Railroad-Highway Grade Crossing Analysis for Corridor Planning Projects

Word Count: 4,305
Submission Date: August 1, 2015

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The railroad-highway grade crossing constitutes a unique type of intersection of two transportation modes that differ in physical characteristics and operations. The procedures for evaluating railroad-highway grade crossings are generally based upon physical and operational characteristics of individual crossings. Implementation of a new commuter rail service requires performing rail crossing assessment to ensure meeting current design and safety standards. This paper summarizes an evaluation methodology for conducting a railroad-highway grade crossing analysis applied to corridor planning projects involving commuter rail as an existing or potential mode. The methodology consists of obtaining existing conditions data, field visits and evaluation of each grade crossing to provide preliminary recommendations to enhance safety and operations. The methodology is illustrated by being applied to a hypothetical example condition.

Recommendations for improvements to the railroad-highway grade crossings are based on state and federal policies and guidelines, industry practices and current automatic highway warning device technologies. The specific recommendations for each railroad-highway grade crossing using the methodology presented in this paper should not be considered final and approved. Further evaluation of existing conditions and proposed commuter rail and freight operations are required to refine design recommendations.
RAILROAD-HIGHWAY GRADE CROSSING ANALYSIS FOR CORRIDOR PLANNING PROJECTS

Introduction
The railroad-highway grade crossing constitutes a unique type of intersection of two transportation modes that differ in physical characteristics and operations. Crossings are divided into two categories: public crossings are those on highways under the jurisdiction of and maintained by a public authority and open to the traveling public; private crossings are those on roadways privately owned and utilized only by the landowner or licensee, (1).

The procedures for evaluating railroad-highway grade crossings are generally based upon physical and operational characteristics of individual crossings. Implementation of a new commuter rail service requires performing a rail crossing assessment to ensure meeting current design and safety standards. This paper presents an evaluation methodology for a railroad-highway grade crossing analysis applied to corridor planning projects that consists of obtaining existing conditions data, field visits and evaluation of each grade crossing to provide preliminary recommendations to enhance safety and operations.

Government Agency Responsibility and Involvement
Railroad-highway crossings involve the intersection of two transportation modes, one public(highway) and the other private (railroad) in most cases. Safe and efficient operations require cooperation of federal, state and local agencies and organizations. The U.S. Department of Transportation (U.S.DOT) seeks to ensure that a viable and safe national transportation system is maintained to transport people and goods while making efficient use of national resources. Agencies within U.S. DOT that actively participate in crossing safety programs are noted in Table 1.

<table>
<thead>
<tr>
<th>Agency</th>
<th>Involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Railroad Administration (FRA)</td>
<td>Maintains the national Railroad Accident/Incident Reporting System. Custodian of the National Railroad-Highway Crossing Inventory.</td>
</tr>
</tbody>
</table>

The Railroad-Highway Grade Crossing Handbook, (1) provides general information on grade crossings, characteristics of the crossing environment and users, and the physical and operational improvements that can be made to enhance safety and operations of both highway and rail traffic over crossing intersections. This handbook draws on a number of different sources including the Manual of Uniform Traffic Control Devices (MUTCD), (2) and provides guidelines for the identification and selection of active control devices.
Jurisdiction over railroad-highway grade crossings resides primarily with the states. State highway and transportation agencies are responsible for administering crossings and programs for improvement projects and maintenance. State and local law enforcement agencies are responsible for the enforcement of traffic laws at crossings. Local government bodies are responsible for ordinances governing traffic laws and operational matters relating to crossings, (1).

**Railroad-Highway Crossing Analysis Methodology**

The railroad-highway crossing assessment consists of evaluating each of the existing grade crossings over the length of the corridor being evaluated. The analysis is performed through a multidisciplinary approach consisting of a review of traffic characteristics and crash experience, highway and track geometry, crossing surface, and adjacent traffic signal and overall rail operations. The specific railroad-highway grade crossing analysis methodology process is shown in Figure 1.

**FIGURE 1 - Railroad-Highway Grade Crossing Evaluation Process**
U.S DOT Crossing Inventory Forms
The U.S DOT National Railroad-Highway Crossing Inventory contains data on the location of each crossing, the amount and type of highway and train traffic, traffic control devices, and other physical elements of the crossing. Data in the inventory is updated through submission of information by the states and railroads.

