GradeDec.NET

Federal Railroad Administration

Training Course and Workbook

North Carolina DOT, Volume 1

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FEDERAL RAILROAD ADMINISTRATION

TRAINING COURSE AND WORKBOOK FOR GRADE CROSSING IMPROVEMENTS EVALUATION USING GRADEDEC.NET

TABLE OF CONTENTS

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MODULE 1 INTRODUCTION

1.1 Introduction of Instructors and Participants

The course will be conducted by instructors from FRA or its consultant. Participation in the course is critical to its success. Participants bring invaluable local experience to the course and your instructors hope to learn from the participants and incorporate their experiences in the course as it evolves.

The course will be divided in time between presentation/discussion sessions and lab sessions. The lab sessions will involve hands-on direct use with GradeDec.NET.

The course and this workbook have been tailored to include examples from North Carolina.

1.2 Course Goals and Objectives

1.2.1 To gain a working knowledge of:

- The evaluation of safety impacts from grade crossing improvements.
- The evaluation of other benefits from grade crossing improvements.
- The use of GradeDec.NET to support resource allocation decisions.
- The use of GradeDec.NET to plan and evaluate grade crossing solutions on proposed Next Generation High Speed Rail corridors.
- Using the advanced features of GradeDec.NET.

1.2.2 Discussion of Goals and Objectives

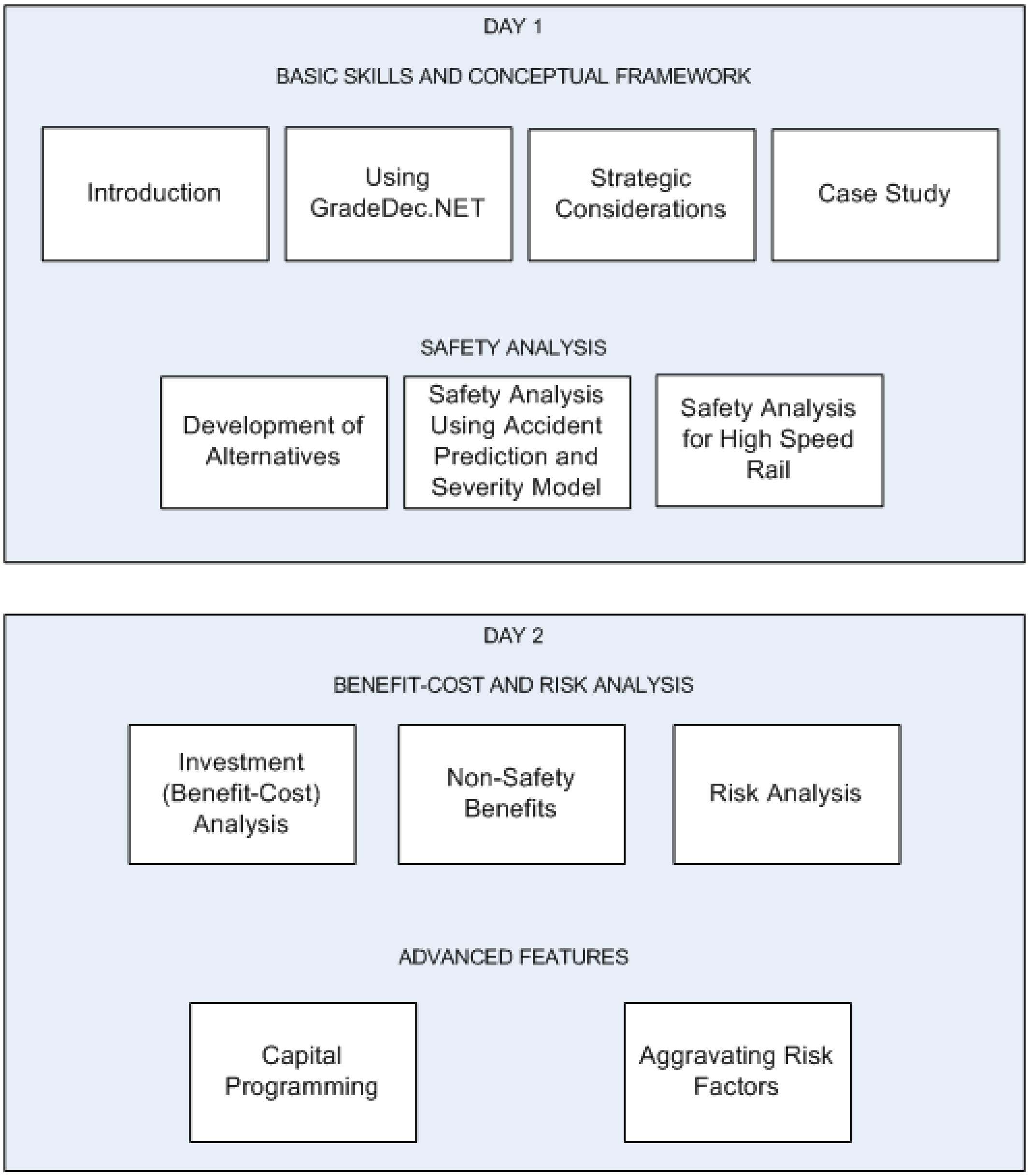
The goal of this course is to provide a comprehensive and practical understanding of the GradeDec.NET software for the planning and evaluation of highway-rail grade crossing improvements. Cost-benefit analysis of infrastructure investment is often a complex process that may require close interaction and coordination among professionals, decision-makers, rail operators and citizen groups. GradeDec.NET incorporates best practice models, analytic tools and data management capabilities to facilitate the analysis, whose purpose is to assess a range of economic, social and environmental impacts and tradeoffs so as to enable informed decision-making.

This course seeks to impart a good working knowledge of using GradeDec.NET while reviewing the principles and practice of benefit-cost analysis that are critical to supporting sound decisions. The course presents: a conceptual framework; methodologies of evaluation used in GradeDec.NET; review of computational algorithms; modes of use; and, a discussion of data requirements. The sections on safety and non-safety impacts include explicit exercises that replicate the calculations in the software. A case study from North Carolina accompanies the course and demonstrates the practical application of GradeDec.NET.

1.3 Course Overview

The course is presented over a period of two days and covers 12 modules, including this Introduction (Module 1). Presentations will be interspersed with lab sessions in which participants will work with GradeDec.NET and apply skills acquired.

Figure 1 Course Overview



1.4 Course Materials

- Workbook, Volumes 1 and 2 (materials in each volume will be covered on days 1 and 2, respectively)
- PC or terminal with browser and Internet connection

- *GradeDec.Net* User's Manual
- *GradeDec.Net* Reference Manual

MODULE 2 USING GRADEDEC.NET

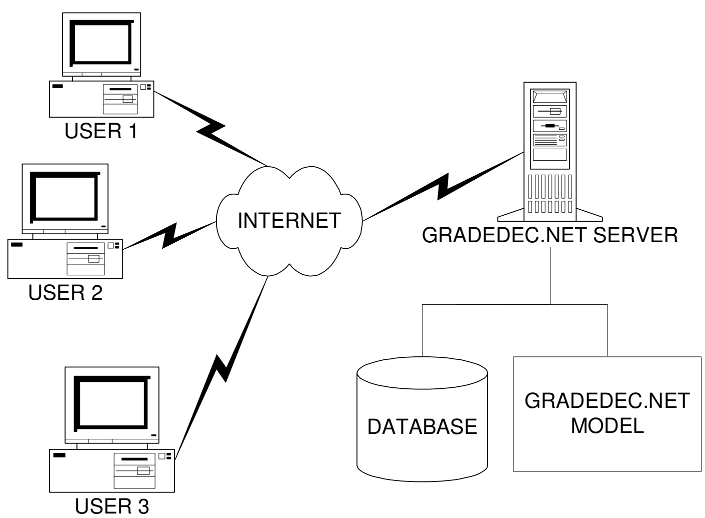
2.1 Introduction

This section is a description of GradeDec.NET and how to use it to conduct analyses. Parts of this section will be covered in the "Introduction" session of the workshop. The remaining parts of this section are for the participant's reference. The material in this section also appears in the User's Manual.

