents to SCRRRA at the completion of the project, and prior to closing of the project.

7.10 FUNDING

7.10.1 Introduction

Any party that is interested in creating or modifying a highway-rail grade crossing may be responsible for financing of the highway-rail grade crossing enhancements. However, financing can be funded by the Federal Aid At-Grade Highway-Rail Grade Crossing Program (Section 130 Program). Some funding for grade separations is available under



Section 190. Additional funding may be available through other state or federal programs.

7.10.2 Section 130

Section 130 of the United State Code, Title 23 (23 U.S.C. 130), provides federal funds for the elimination of hazards at existing highway-rail grade crossings. The purpose of the Section 130 Program is to reduce the number, severity, and potential of hazards to motorists, bicyclists, and pedestrians at highway-rail grade crossings. This program is a cooperative effort between the FHWA, Caltrans, the CPUC, railroad companies, and highway agencies. Additional information can be found on the FRA website at <http://www.fra.dot.gov>.

In order to authorize the highway-rail grade crossing under the Section 130 Program, the highway-rail grade crossing must go through a series of diagnostic reviews initiated by the railroad (in association with the highway agency, CPUC, and Caltrans), and be eligible to receive funding. Not all highway-rail grade crossings are eligible to be financed by the Section 130 Program. Highway-rail grade crossings that are not eligible for the Section 130 Program are as follows:

- Pedestrian-rail grade crossings solely for the use of pedestrians or bicyclists, including station crossings
- Highway-rail grade crossings used by light rail vehicles, either solely, or in conjunction with freight operation
- Private highway-rail grade crossings
- Existing grade-separated crossings

The submittal of a highway-rail grade crossing for Section 130 funding shall include the documented record of a thorough diagnostic process. This is accomplished at the concept level of engineering for programming into the system. It is important to consider the timeline associated with the programming of Section 130 associated modifications. The normal programming of Section 130 funding occurs several years in advance of construction. Because of this, it is important to allow for this time within the implementation schedule for the proposed enhancements.

In order to be properly considered for Section 130 funding, a complete engineering analysis of the highway-rail grade crossing is required. As part of this analysis, a hazard analysis is necessary to properly determine the level of highway-rail grade crossing improvements to be installed under the plan. Further work involves prioritization of the funding request with requests from other crossings throughout California. During the early stages of the project, it is important for the involved parties to consider the sources of funding and the requirements associated with that funding. In addition, the purpose and need of the proposed improvements should be considered for eligibility under the Section 130 Program.

7.10.3 Section 190

The State of California has instituted the Section 190 Program to provide funding to highway agencies to separate public highway-rail grade crossings, eliminate existing highway-rail grade crossings, or provide funds to highway agencies to grade separate



existing crossings. This funding is based upon a priority list developed by analyzing the hazards related to the crossing. Factors such as traffic demands and accident history play a large role in this prioritization. When the entire cost of the grade separation is considered, this funding may be a small percentage of the construction costs for the project.

This program is administered by the CPUC and Caltrans. Additional information can be found on the CPUC website at <http://www.cpuc.ca.gov>.



8.0 SPECIAL ISSUES

8.1 ADJACENT FREIGHT OR TRANSIT TRACKS

The location of adjacent track(s) owned and operated by another railroad company or transit agency creates conditions that need to be evaluated during the design of warning devices for vehicles and pedestrians. It is currently beyond the scope of the Manual.

8.2 ADJACENT DEVELOPMENT

Redevelopment and new developments have afforded the opportunity to control the location of driveway approaches that are close to the highway-rail grade crossing (see Section 3.7). The SCRRA Engineer shall review the development plans, coordinate with the highway agency, and ask the agency to impose “conditions for development approval” relative to development street access.