Grade Crossing Collision Data
FRA requires each railroad to report collisions between railroad on-track equipment and any other vehicle or pedestrian at a railroad-highway grade crossing.

Hazard Indices and Accident Prediction Formulae
A hazard index ranks crossings in relative terms. In general, crossings that rank highest on the hazard index are selected to be investigated in the field by a diagnostic team. The Federal-Aide Policy Guide (FAPG) requires that potential danger to large numbers of people at crossings used on regular basis by passenger trains, school buses, transit buses, pedestrians, bicyclists, or by trains/motor vehicles carrying hazardous materials be one of the considerations in establishing a priority improvement schedule, (I).

A commonly used index is the New Hampshire Hazard Index ranking methodology in which the hazard index is calculated based on the annual average daily traffic (AADT), average daily train traffic and a protection factor that varies in relation to the level of protection (automatic gates, flashing lights, signs only). Several modifications to this method are in use, some states incorporate other factors to comply with FAPG requirements such as train speed, crossing angle, surface type, number of school buses, vehicles carrying hazardous materials surface type, and sight distance.

An accident prediction formula is intended to predict the likelihood of a collision occurring over a given period of time. The U.S DOT collision prediction formula provides an initial hazard ranking based on the crossing’s characteristics including highway and train traffic, number of main tracks, and highway type. The model also incorporates the actual collision history and various factors to account for the level of protection at a crossing.

The basic collision prediction formula is express as a series of factors that yield an initial predicted number of collisions per year as shown in Figure 2.
FIGURE 2 – U.S. DOT Collision Prediction Equations for Crossing Characteristics Factors


Priority Schedule

A systematic method of identifying crossings that have the most need for safety and/or operational improvements is necessary to comply with the requirements of the FAPG, which specifies that each state should maintain a priority schedule of crossing improvements.

The priority schedule is based on seven factors:

- Hazard index
- Project cost
- Incident history
- Corridor emphasis
- Diagnostic field review observations
- Upgrading crossings from passive devices to active devices
- Input from local governments

A relative priority ranking is given to each grade crossing by the State’s Rail Office. When creating the priority schedule, the lowest the ranking given, the greater the need for improvements at that particular location. The relative priority ranking can be determined by calculating the ratio of the most recent priority ranking found in the Railroad-Highway Crossing Inventory Forms and the statewide rank; in general priority is given to the crossings with the lowest rankings. Obtaining this ratio is essential to
prioritize grade crossings in the corridor that have been already determined to require safety improvements by the State Department of Transportation Rail Office.

Field Review
A field review of each railroad-highway crossing is performed to confirm existing conditions data including:
- Condition and visibility of warning devices, including advance warning signs and pavement markings.
- Alignment, grade and sight distance of crossing.
- Crossing surface conditions.
- Roadway geometrics diverting driver attention.
- Physical characteristics of the crossing including auxiliary lanes, lighting, and driveways.
- Type of roadway and roadway operational characteristics including traffic volume, vehicular speed, and type of use.

Needs Criteria
Recommendations for improvements to the railroad-highway grade crossings are based on the need to enhance safety at the crossings for implementation of a new commuter rail service. The recommendations are determined based on state and federal policies and guidelines, industry practices and current automatic highway warning device technologies.

The specific recommendations for each railroad-highway grade crossing using the methodology presented in this paper should not be considered final and approved. Further evaluation of existing conditions and proposed commuter rail and freight operations are required to refine improvement recommendations.

Traffic Control Devices
The purpose of traffic control at railroad-highway grade crossings is to permit safe and efficient operation of rail and highway traffic over such crossings. The traffic control devices are classified as follows:
- Passive Devices: Provide static messages of warning; their purpose is to identify and direct attention to the location of a crossing to permit drivers and pedestrians to take appropriate action. Federal law requires that, at minimum, each state shall provide signs at all crossings.