2.2 GradeDec.NET – System Overview

GradeDec.NET is a web-based application deployed over the Internet. This enables many users to access the system simultaneously, while using minimal resources from each user's computer.

Figure 2 Schema of GradeDec.NET



Advantages to the web-based system over desktop systems:

No special hardware or software user requirements

No need for installation on secure systems

Model and data updates immediately accessible to all users

Few demands on user to manage data and analyses

2.3 Registration and Logon

To use GradeDec.NET you must register the first time you logon. You will then use the user ID and password that you select during registration to logon during subsequent sessions.

The logon page includes a toolbar at the top, which links to "About", "Terms of Use" and "Messages". You should check the messages periodically. Also, read and understand the terms of using the system.

2.4 Navigation

After logging in, you will be shown the Settings page. From this page you select the data object (see 1.8 below). On the left side of the screen is a navigation bar, which enables access to all the pages of GradeDec.NET. Note that while the navigation bar is fixed, the submenu for each item on the bar only appears after the user has navigated to the page.

2.5 Modes of Use

GradeDec.NET has several modes of use, and the specific mode of use that you choose will depend upon the type of decision that your analysis should support. This section identifies and describes the two principal modes of use with *GradeDec.NET*. These are:

- Safety analysis, and
- Full investment analysis

2.5.1 Safety Analysis

For a safety analysis, the user examines predicted accidents at grade crossings and for the corridor (or region) as a whole. The safety analysis is, essentially, a comparison of a "before" and "after" situation, where "before" represents the *status quo* and "after" reflects the impact of crossing improvements (through device upgrade, closures, separations, traffic management measures, etc). The safety analysis is restricted to examining the safety impacts at a crossing. The safety analysis reflects a snapshot of current conditions and does not account for the forecast growth of highway traffic or rail operations.

2.5.2 Full Investment (Benefit-Cost) Analysis

A full investment analysis supports resource allocation and planning decisions. The full investment analysis accounts for safety benefits and, as well, other highway user costs. These user costs include time savings, vehicle operating costs and emissions. The full investment analysis monetizes the benefits from each benefits category and sums the benefits from the improvements over the time horizon of the investment. This analysis includes user assumptions regarding the forecast of traffic growth, by highway and rail, and analyzes the risk associated with the forecast values.

A "safety analysis" will involve a subset of the *GradeDec.NET* features required for a "full investment analysis". The following table shows the two modes of use, purposes associated with each, and the functional pages in *GradeDec.NET* used in each type of analysis.

Table 1 GradeDec.Net Modes of Use

Mode of Use	Purpose	Functional Pages in GradeDec.NET to Use
Safety analysis	Calculate accident risk and impacts of improvements, identify improvement programs, analyze the supplementary safety measure specified in FRA rule. Support safety decisions.	Settings, Import, Crossings, Parameters
Full investment analysis	Benefit-cost and risk analysis of programs of improvements; analyze safety, delay and user cost impacts Support resource allocation and investment decisions. Support planning process.	Settings, Import, Crossings, Parameters, Scenario, Simulation, Results

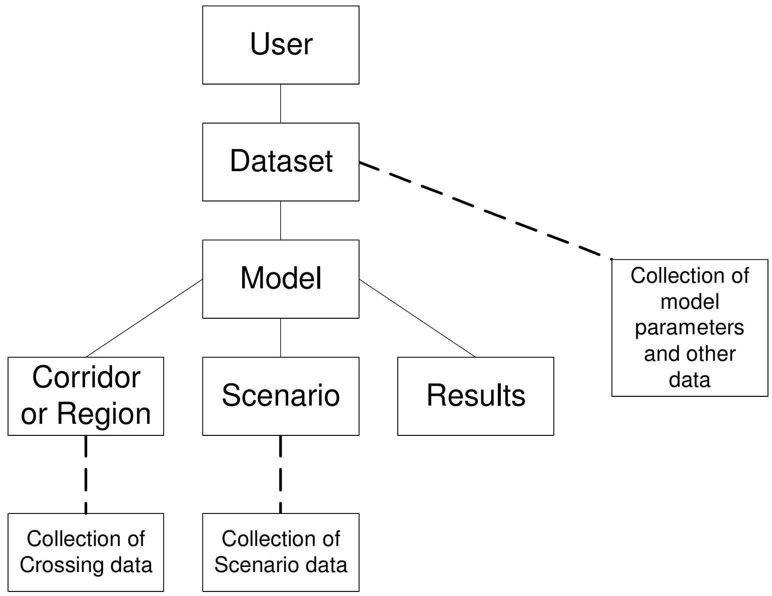
2.6 *The Data Hierarchy in* GradeDec.NET

In order to conduct analyses effectively in *GradeDec.NET* you should be familiar with its data hierarchy.

Every active session of *GradeDec.NET* has a data hierarchy that is populated with values at all times. These values correspond to the current selections of data collections that are viewable, editable and are used in *GradeDec.NET* model calculations. You navigate among different data collections by making selections on the **Settings** page, which sets the values in the data hierarchy.

The data hierarchy is shown in the figure below. A brief description of each of the nodes (boxes) in the figure follows at the end of this section.

Figure 3 Data Hierarchy in GradeDec.NET



The connecting lines in the data hierarchy figure mean that the lower node is a "child" of the parent node above it to which it is connected. When you change the value of a parent node (by making a selection in the **Settings** page) you are also re-populating the nodes in the hierarchy below the parent with values that represent data collections belonging to the newly selected parent node value.

For example, when a newly registered user logs on, the data hierarchy is populated with values like in the table below.

Table 2 Data Heirarchy at New User Logon

Data Hierarchy Node	Value
User	Your user id
Dataset	"Initial dataset"
Model	"Corridor Model"
Corridor	"South Empire"
Scenario	"Strong rail growth"
Result	"Placeholder – Corridor Model"

Suppose the user then changes the Model selection in the **Settings** page to "Regional Model". The data hierarchy will then be populated with the following values (changed values in italics):

Table 3 Data Heirarchy After Changing Model

Data Hierarchy Node	Value
User	Your user id
Dataset	"Initial dataset"
Model	"Regional Model"
Region	"Montgomery, MD"
Scenario	"Strong highway growth"
Result	"Placeholder – Regional Model"

For every parent node value there are designated default values for its child nodes, which fill the data hierarchy when the parent node value is selected. When you first register as a *GradeDec.NET* user you are assigned an "Initial Dataset" that includes data collections with sample values, and the system designates some of these data collections as defaults. You can never delete a data collection that is a default of its parent node. You can designate another data collection to be a default, and then delete the collection that was previously designated as default. You can create and delete data collections, set their defining values and set defaults from the **Settings** page.