Adjacent residential and commercial development to highway-rail grade crossings may substantially increase the volume of highway traffic over a crossing. This may occur during certain times of day, such as during peak rush hour periods, or during certain times of the year. Schools near highway-rail grade crossings may generate increased volumes of vehicular and pedestrian traffic before and after school hours. Likewise, certain entertainment/sporting venues may increase vehicular and pedestrian traffic before, and after, an event. Observations of a highway-rail grade crossing during different times of the day and year should take place to understand how the dynamics of adjacent development affect a highway-rail grade crossing. The selection of appropriate traffic control/warning devices shall be installed to mitigate these affects.

8.3 LIGHT RAIL TRANSIT

Currently, the SCRRA System does not include any Light Rail Transit (LRT) systems that share the rail corridor with SCRRA trains. This section of the Manual may be updated in the event of introduction of an LRT system(s). Light Rail Transit (LRT) systems are becoming more prevalent in urban areas. The Gold Line Foothill LRT is proposing to share the existing SCRRA's Pasadena subdivision from Azusa to Montclair in a common shared corridor that would potentially include over 25 shared grade crossings. LRT systems operate very differently from other commuter and freight rail systems; therefore, the close proximity of these systems warrants special attention. When considering shared corridors and grade crossings, the designer shall become thoroughly familiar with the July 10, 2000 joint FRA/FTA statement addressing the General System and Rail Transit Common Corridor Safety Program and the FRA 2008 PowerPoint presentation by Ed Pritchard of FRA on the same subject. The link is as follows: <http://www.techtransfer.berkeley.edu/railroad08downloads/pritchard.pdf>.

LRT crossings adjacent to SCRRA crossings shall be addressed individually from the beginning of the project. **LRT (Light Rail Transit) tracks located adjacent to SCRRA highway-rail and pedestrian-rail grade crossings shall be analyzed as a joint system. If the combined number of SCRRA and LRT tracks exceeds three (3), a grade separation shall be constructed.** Refer to Section 3.13 for additional information on adjacent highway-rail grade crossings.



The nature of LRT operations places stations in closer proximity to each other than commuter rail operations. As such, an LRT vehicle may be stopped at a station while commuter operations continue pass by. The lead Engineer shall analyze crossings where LRT and SCRRA operations are closely related yet mutually exclusive.

8.4 LANDSCAPING

It is important that landscaping not decrease the level of safety at a highway-rail grade crossing by impeding the visibility of any active or passive warning signals or signage by motorists, pedestrians, or railroad engineer.

SCRRA has developed Landscaping Design Guidelines to provide uniform and consistent standards for landscaping during design, construction, and maintenance on commuter and freight railroad rights-of-way. SCRRA staff worked together with the member agencies' staff in preparing and finalizing these guidelines. These proposed guidelines are intended to provide minimum standards and general requirements for the design, construction, and maintenance of landscaping in a manner compatible with safe operation of railroad corridors and with the rail capacity expansions envisioned.

As mentioned previously in the Manual, in general, within 100 feet of the crossing, stamped concrete or other hardscape materials, infill for median islands is the standard landscape treatment for median islands.

8.5 BIKEWAYS AND TRAILS

The addition of bikeways and trails within, or adjacent to, the railroad right-of-way presents a challenge to both the highway agency and railroad operators. (See Figure 8-1 for an example of a bikeway adjacent to active railroad tracks). Of particular concern to SCRRA is the activity of pedestrians and bicyclists within the right-of-way. Also, the incorporation of a bike path that is adjacent to the highway-rail grade crossing intersection introduces another element to be accounted for within the analysis and determination of preemption requirements for the highway-rail grade crossing. Refer to Section 6.0, Railroad Signal Interconnect, for provisions governing the design of the interconnection of the traffic signal system with the railroad signal system. SCRRA has developed "Rail with Trail Design Guidelines" that shall be referred to whenever a bikeway is to be constructed within railroad right-of-way. The highway agency shall follow this procedure in the development of the trail, including improvements to site within and adjacent to the railroad right of way, and may include the installation of additional fencing and channelization, modified traffic signals, pedestrian treatments, and additional highway-rail grade crossing warning devices. The initiating agency shall facilitate a diagnostic review and highway-rail grade crossing design process to mitigate these effects.