![FIGURE 3 - Regulatory Signs for Grade Crossings](source: Manual on Uniform Traffic Control Devices, 2009.)
Active Devices: Provide advance notice of the approach of a train; they are activated by the passage of a train over a detection circuit in the track. Active devices include automatic gates, flashing-light signals, traffic control signals, and other traffic control devices. Figure 4 shows a composite drawing of active control devices for grade crossings.

Active devices are generally required for public crossings with presence of passenger trains, school buses, transit buses or trucks carrying hazardous materials. Other considerations are: multiple mainline railroad tracks, history of collisions, roadways with a prevailing speed exceeding 25 mph, and roadways with traffic volumes exceeding 2000 AADT in urban areas or 500 AADT in rural areas.

**FIGURE 4 - Composite Drawing of Active Control Devices for Grade Crossings**


Crossing Closure
Eliminating redundant and unneeded crossing requires balancing public necessity, convenience and safety. The crossing closure decision should be based on economics; comparing the cost of retaining the crossing against the cost of providing alternate access and any adverse travel costs incurred by users. It is important to assess the effects of diverted traffic on the surrounding street system, (1).

Preemption of Traffic Signals
A railroad crossing with active devices should be interconnected with any adjacent traffic signal control equipment, and the normal operation for the traffic signals controlling the intersection should be preempted to operate in a special control mode when trains are approaching at locations where a signalized highway intersection exists in close proximity to a railroad crossing. At grade crossings where the roadway corridor extending downstream from the crossing is heavily congested, it may be necessary to implement queue prevention strategies, (1).
Pedestrian and Bicyclist Considerations

Non-motorist crossing safety should be considered at all railroad-highway grade crossings, particularly at or near commuter stations and at non-motorist facilities, such as bicycle/walking trails, pedestrian only facilities, and pedestrian malls, (1). Pedestrian gates should be considered if flash-light signals with a crossbuck sign and audible device would not provide sufficient notice of an approaching train and/or commuter rail speeds exceeds 35 mph.

Site Improvements

Site improvements can contribute greatly to the safety of grade crossings. Vegetation is often desired along railroad right-of-way to serve as an environmental barrier to noise; however, vegetation should be removed or cut back periodically to keep sight distance area free of obstructions, (1).

The ideal crossing geometry is a 90-degree intersection of track and highway with slight-ascending grades on both highway approaches to reduce the flow of surface water toward the crossing.

Crossing Surfaces

Providing a reasonably smooth crossing surface would limit a driver’s attention to be devoted primarily to choosing the smoothest path over the crossing rather than determining if the train is approaching.

Roundabouts

Provision of traffic control devices consistent with treatments at other railroad-highway grade crossings should be considered. If traffic queues are determined to impact the grade crossing, the following actions can be taken to keep the grade crossing clear of traffic prior to the arrival of rail traffic, (2):

- Elimination of the roundabout
- Geometric design revisions
- Grade crossing regulatory devices
- Highway traffic signals
- Traffic metering devices
- Activated signs

Private Crossings

Private crossings should be evaluated on a case by case basis. Improvements consistent with public railroad-highway grade crossings should be considered for private roadways with moderate to high volume traffic and locations with high pedestrian activity. For private roadways with low traffic volume, a combination of passive devices and a gate with a lock may be appropriate.