The following are descriptions of the nodes in the data hierarchy.

2.6.1 User

When you log in to *GradeDec.NET*, a value representing your user account is set in the User node. This never changes during your session and ensures that users can only access their own data and not those of others.

2.6.2 Dataset

User data for analyses are organized in datasets in the *GradeDec.NET* database. A user may create and maintain up to 10 datasets. A dataset is a comprehensive container of data collections used in *GradeDec.NET* analyses. Note that data from different datasets cannot be combined in a single analysis. You can use datasets to preserve a baseline analysis, and then develop new analyses from copies of the baseline. You can download a dataset to your computer and restore it to the system at a later date. You can also share data with a colleague by sending him or her your downloaded dataset, which your colleague can then upload during a session with *GradeDec.NET*.

Access the options for selecting, creating, deleting, downloading and uploading datasets from the **Settings** page.

2.6.3 Model Parameters and Other Data

Each dataset contains a set of model parameters (including: crossing device effectiveness rates; model coefficients for emissions and fuel consumptions calculations; high speed rail model calculations – see the *Model Reference* for a full description). "Other data" refers to traffic time-of-day distributions and cost data for grade crossing devices and supplementary safety measures.

These parameter and data are specific to the selected dataset and can be viewed and modified from the **Parameters** page.

2.6.4 Model

GradeDec.NET has both a corridor model and a regional model. The data requirements are slightly different for each model so that data collections below the Model node are specific to the selected model.

2.6.5 Corridor

A corridor has a set of defining values (these can be viewed and modified in the data grid at the bottom of the **Settings** page – see Section 2.1 Settings Page below) and refers to a collection of grade crossings along a single rail alignment. A corridor is selected in the data hierarchy only if the Model node is set to the corridor model. A dataset will contain at least one corridor and may contain as many as 50.

Create and delete corridors, and modify their defining values in the **Settings** page. After selecting a corridor, view or modify its crossings data from the **Crossings** page.

2.6.6 Region

A region has a set of defining values (these can be viewed and modified in the data grid at the bottom of the **Settings** page – see Section 2.1 Settings Page below) and refers to a collection of grade crossings in a designated region. A region is selected in the data hierarchy only if the Model node is set to the regional model. A dataset will contain at least one region and may contain as many as 50.

Create and delete regions, and modify their defining values in the **Settings** page. After selecting a region, view or modify its crossings data from the **Crossings** page.

2.6.7 Scenario

A scenario has a set of defining values (a description, start year, last year of near term, and end year) and an associated collection of scenario data. A dataset will contain at least one scenario for each of the two models, and may contain as many as 30 scenarios for each model.

Create and delete scenarios, and modify their defining values from the **Settings** page. After selecting a scenario, view and modify the scenario data from the **Scenario** page.

2.6.8 Results

You set the description of a results set when you create it. GradeDec.NET sets the other defining values of a results set automatically when you run a simulation.

Create and delete result sets, and modify its description from the **Settings** page. After selecting a results set and running a simulation, view results from the **Results** page.

2.7 *Steps in Conducting a* GradeDec.NET *Analysis*

2.7.1 Overview

The following table shows a sample set of steps that you would undertake to conduct each of the two analyses. The Case Study sections in the respective analysis modules will walk you through these steps in a sample analysis.

Table 4 GradeDec.Net Modes and Sample

Mode of Use	Functional Steps	Page
Safety analysis	(Optional) Create and select a new dataset	Settings
	Create and select a new corridor (or region)	Settings
	Set values for corridor (or region)	Settings
	(Optional) Set default crossing device cost data	Defaults
	Import data from Grade Crossing Inventory (or, use Quick Import to import data of pre-identified crossings)	Import
	Verify and refine data, assumptions and choice of alternative	Crossings
	Calculate predicted accidents, view/print reports and charts	Crossings
Full investment analysis	Conduct all of the steps in the "Safety analysis" mode of use listed above	
	Create new results set	Settings
	Create new scenario	Settings
	Populate the scenario data with forecast data and assumptions	Scenario
	Verify and modify parameters and other data values	Parameters
	Set the simulation parameters and run the simulation	Simulation
	View results table and charts, print report	Results

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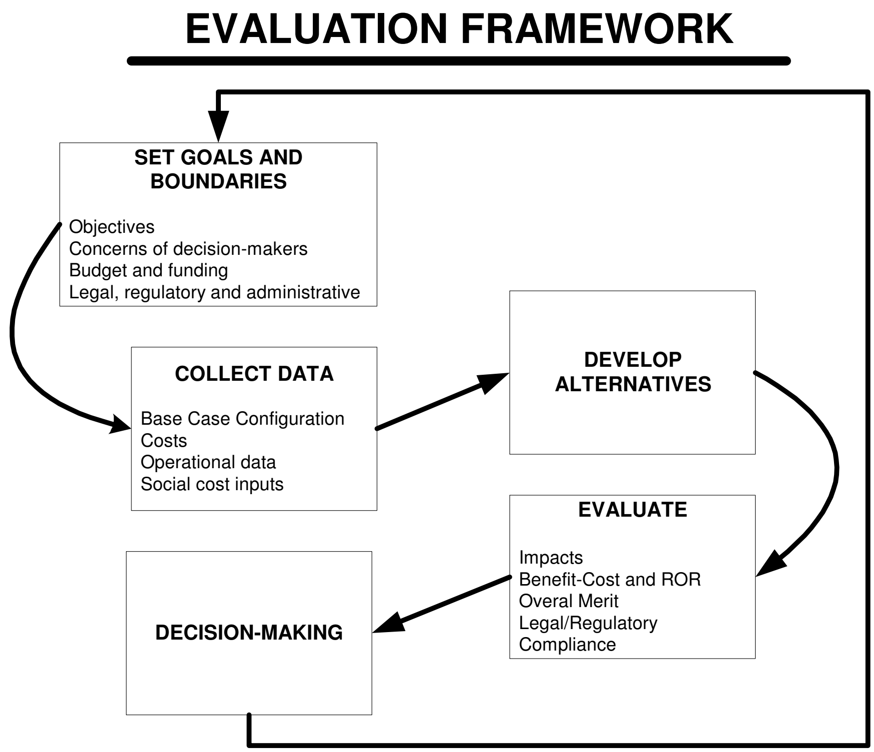
MODULE 3 STRATEGIC CONSIDERATIONS IN EVALUATION

3.1 Conceptual Framework for Evaluation



3.2 Objectives of Evaluation

An analysis of grade crossing improvements can have one or several objectives:

- To address acute safety issues for a crossing, corridor or region.
- To support funding allocation decisions for safety improvements.
- To support investment analysis decisions considering the additional benefits of congestion relief and emissions reduction.
- To develop a grade crossing improvement program to accommodate high speed rail initiatives.
- To evaluate compliance with new and emerging regulations that govern horn-blowing, whistle bans and grade crossing quiet zones.

3.2.1 Safety Analysis

With safety analysis the user estimates predicted accidents and severity for a specified corridor or region and evaluates the safety impacts of improvements and mitigating measures.