Figure 8-2. Bikeway and Trail Separation

8.6 FENCING AND SECURITY GATES

It is SCRRA's desire to keep trespassers out of the operating railroad corridor. The design of the travelway shall incorporate adequate fencing to limit access by trespassers onto SCRRA railroad tracks. This fence shall be tubular steel fencing or welded wire mesh fencing as per SCRRA Engineering Standards. The fence shall be located at the edge of the trail, as defined by the appropriate agreement.

A three rail split-rail fence, in combination with landscaping that can serve as a positive barrier between the track and the trail, may be used in rural or environmentally- sensitive areas, if approved by SCRRA and the member agency. Since newly planted landscaping may take a few years before it becomes an effective barrier, suitable temporary measures may be required until the landscaping has sufficiently matured. Any landscaping must be maintained so it does not impede the visibility of any active or passive warning devices—or signage—by trains, pedestrians or engineers.

It is the policy of SCRRA to maintain access along its right-of-way for maintenance and inspection. The travelway fencing shall not be constructed so as to limit this access. Should access points be necessary, the fencing shall incorporate gates at locations as per SCRRA Engineering Standards. These gates shall be secured with SCRRA locks. The highway agency shall install "No Trespassing" warning signs, as per SCRRA Engineering Standard.



The height of the fence within 150 feet of highway-rail grade crossings shall be four (4) feet. The height of the fence in the balance of the right-of-way shall be at least six (6) feet.

All access points to SCRRA rights-of-way at highway-rail grade crossings shall utilize a right-of-way fence in accordance with SCRRA Engineering Standards. These gates are to be installed in accordance with the instructions shown on these drawings, in particular as follows:

- The gate shall be placed to allow a maintenance vehicle to park prior to opening the gate.
- Gate shall swing away from the tracks.
- The installation of the gate shall be incorporated into the proposed fencing plan to adequately secure the rights-of-way.
- Bollards, K-Rails, or other substantial barriers shall be used with the right-of-way gates to provide a maximum level of security.

8.7 LIGHTING

The highway agency shall provide lighting for the travelway to maintain a safe environment for the users. Local, state, and federal guidelines, as well as industry standards for lighting, shall be incorporated into the design.



9.0 CONSTRUCTION

9.1 GENERAL

As mentioned previously, construction cannot begin until a C&M Agreement and a SCRRA Form No. 6 (Temporary Right-of-Entry Agreement) have been executed by SCRRA, and workers have completed railroad safety training. The construction shall meet requirements stated in SCRRA's Standard Specifications, guidelines, and Engineering Standards. It shall also meet applicable AREMA requirements.

Any damage to rails, ties, structures, embankments, third-party property, signal and communications equipment, or any other facility shall be repaired, at the highway agency's or its contractor's expense, to a condition equal to or better than the condition prior to entry (and to a level accepted by SCRRA). The highway agency or its contractor agrees to reimburse SCRRA, and any affected operating railroads, for any and all costs and expenses incurred as a result of their work, which may result in the following:

- Unscheduled delay to the trains, or interference in any manner with the operation of trains
- Unscheduled disruption to normal train operation
- Unreasonable inconvenience to the public or private users of the system
- Loss of revenue
- Alternative method of transportation for passengers

The **highway agency and its contractors shall comply with the rules and regulations contained in the current editions of the SCRRA documents (listed below) during construction of the project.** These SCRRA forms are available on SCRRA's website:

- Temporary Right-of-Entry Agreement (SCRRA Form 6).
- Rules and Requirements for Construction on Railroad Property (SCRRA Form 37).
- General Safety Regulations for Construction/Maintenance Activity on Railway Property.
- Applicable SCRRA Engineering Standards.