Table 2 summarizes the criteria for minimum requirements related to level of protection at railroad-highway crossings for the implementation of a new commuter rail service.
<table>
<thead>
<tr>
<th>Type</th>
<th>Device</th>
<th>Description</th>
<th>Criteria</th>
<th>Exemptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crossing Closure</td>
<td>Crossing Closure</td>
<td>Eliminating redundant and unneeded crossings.</td>
<td>Comparing the cost of retaining the crossing against the cost of providing alternate access. Surrounding street system should be examined to assess the effects of diverted traffic. More than four crossings per mile with fewer than 2,000 vehicles per day and more than 2 trains per day.</td>
<td></td>
</tr>
<tr>
<td>Passive</td>
<td>Crossbuck</td>
<td>Shall be reflectorized white with the black lettering</td>
<td>As a minimum, one crossbuck sign shall be used on each approach to every highway-rail grade crossing.</td>
<td></td>
</tr>
<tr>
<td>Passive</td>
<td>Stop Sign</td>
<td>Road user must come to a full and complete stop not less than 15 feet short of the nearest rail.</td>
<td>Maximum train speed equals or exceeds 30 mph. Rail line is used by passenger trains. The angle of approach to the crossing is skewed. The highway crosses two or more tracks.</td>
<td></td>
</tr>
<tr>
<td>Pavement Markings</td>
<td>Pavement Markings</td>
<td>All grade crossing pavement markings shall be reflectorized white.</td>
<td>Identical markings shall be placed in each approach lane on all paved approaches where signals and automatic gates are located, and all other crossings where the statutory highway speed is 40 mph or greater.</td>
<td>Pavement markings should not be required at grade crossings where the posted highway speed is less than 40 mph.</td>
</tr>
<tr>
<td>Illumination</td>
<td>Street Lighting</td>
<td>Illumination at a crossing may be effective in reducing nighttime collisions.</td>
<td>Nighttime train operations. Restricted sight or stopping distance in rural areas. Low ambient light levels.</td>
<td></td>
</tr>
<tr>
<td>Removing Obstructions</td>
<td>Clear Vegetation</td>
<td>Clearing sight distance.</td>
<td>Vegetation should be removed or cut back periodically at grade crossings.</td>
<td></td>
</tr>
</tbody>
</table>
## TABLE 3 Level of Protection Criteria (Cont.)

<table>
<thead>
<tr>
<th>Type</th>
<th>Device</th>
<th>Description</th>
<th>Criteria</th>
<th>Exemptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active</strong></td>
<td>Flashing-Light Signals</td>
<td>Consists of two red lights in a horizontal line flashing alternately at approaching highway traffic.</td>
<td>Grade crossings in semi-exclusive alignments shall be equipped with flashing-light signals where train speeds exceed 35 mph.</td>
<td>Traffic control signals shall not be used instead of flashing-light signals to control road users at a mainline highway-rail grade crossing.</td>
</tr>
<tr>
<td></td>
<td>Automatic Gates</td>
<td>Consists of a drive mechanism and a fully reflectorized red-and white-striped gate arm with lights.</td>
<td>Grade crossings in semi-exclusive alignments should be equipped with automatic gates and flashing-light signals where train speeds exceed 35 mph. Presence of passenger trains.</td>
<td>Traffic control signals or flashing-lights without automatic gates may be used where crossing is at a location other than an intersection and where train speeds do not exceed 25 mph and the roadway is a low-volume street where prevailing speeds do not exceed 25 mph.</td>
</tr>
<tr>
<td></td>
<td>Pedestrian Gates</td>
<td>A pedestrian gate is similar to an automatic gate except the arm is shorter.</td>
<td>Pedestrian gates should be considered if flash-light signals with a crossbuck sign and audible device would not provide sufficient notice of an approaching train. Commuter rail exceeds 35 mph.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preemption/ Interconnection</td>
<td>Preemption serves to ensure that the actions of separate traffic control devices complement rather than conflict with each other.</td>
<td>When a highway-rail grade is equipped with a flashing-light signal system and is located within 200 ft of an intersection controlled by a traffic control signal, the traffic control signal should be provided with preemption.</td>
<td></td>
</tr>
</tbody>
</table>
Evaluation Categories

Thirteen evaluation categories have been identified to determine specific recommended improvements at railroad-highway grade crossings for a corridor planning project.

1. **Investigate Crossing Closure**: Railroad-highway crossing with poor geometric configurations, sight distance issues, and/or redundant roadway network.

2. **Relocate and Upgrade Automatic Warning Devices**: Relocation is required due to additional track installation and installation of new automatic crossing warning equipment is recommended based on equipment age.

3. **Upgrade Automatic Warning Devices**: Installation of new automatic crossing warning equipment is recommended based on equipment age.

4. **Install New Automatic Warning Devices**: Installation of new automatic crossing warning equipment is recommended at locations with passive warning devices only.

5. **Install Gate and Lock**: Private roadways with low traffic volume where a combination of passive devices and a gate with a lock may be appropriate.

6. **Install New Crossing Surface**: New crossing surface is required to provide reasonably smooth crossing surface.

7. **Install RR Warning Signs and Pavement Markings**: Pave approaches where signals and automatic gates are located and/or grade crossings where existing signs and pavement markings do not comply with the MUTCD guidelines.