The safety analysis can utilize the Accident Prediction and Severity model, which is suited for the evaluation of crossings in corridors and regions with general freight or regular passenger service. For analyzing and developing risking mitigation strategies for high-speed rail corridors, the safety analysis can utilize the High Speed Rail safety model.

3.2.2 Non-Safety Impacts

Non-safety benefits stem from reduced queuing at crossings. In general, these benefits (or, disbenefits) will accrue only in the event that improvements include grade separations. Grade crossing closures may result in safety benefits, but also may cause highway travelers to drive circuitous routes and queue more at other crossings.

3.2.3 Investment Analysis and Resource Allocation Decisions

GradeDec.Net analyses support resource allocation decisions. It can be used to evaluate the comprehensive benefits and costs associated with improvement alternatives in a crossing or region.

Use investment analysis to develop and recommend alternatives for crossing improvements where safety and non-safety benefits, and best resource use, are important factors in the decision process.

3.3 Evaluation Context

You should conduct your evaluation with the concerns of decision makers in mind. It is often best to conduct discussions with stakeholders to gauge their concerns. Listen especially to the concerns of the rail operators, affected agencies and affected citizens.

Understand the impacts of rules, regulations and pre-existing agreements that could affect improvements and their cost- and liability-bearing implications.

MODULE 4 WORKSHOP CASE STUDY

4.1 Introduction

In this section we present a case study from which subsequent examples in the course will be drawn. The case study is a hypothetical example that corresponds to a corridor currently being studied (the analysis here is not indicative of the actual study and the assumptions and alternatives presented are for exposition purposes only).

4.2 The Case Study

4.2.1 The Study Area

(Note: the case study has been developed for exposition purposes and use in the training workshop. While based on an actual corridor, some of the data do not reflect actual conditions in this corridor).

The corridor under evaluation is a eight-mile segment of a freight line belonging to CSX in Greenville, North Carolina (on the map below, it is the central North-South alignment). Currently, there is no railroad track connection to permit train traffic moving from south to east. Southbound train traffic is hauled through the CSX Transportation/Carolina Coastal Railway railroad crossing to a small switching yard located between Arlington Road and Howell Street. Freight cars maneuver in and out of the railroad sidings as they connect cars to build eastbound trains. This operation often occurs during peak travel times, blocking the railroad crossings at Fourteenth Street, Howell Street and Arlington Road. Recent study data show that Fourteenth Street carries approximately 16,000 vehicles per day and Arlington Road carries approximately 30,000 vehicles per day; therefore, this railroad operation has significant impact on vehicle traffic.

The Greenville Connector project involves building a connector track, known as a wye, and joining the CSX Transportation line with the Carolina Coastal Railway line. This will improve flow and movement of freight, as well as decrease motorist delays at these crossings.

Conceptual plans and cost estimates are being completed for relocating the CSX switching operation, currently located between Arlington Road and Howell Street, to a new yard located just north of NC 903. The Greenville Rail Yard project will also include the addition of two long siding tracks. A new connection track (known as a wye) will be located near the CSX Transportation and Carolina Coastal Railway crossing between Arlington Road and Howell Street. This new rail yard will help eliminate the blockage of crossings and improve the movement of freight through downtown Greenville.

The study objectives are to improve safety and mitigate congestion in the corridor.

Figure 4 Maps of the Case Study Area

4.3 The Case Study in GradeDec.NET

4.3.1 Set Up the Data for the Corridor Safety Analysis

4.3.1.1 Create and select a new dataset

On the **Settings** page, click on the link “Create New Dataset” on the row with “Selected Dataset”. This will transfer you to the **New Dataset** page. On this page you choose to either “Create new dataset by copying a dataset” – in which case you select one of your datasets from the drop down list – or choose “Create new dataset from sample data”. Select the second option.

Enter a name for the new dataset (i.e., “NC Workshop”.) and then click create. This will transfer you back to the **Settings** page. From the dataset drop down list, select the dataset that you just created.

4.3.1.2 Create and select a new corridor

The case study examines a corridor so we will use the GradeDec.NET Corridor Model.

Select the “Corridor Model” (or ensure that it is selected) from the drop down list

On the **Settings** page, click on the link "Create New Corridor" to the right of "Selected Corridor". This will transfer you to the **New Corridor** page. On this page select "Create a new, empty corridor". Enter a name for the new corridor (e.g., Greenville CSX 1) and then click create. This will transfer you back to the **Settings** page.

Enable the "Corridor" drop down list by selecting the radio button by "Selected Corridor" (or, ensure that it is selected).

From the "Selected Corridor" drop down list, select the corridor that you just created.

4.3.1.3 Set values for corridor characteristics

In the table at the bottom of the **Settings** page you need to set the characteristics that correspond to your corridor. This includes: the number of daily trains by type, the time-of-day distribution for rail operations in the corridor, specify yes/no whether highway traffic signals in the corridor are synchronized with crossing signals.

Modify the values in the table by clicking on the "Edit" button.

For this case study, modify the values in the form as follows:

- Passenger trains to 0
- Freight trains to 0
- Switch trains to 4
- Rail TOD (time-of-day) distribution to Uniform
- Signal Synchronization to False

Click on "Update" after entering the new values.

4.3.1.4 (Optional) Modify or Add Time-of-Day Traffic Distributions

If the sample time-of-day traffic distributions provided, adequately reflect the distributions of highway traffic at crossings and for rail movements in the corridor, then skip this step. Otherwise, browse to the **Parameters** page by clicking on the link on the main navigation menu. On this page select from the toolbar at the top "Other data".

Add new time-of-day crossings distributions as needed. (The provided time-of-day traffic distributions should be adequate for the case study).

4.3.1.5 (Optional) Set default crossing device cost data

If needed, modify the default costs for crossing improvements. These default values can be applied to all crossings in the corridor and can save time entering data for each crossing.

Browse to the **Parameters** page by clicking on the link on the main navigation menu. On this page select from the toolbar at the top "Other data". From the drop down list select crossing device costs. Enter alternative values to the ones listed, as needed.

4.3.1.6 Import data from Grade Crossing Inventory

Using the Import page we find the crossings for inclusion in the corridor. To get the crossings that we want we'll follow these steps:

1) Restrict the geographic area to Greenville.
2) Restrict crossings to consider only those that have a positive value for daily trains and a positive value for AADT. This will remove from consideration crossings that may be on unused sidings or roads.
3) Include crossings from corridors that have CSX railroad, KINSTON or AA specified in the branch or division or subdivision.

From the main navigation menu, select the **Import** page. From the drop down lists on the left select:

State: North Carolina

County: Pitt

Area: Greenville

The "Selected Areas" table will show your selection. Click on the button "Create list of corridors in selected areas". The list of corridors will appear as options in the following drop down list. All of the corridors with CSX are in the corridor of interest (data entry discrepancies sometimes result in crossings of interest being included in more than one corridor). In our case, 17 crossings have been captured in one import corridor and an additional four crossings have been placed in three other import corridors. Thus the case study has a total of 21 crossings before removing from consideration those crossings that have no traffic (three of those crossings will be eliminated in the import because of the absence of traffic, leaving 18 crossings in the corridor).