The highway agency shall notify SCRRA 30 working days prior to beginning work on the right-of-way, and secure any protection SCRRA deems necessary. The highway agency shall be responsible for reimbursing SCRRA the actual costs and expenses incurred by SCRRA for all services and work performed in connection with the highway-rail grade crossing project, including a computed surcharge representing SCRRA's costs for administration and management.

The latest version of SCRRA Standard Specifications for work within rights-of-way operated and maintained by SCRRA shall be included within the contract documents. The list of these specifications is shown in Appendix I in these standards, and the latest electronic version of these specifications is available from SCRRA's Engineering Department upon request.



9.2 EXCAVATION AND BACKFILL

The excavation and backfill shall meet all the requirements shown in SCRRRA Standard Specification 02300, Earthwork. Excavation for construction of footings, piers, columns, walls, or other facilities that require shoring to support active tracks shall comply with AREMA requirements and standard specifications. The contractor shall perform excavation and grading so that the finished surfaces are in uniform planes, with no abrupt breaks in surface, and have positive drainage on the right-of-way away from the track structure.

9.3 EROSION CONTROL

The general plans for the bridge shall indicate the proposed methods of erosion control, and must specifically address means to prevent silt accumulation in ditches and culverts and prevent fouling the track ballast, sub-ballast, and existing drainage systems. Existing track ditches shall be maintained at all times throughout the construction period. After construction has been completed, all erosion control devices and all deposits of silt shall be removed, and affected ditches restored. Approval of the erosion control plan does not relieve the submitting agency, consultant, or contractor of the ultimate responsibility and liability for a satisfactory erosion control plan.

9.4 TEMPORARY TRAFFIC CONTROL

SCRRRA's "Temporary Traffic Control Guidelines for Highway-Rail Grade Crossings" shall be referenced for further information on definitions, referenced standards, traffic control plans, submittals, traffic control elements, and responsibility/authority for temporary traffic control at highway-rail grade crossings. The guidelines provide acceptable alternatives and procedures to prescribe appropriate temporary traffic control measures at highway-rail grade crossings.

The construction of a new highway-rail grade crossing, or the modification of an existing crossing, shall require temporary traffic control. A temporary traffic control plan, including traffic detours, shall be prepared in accordance with Part 6 of the CA MUTCD, the WATCH Manual, and the local highway agency's requirements. **When a highway-rail grade crossing exists either within, or in the vicinity of, a temporary traffic control zone, lane restrictions, flagging, or other operations shall not be performed in a manner that would cause vehicles to stop on the railroad tracks unless a law enforcement officer or qualified flagger is provided at the highway-rail grade crossing to minimize the possibility of vehicles stopping on the tracks.** This applies even if automatic warning devices are in place.

SCRRRA shall be contacted when the initial planning begins for any temporary traffic control zone that may, directly or indirectly, influence the flow of traffic over highway-rail grade crossings. Responsible agencies (along with others affected, such as emergency services and businesses) should meet to plan appropriate traffic detours and the necessary signing, marking, and flagging requirements for operations during temporary traffic control activities. Consideration should be given to: the length of time the highway-rail grade crossing will be closed; highway classification; type of vehicle and traffic affected; the time of day; and the materials and techniques of repair. Temporary traffic control operations should minimize the inconvenience, delay, and crash potential related



to affected traffic. Temporary traffic control activities should not be permitted to extensively prolong the closing of a crossing.

Temporary traffic control shall be used when a maintenance or construction activity is located on the railroad right-of-way, or when activity in the vicinity of a highway-rail grade crossing could result in queuing of vehicles across the railroad tracks. The issue of temporary traffic control shall be addressed within the specifications for the crossing.