8. **Modify Roadway Grading/Geometry**: Approach profile grading and roadway alignment modifications to improve access over crossing and sight-distance capabilities.

9. **Install Pedestrian Gates/Flashers**: All sidewalk approaches to railroad-highway grade crossings and locations close to stations or high pedestrian activity centers.

10. **Construct Sidewalk Connections**: Construct new sidewalk across railroad right-of-way to connect existing sidewalk that terminates at either side of the crossing.

11. **Install/Maintain Traffic Signal Preemption**: Railroad-highway grade equipped with a flashing-light signal system and located within 200 ft of an intersection controlled by a traffic control signal.

12. **Install Street Lighting**: Recommended for locations with low ambient light levels and/or restricted sight distance in rural areas.

13. **Clear Vegetation**: Vegetation should be removed or cut back periodically to keep sight distance area free of obstructions.
### Application Example

The methodology presented in this paper can be applied for evaluating the implementation of a new commuter rail service at the planning stage. The hypothetical corridor used for this example consists of an existing track currently being used for freight service. The track crosses several public and private grade crossings that require an initial assessment to determine if the existing level of protection is adequate for commuter rail operations, and to generate a list of preliminary recommended improvements that will serve as a basis for further evaluation.

### Railroad-Highway Grade Crossing Assessment

Three existing railroad-highway grade crossings along the corridor are evaluated to determine what improvements to the existing level of protection are adequate for commuter rail operations.

The Crossing Inventory Forms can be downloaded from the U.S. DOT website using the unique rail crossing identification number. These forms are used to determine the existing level of protection and other physical and operating characteristics such as traffic volumes and crossing surface. Table 3 shows a summary of the existing conditions data found in the grade crossing inventory from U.S. DOT for the railroad-highway crossings analyzed for this example.

The priority rankings for year 2013 as found in the Crossing Inventory Forms are also shown and the relative priority ranking calculated as the ratio of the 2013 ranking to the statewide ranking which for this example is assumed to be 5357. The results for the relative priority ranking are color coded in green, yellow, and red to denote highest, medium, and lowest; the lower the ranking the greater the need for improvements at this grade crossing.

### TABLE 3 - Railroad-Highway Grade Crossings A, B, and C – Existing Data

<table>
<thead>
<tr>
<th>Crossing ID</th>
<th>AADT</th>
<th>Passive Traffic Control Devices</th>
<th>Roadway Gate</th>
<th>Active Devices</th>
<th>Pedestrian Gates</th>
<th>Crossing Surface</th>
<th>Priority Rank 2013</th>
<th>Relative Priority Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4820</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>X</td>
<td>Concrete</td>
<td>3784</td>
<td>0.71</td>
</tr>
<tr>
<td>B</td>
<td>2100</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>X</td>
<td>Asphalt</td>
<td>608</td>
<td>0.11</td>
</tr>
<tr>
<td>C</td>
<td>127</td>
<td>✓</td>
<td>x</td>
<td>x</td>
<td>X</td>
<td>Non-Paved</td>
<td>1283</td>
<td>0.24</td>
</tr>
</tbody>
</table>

The calculated relative ranking indicates that grade crossing B and C are part of the lowest 25 percentile compare to the statewide ranking and has been identified by the State’s Rail Office as a priority for improvements to enhance safety. The identification of the relative ranking can be used to prioritize improvements needed for implementation of new commuter rail service, which in this case indicates that improvements to grade crossing B will take priority over grade crossing A and C.

A field review is performed to confirm existing conditions data including:

- Condition and visibility of warning devices, including advance warning signs and pavement markings.
- Alignment, grade and sight distance of crossing.
- Crossing surface conditions.
- Roadway geometrics diverting driver attention.
- Physical characteristics of the crossing including auxiliary lanes, lighting, and driveways.
- Type of roadway and roadway operational characteristics including traffic volume, vehicular speed, and type of use.
Railroad-Highway Grade Crossing A is a public crossing located in a residential area with high pedestrian traffic. As shown in Figure 5, pedestrian crossing safety devices are not provided. Following the guidelines for the pedestrian protection at grade crossings in Table 2, pedestrian gates should be considered for commuter rail speeds exceeding 35 mph; therefore, a preliminary recommendation for pedestrian protection at this location should be indicated. The existing curved sidewalks at this grade crossing force pedestrians to cross not only over the tracks but also across the roadway; recommendations should be made to provide sidewalk connections at this location.