You can view the National Grade Crossings Inventory data for the selected crossings at the table at the bottom of the page. You can modify the options and criteria that appear on the right side of the page (see the section 5.1 Import Page section of the *GradeDec.Net* User's Manual for a full description), or you can just click on "Import crossings data" to import your data to your Lincoln 1 corridor. We will set the criteria to Daily Trains > 0 and AADT >0.

After clicking import, your browser will automatically shift to the **Crossings** page.

The following crossings will have been imported (after importing the four corridors identified on the import page):

Figure 5 Imported Crossings

No.	Crossing ID	Milepost	Description
1	640431H	145.85	CSX -
2	641848H	145.86	CSX -
3	641850J	146.41	CSX - STATON BLVD.
4	641851R	146.67	CSX - SR 1527
5	641857G	147.39	CSX - BELVOIR RD
6	641860P	147.93	CSX - AIRPORT ROAD
7	641553R	148.02	CSX - DUDLEY STREET
8	641557T	149.16	CSX - 3RD ST
9	641558A	149.23	CSX - 4TH ST
10	641609H	149.3	CSX - 5TH
11	641610C	149.42	CSX - ALLEY
12	641855T	149.64	CSX - DICKINSON STREET
13	641854L	149.66	CSX - TENTH STREET
14	641612R	149.88	CSX - CROSS
15	641613X	149.9	CSX - CENTER
16	641614E	149.96	CSX - 14TH STREET
17	641615L	150.2	CSX - HOWELL ST.
18	642719W	150.71	CSX - ARLINGTON BLVD

4.3.2 Customizing the Crossing Data for the Analysis

Imports with Quick Import Page do not set the alternative device type. When importing with the Import Page instead, alternate crossing improvements are assigned to each imported crossing. You can manually customize the alternate crossing. You should review each crossing and set data and parameters that best reflect the conditions at the crossing. This should be done in conjunction with developing alternatives (see the following section).

In particular you should review and examine the following factors:

Supplementary Safety Measures – GradeDec.NET allows for seven supplementary safety measures that are available for gated crossings and you can include these in your crossing improvements. The seven measures are: four quadrant-gates (without detection), four-quadrant gates (with detection), four-quadrant gates with 60 foot medians, mountable curbs, barrier curbs, one-way street, and photo enforcement.

Time-of-day Traffic Distribution – In the corridor definition (see the Settings Form), the user sets the time-of-day distribution for rail operations in the corridor. The time-of-day distribution of highway traffic at the crossing will determine the degree of exposure to accident risk. For each crossing, the user can set the time-of-day distribution for each of three highway traffic segments: car, truck and bus. There are five default time-of-day distributions. However, you can enter additional distributions in the Default Values and Parameters Page. See the Reference Manual for additional discussion of the time-of-day distribution.

Traffic Management Measures – An additional option to consider in the alternate case is the implementation of traffic management measures (i.e., signage, restricted turns, restrictions on trucks, periodic closure of crossings) that result in changes to the flow of highway traffic at the crossing. If the box is checked for "Measures in alternative the re-direct traffic flow at crossing", then the user needs to specify the anticipated changes to AADT and time-of-day distribution of traffic by segment (car, truck, bus) at the crossing.

Costs (for investment analysis only) – The costs associated with the crossing are entered on the Costs tab of the crossings page. However, the costs are only used in the calculation of the corridor benefit-cost and have no impact on the results of the *GradeDec.Net* safety analysis.

The base case costs (operating and maintenance, other lifecycle) and alternate case costs (O&M, other lifecycle and capital costs) should be specified for each crossing. The user can specify default values (set in the Default Values and Parameters Form).

4.3.2.1 Calculate predicted accidents, view/print reports and charts

When you are satisfied with the data and the alternative selections, click on the calculator button on the toolbar in order to calculate the predicted accidents for each crossing and for the whole corridor. You can view the results in the "Accident Prediction" section of the page.

You can generate a report for viewing and printing by pressing the report icon button.
You can view a chart of the predicted accidents by selecting the chart icon button.

4.3.2.2 Sources of Data

Users can look to a number of sources for your data.

Sources for Safety Analysis

For rail and highway operations data, the railroads and state DOTs are good, likely sources.

Sources for Investment Analysis

Regarding forecast traffic growth the best source is likely to be the local MPO (for metropolitan areas). For social costs you may want to rely on the default values that come packaged with GradeDec.NET, unless the user has access to better sources reflecting local conditions.

The Reference Manual contains a complete description of the data requirements for GradeDec.NET.

4.3.3 Next Steps in the Case Study Safety Analysis

The following module continues with the CSX Greenville, NC case study and develops the alternative case for the safety analysis. Module 5 Conducting a Safety Analysis Using the Accident Prediction and Severity Model presents the results of the case study safety analysis. Volume 2 presents the case study investment analysis and illustrates use of the advanced features (capital programming and aggravating risk factors).

MODULE 5 DEVELOPMENT OF ALTERNATIVES

5.1 Introduction

In this section we review the crossing data and identify improvements in accordance with the study's objectives. For the Case Study, the objectives are: Improve safety and mitigate traffic congestion.

5.2 Base Case Devices

One of the factors that determine the accident risk at a crossing, and the one which is a prime target for improvement, is the device type. The conventional crossing device types are: passive (signs and road markings only), flashing lights. The base case crossing types at the crossings in the corridor (according to the imported data from the Grade Crossing Inventory) are as follows:

Figure 6 Base Case Crossing Devices

Data for all crossings in the corridor

No.	Crossing ID	Milepost	Description	Base Ca
1	640431H	145.85	CSX -	Gates
2	641848H	145.86	CSX -	Lights
3	641850J	146.41	CSX - STATON BLVD.	Gates
4	641851R	146.67	CSX - SR 1527	Gates
5	641857G	147.39	CSX - BELVOIR RD	Gates
6	641860P	147.93	CSX - AIRPORT ROAD	Lights
7	641553R	148.02	CSX - DUDLEY STREET	Lights
8	641557T	149.16	CSX - 3RD ST	Gates
9	641558A	149.23	CSX - 4TH ST	Lights
10	641609H	149.3	CSX - 5TH	Lights
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13	641854L	149.66	CSX - TENTH STREET	Lights
14	641612R	149.88	CSX - CROSS	Lights
15	641613X	149.9	CSX - CENTER	Lights
16	641614E	149.96	CSX - 14TH STREET	Gates
17	641615L	150.2	CSX - HOWELL ST.	Gates
18	642719W	150.71	CSX - ARLINGTON BLVD	Gates