9.5 UTILITY ADJUSTMENTS

The existing utilities shall be located prior to commencing any excavations. *Approval of the project by SCRRA does not constitute a representation as to the accuracy or completeness of location or the existence or non-existence of any utilities or structures within the limits of this project.* The appropriate regional notification center [Underground Service Alert (DIGALERT) at (800) 227-2600], railway companies, and utility companies shall be notified prior to performing any excavation close to any underground pipeline, conduit, duct, wire, or other structure. Refer to SCRRA's website www.metrolinktrains.com to ensure proper contracts and phone numbers. SCRRA is not a member of DIGALERT; it is, therefore, necessary to call SCRRA's signal department phone number (refer to SCRRA's website) to mark, at highway agency's or contractor's expense, signal and communication cables and conduits. In case of signal emergencies or highway-rail grade crossing problems, the contractor shall call SCRRA's 24-hour signal emergency number. If utilities cannot be located, potholing shall be done to locate the utilities. SCRRA and appropriate utility owners shall be notified immediately when utility lines not known or indicated on the drawings are encountered. No service shall be disrupted until the utility owner and SCRRA have determined the required action on such lines.



10.0 OPERATION AND MAINTENANCE

The design and operation of a highway-rail grade crossing requires the coordination of maintenance between the agency and SCRRRA, as defined in the C&M Agreement. The complexity of this interaction increases when traffic signals and preemption are incorporated into the crossing design. In cases when the efficient operation of the traffic signals and other highway agency-controlled devices provide an important element in the overall safety of the crossing, the following procedures should be used.

10.1 HIGHWAY AGENCY INSPECTIONS

The highway agency shall independently inspect the preempted traffic signals intersection a minimum of every three (3) months, and shall report the results of this inspection to SCRRRA. A general review of the highway intersection and highway-rail grade crossing for proper signing, pavement marking, sight distances, vegetation, visibility and changes in conditions should be made. Independent inspection and testing should include at least the following:

- Ensure the timing design parameters are recorded
- Simulate the preemption signal input from the highway-rail grade crossing warning system while confirming the railroad interconnect is connected to the highest priority control unit input
- Confirm preemption activation of traffic signals, including any associated pre-signals or active signs, and confirm that the devices are operating as designed
- Confirm that the standby battery power operates as designed
- Ensure all warning labels are clearly visible and legible
- Ensure all advance warning signals and signs are clearly visible, and that any trimming of vegetation or trees is done as necessary

10.2 JOINT INSPECTIONS

Highway-rail grade crossings with preempted traffic signals shall be jointly inspected on a semi-annual basis. SCRRRA shall be contacted prior to each inspection to coordinate and schedule the work, and SCRRRA's representative shall be present during each inspection. The inspection should be conducted while a train passes through the crossing, if possible. During joint inspections, a general review of the highway intersection and highway-rail grade crossing for proper signing, pavement marking, sight distances, and changes in conditions, should be made. Joint inspection and testing should include at least the following:

- Confirm timing design parameters, including maximum preemption time and gate lowering times
- Confirm interconnection circuit wires are free of grounds or foreign currents, and that the system fails in a safe mode
- Confirm the preemption signal from SCRRRA is connected to the highest priority preemption input
- Identify whether special features are included, and functioning as designed
- Activate the highway-rail grade crossing warning system and confirm that preemption activation of traffic signals responds during all phases of the traffic controller unit



- Confirm that the pedestrian clear-out time matches the design timing
- Record the joint inspection and test date, as well as the next due date

10.3 HIGHWAY-RAIL GRADE CROSSING CONDITION CHANGES

Any changes to railroad or highway traffic conditions discovered during routine inspection and tests shall be reported to each party. The relevance of these observed changes may trigger an engineering safety evaluation of the site. The following are examples of reportable changes at the preempted site:

- Changes to railroad operation or speed
- Changes to vehicle traffic or speed
- Changes to the preemption or related signal settings
- Spotting of vehicles queuing onto the highway-rail grade crossing area
- Vehicles having difficulty stopping safely when a train approaches and activates the warning system