A need for improvements to the crossing surface is also identified in order to provide a smooth crossing surface that would limit a driver’s attention to be devoted primarily to choosing the smoothest path over the crossing rather than determining if the train is approaching. Commuter rail operations will require an added track for a segment of the rail passing through this crossing indicating the need for the relocation of the existing automatic warning devices. Clearing vegetation and illumination for this railroad-highway crossing should also be recommended for further evaluation in future stages of the project.

**FIGURE 5 - Railroad-Highway Grade Crossing A**

Railroad-Highway Grade Crossing B is shown in Figure 6. This public crossing is located in a residential area; sidewalk connections are in place but pedestrian crossing safety devices are not provided. Following the guidelines for the pedestrian protection at grade crossings in Table 2, pedestrian gates and flash-light signals should be considered. Also automatic warning devices are not installed at this location. Public grade crossings should be equipped with automatic warning devices for passenger train operations.

Clearing vegetation, illumination, approach profile grading and roadway alignment modifications to improve access over crossing and sight-distance capabilities are also recommended for railroad-highway grade crossing B.
Railroad-Highway Grade Crossing C is shown in Figure 7. This is a private crossing located in a rural area. For private roadways with low traffic volume, a combination of passive devices and a gate with a lock may be appropriate. Clearing vegetation, illumination, new crossing surface, approach profile grading and roadway alignment modifications to improve access over crossing and sight-distance capabilities are also recommended for railroad-highway grade crossing B.

Poor geometric configuration, sight distance issues, and redundant roadway network characteristics were also observed for this location; therefore, alternatively investigating crossing closure is recommended at this location.
Table 4 shows a summary of the recommended improvements for grade crossings A, B, and C using the thirteen categories identified for railroad-highway grade crossing assessment. As previously noted in this paper, further evaluation of existing conditions and proposed commuter rail and freight operations are required to refine the improvement recommendations.

**TABLE 4 - Preliminary Recommended Improvements for Crossings A, B and C**

<table>
<thead>
<tr>
<th>Crossing ID</th>
<th>Investigate</th>
<th>Investigate</th>
<th>Relocate &amp; Upgrade Automatic Warning devices</th>
<th>Upgrade Automatic Warning devices</th>
<th>Install New Automatic Warning devices</th>
<th>Install Gate &amp; Lock</th>
<th>Install New Crossing surface</th>
<th>Install RR Warning Signs &amp; Pavement Markings</th>
<th>Modify Roadway Geometry</th>
<th>Install Pedestrian Gates/Flashers</th>
<th>Construct Sidewalk Connections</th>
<th>Install/ Maintain Traffic Signal, Preemption</th>
<th>Install Street Lighting</th>
<th>Clear Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>B</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>C</td>
<td>✓</td>
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<td></td>
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<td></td>
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<td>✓</td>
<td>✓</td>
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</tbody>
</table>

**Conclusion**

The procedures for evaluating railroad-highway grade crossings are generally based upon physical and operational characteristics of individual crossings. Implementation of a new commuter rail service requires performing rail crossing assessment to ensure meeting current design and safety standards. The analysis is performed through a multidisciplinary approach consisting of traffic characteristics, crash experience, highway/track geometry, crossing surface, and adjacent traffic signal and overall rail operations.

Recommendations for improvements are based on state and federal policies and guidelines, industry practices and current automatic highway warning device technologies. The methodology presented in this paper has been successfully applied in corridor planning projects providing an effective tool for an initial assessment of the adequacy of physical and operating characteristics of existing railroad-highway grade crossings that can be used as base for identifying potential improvements needed and locations that should be prioritized to comply with safety requirements at grade crossings for commuter rail operations.

The specific recommendations for each railroad-highway grade crossing using the methodology presented in this paper should not be considered final and approved. Further evaluation of existing conditions and proposed commuter rail and freight operations are required to refine improvement recommendations.
REFERENCES