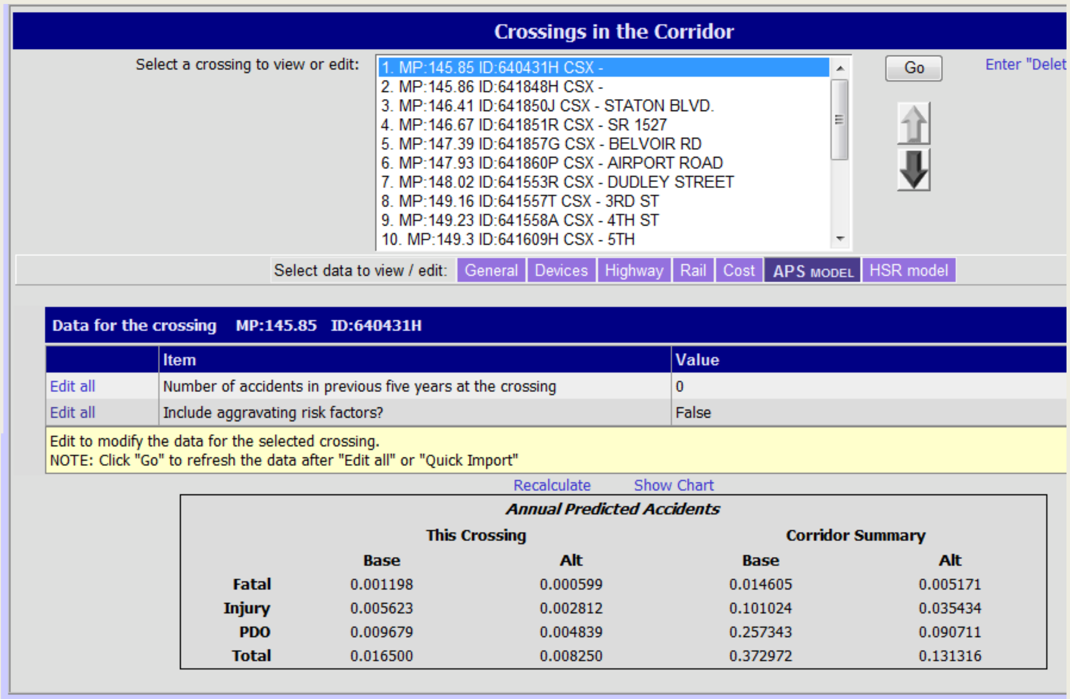
5.3 Identify Accident Risk in the Corridor

Two of the convenient features for identifying accident risk in the corridor are: 1) the corridor summary of predicted accidents and 2) the Corridor Risk Charts.

Double-click on the "Crossings" link on the navigation bar to browse to the Crossings page. On the page, click on the tab "Accident Prediction". This shows you the predicted accidents by type for the crossing and the corridor. For now we focus on the Base Case. The Alternate Case reflects the automatic assignment of improvements from the data import process – in this section we seek to refine the improvements in the alternate case.

Note that the table shows total annual predicted accidents in the corridor to be .37297 in the base case.

Figure 7 Case Study - Summary Table of Predicted Accidents



	This Crossing		Corridor Summary	
	Base	Alt	Base	Alt
Fatal	0.001198	0.000599	0.014605	0.005171
Injury	0.005623	0.002812	0.101024	0.035434
PDO	0.009679	0.004839	0.257343	0.090711
Total	0.016500	0.008250	0.372972	0.131316

The table also shows that for the selected crossing (Milepost 145.85) the predicted accidents in the base case is 0.0165. You can browse each crossing to find its predicted accident and pick out the higher risk crossing.

An easier way to accomplish this is using the charting feature. Click on the "show chart" icon in the tool bar. The first chart you see displays crossings by predicted fatal accidents. This gives you a good initial indicator of which crossings contribute the most to accident risk in the corridor.

The chart below is the crossings for the Case Study corridor:

Figure 8 Predicted Fatal Accidents – Ordered by Milepost

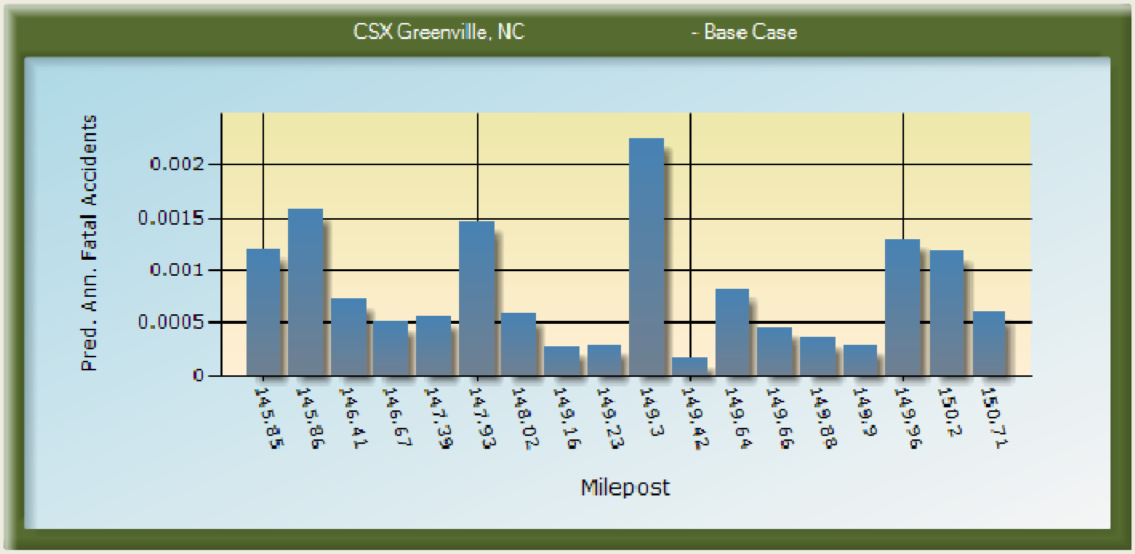
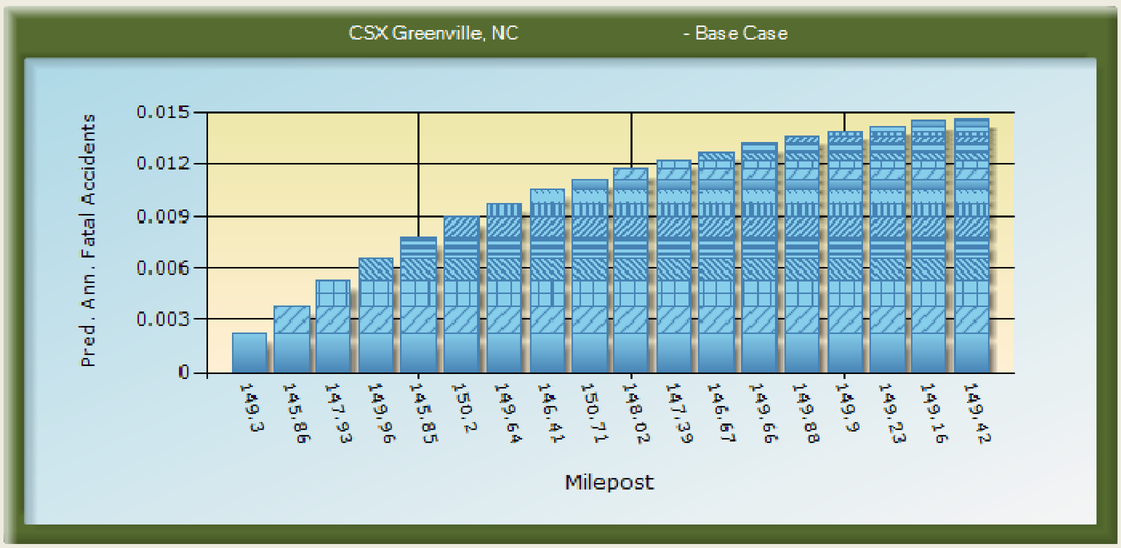


Figure 9 Cumulative Predicted Fatal Accidents – Ordered by Risk



By selecting options in the drop-down lists you can show the cumulative risk in the corridor and rank the crossings by predicted fatal accidents.

The chart shows us that the first nine riskiest crossings contribute nearly 80% of the accident risk in the corridor. In developing alternatives, this should indicate where to devote resources to best meet your safety objective.

5.4 Summarizing Improvement Targets

For the Case Study corridor the following table shows the ranked fatal accident risk by crossing. For corridors with a large number of crossings you may want to focus only on the crossings that contribute 50 or 80 percent of the total risk in the corridor.

Table 5 Ranking of Crossings with over 50% of Accident Risk in Corridor

Rank	ID	Milepost	Predicted annual fatal accidents
1	641609H	149.3	.002247
2	641848H	145.86	.001584
3	641860P	147.93	.001454
4	641614E	149.96	.001298
5	641431H	145.85	.001198

The next table looks at crossings from the perspective of the congestion management objective. Here the crossings are ranked by AADT.

Table 6 Top 5 Crossings in Case Study Corridor Ranked by AADT

Rank	ID	Milepost	AADT
1	641855T	149.64	11257
2	641860P	147.93	7996
3	641857G	147.39	7646
4	641850J	146.41	7470
5	641614E	149.96	6800

All crossings in the corridor are gated.

5.5 Developing Alternatives

In developing alternatives, use the information that has been gathered in this section to screen and assign alternatives to crossings in the corridor. You should, of course, examine additional factors that are covered in a comprehensive engineering review. These factors include: roadway geometry, humped crossings, line-of-sight issues and others. For a comprehensive review of factors to consider consult the "Rail-Highway Grade Crossing Handbook".

5.5.1 Select Candidates for Closures

Candidates for closures are high-risk, low-volume crossings. Closures can adversely impact neighborhoods and businesses, especially if alternative routings are long and circuitous. Agencies considering closures should gauge the local impacts to determine the suitability of closure.

We will close the crossings at Dudley Street (641553R) and Alley (641610C) based on the criteria of low traffic volume and high risk.

5.5.2 Select Candidates for Grade Separation

The natural candidates to consider for grade separation are those crossings that are high risk and high volume. Grade separation practically eliminates accident risk and congestion, however, usually at a high cost. Separation may be extremely costly in urban settings where solutions potentially infringe upon developed and valued real estate.

We will not grade separate any crossing in the corridor.

5.5.3 Select Other Improvements

Other improvements in the corridor could follow a broad policy guideline. Apply the following guideline to select the other improvements in our Case Study corridor.

Upgrade crossings to four quadrant gates (a supplementary safety measure) that meet either or both of the following criteria:

- At least one accident in the previous five year period, or
- AADT exceeds 10,000

Also, upgrade the crossings with flashing lights gates.

5.5.4 The Alternate Case

The following table shows the crossing device improvements for the alternate case.

Enter costs for each crossing or use the default costs. The default costs can be modified in the Parameters and Default Values Form.

Table 7 Alternate Case Devices for Crossings in Corridor

Data for all crossings in the corridor

No.	Crossing ID	Milepost	Description	Alternate Case Device
1	640431H	145.85	CSX -	Gates
2	641848H	145.86	CSX -	Gates
3	641850J	146.41	CSX - STATON BLVD.	Gates
4	641851R	146.67	CSX - SR 1527	Gates
5	641857G	147.39	CSX - BELVOIR RD	Gates
6	641860P	147.93	CSX - AIRPORT ROAD	Gates
7	641553R	148.02	CSX - DUDLEY STREET	Closure
8	641557T	149.16	CSX - 3RD ST	Gates
9	641558A	149.23	CSX - 4TH ST	Gates
10	641609H	149.3	CSX - 5TH	Gates
11	641610C	149.42	CSX - ALLEY	Closure
12	641855T	149.64	CSX - DICKINSON STREET	Gates
13	641854L	149.66	CSX - TENTH STREET	Gates
14	641612R	149.88	CSX - CROSS	Gates
15	641613X	149.9	CSX - CENTER	Gates
16	641614E	149.96	CSX - 14TH STREET	Gates
17	641615L	150.2	CSX - HOWELL ST.	Gates
18	642719W	150.71	CSX - ARLINGTON BLVD	Gates

Table 8 Alternate Case Supplementary Safety Measure

Data for all crossings in the corridor				
No.	Crossing ID	Milepost	Description	Alternate Case Supplementary Safety Meas
1	640431H	145.85	CSX -	Mountable curbs
2	641848H	145.86	CSX -	None
3	641850J	146.41	CSX - STATON BLVD.	Mountable curbs
4	641851R	146.67	CSX - SR 1527	Mountable curbs
5	641857G	147.39	CSX - BELVOIR RD	Mountable curbs
6	641860P	147.93	CSX - AIRPORT ROAD	Mountable curbs
7	641553R	148.02	CSX - DUDLEY STREET	None
8	641557T	149.16	CSX - 3RD ST	Mountable curbs
9	641558A	149.23	CSX - 4TH ST	None
10	641609H	149.3	CSX - 5TH	Mountable curbs
11	641610C	149.42	CSX - ALLEY	None
12	641855T	149.64	CSX - DICKINSON STREET	4 quad - no detection
13	641854L	149.66	CSX - TENTH STREET	None
14	641612R	149.88	CSX - CROSS	None
15	641613X	149.9	CSX - CENTER	None
16	641614E	149.96	CSX - 14TH STREET	Mountable curbs
17	641615L	150.2	CSX - HOWELL ST.	Mountable curbs
18	642719W	150.71	CSX - ARLINGTON BLVD	Mountable curbs

5.5.5 Creating Additional Alternatives

You can create and save more than one alternative set of improvements. Do this by returning to the Settings Page and create a new corridor, this time using the Case Study corridor as the source to copy. Give the new corridor a name like "CSX, North Carolina–Alternative 2". Develop your alternative and enter the data in the crossings for the newly defined corridor.

5.6 Managing your Data and Creating Versions

GradeDec.NET automatically stores your data on the GradeDec.NET server. Data are saved automatically when you import from the National Grade Crossing Inventory and when you click on either the "Update" or "Calculate Predicted Accidents" icons.

From the Settings page you can download your dataset and save it locally as a backup (or, in case you wish to delete your data from GradeDec.NET server. You can upload your dataset for use in a subsequent session.

MODULE 6 SAFETY ANALYSIS USING THE ACCIDENT PREDICTION AND SEVERITY MODEL (APS)

6.1 Introduction

This section covers safety benefits using the Department of Transportation Accident Prediction and Severity Models. This model is one of two models in GradeDec.NET that is used for estimating safety impacts and is available for both the Corridor and Regional models. The other model, the High Speed Rail model, is available only in the Corridor Model.

In GradeDec.NET, there are two levels of safety analysis:

The Crossing pages show predicted accidents and includes ranking charts for the base year data.

The simulation results report on the monetized safety benefits, corridor summary and by crossings, for the full forecast time horizon. The results also report the changes between base and alternate predicted accidents for selected years.

6.2 Analysis with the Crossing Pages

In the Corridor and Regional Crossing pages, you can evaluate the predicted accidents in the base year (this is the year that precedes the “Start” year of the analysis). Select the tab “Accidents”. This shows a table of the predicted accidents for the selected crossing and the corridor (or region), for each of the three accident categories (fatal, injury and property damage only). The values here are calculated based upon the data for the corridor or region and each of the individual crossings.

At the end of this section there is a demonstration of the calculation of predicted accidents using the Accident Prediction and Severity Models.

In addition to this table, by clicking on the bar chart icon on the toolbar of the Crossing page you can view summary charts that rank crossings by predicted fatal accidents in the base year.

Analysis from the Crossing page is useful in identifying those crossings with the highest risk. You can use this information to screen and develop alternatives, prior to conducting you full analysis (that covers all benefit categories and all years of the forecast time horizon).

6.2.1 Results for the Safety Analysis with the Case Study Corridor

Figure 10 Corridor Accident Risk Summary with Improvements

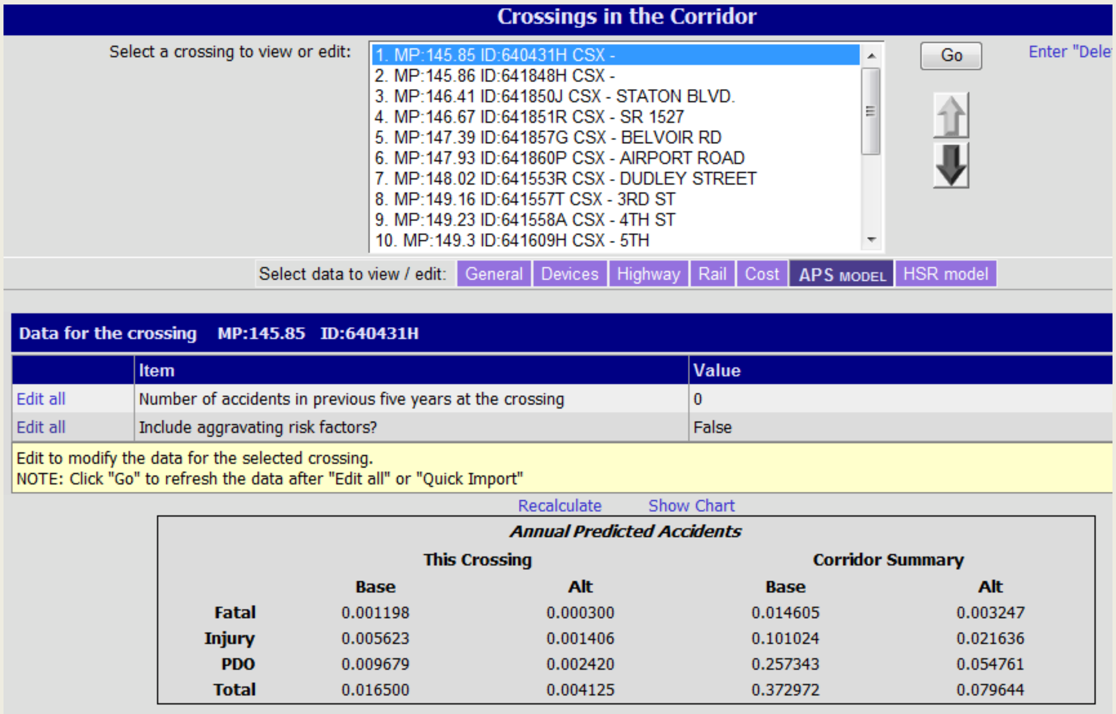
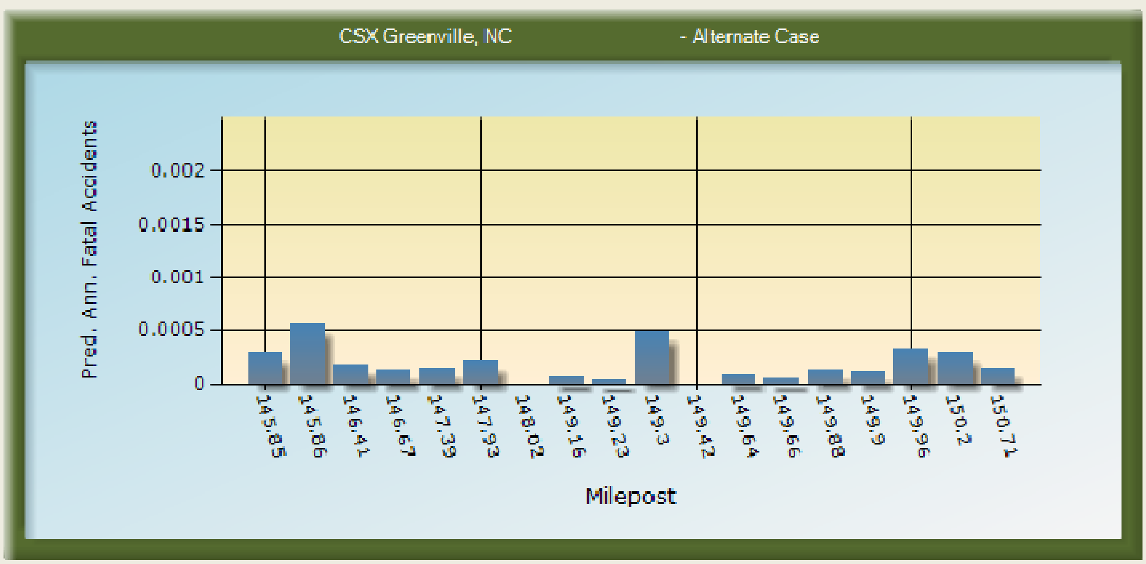


Figure 11 Chart of Risk in Corridor with Improvements



6.3 Safety Analysis Component of Investment Analysis Results

The investment (benefit-cost) analysis includes safety benefits over the period of analysis along with non-safety benefits. If you complete all the steps in an investment analysis you can view the monetized safety benefit results of that analysis.

The following are the steps for completing the investment analysis and reviewing its safety results:

- Run a simulation (see Module 9) after completing the following tasks:
- Select the alternative for each crossing and enter data as required
- Select a scenario and modify data as required
- Verify that the parameter and default values are suited to your locale
- When a simulation completes the Results Page appears. From the Results Page you can view the safety benefits that accrue over the entire period of analysis. The following results metrics track the safety benefits in GradeDec.NET. The "safety benefits" in the GradeDec.NET results is:

  The reduction in predicted accidents (base less alternate) by accident type (fatal, injury and property damage only), with each type multiplied by its social cost and summed. Total safety benefits for the corridor is summed over the crossings in each year and the present value of the safety benefit stream is reported in the "Benefits and Benefit-Cost Summary" sheet of the Results page.

Safety benefits are also tracked in the results through the following:

- The present value safety benefit is given for each individual grade crossing in the "Benefit by GCX – Safety" sheet.
- A quantity measure, the decrease in predicted fatal, injury and property damage only accidents is reported for each of three years: the start year, the last year of the near term and the last year.

SAFETY BENEFITS (Module 6)
A. Predicted Accidents - Calculate Exposure Correlation Factor

		D	E	F	G	
	Determine Inputs					
		Early AM	**Late AM**	**Early PM**	**Late PM**	
6	Time-of-day distribution of trains	0.4	0.1	0.1	0.4	
7	Time-of-day distribution of autos	0.1	0.4	0.4	0.1	
8	Time-of-day distribution of trucks	0.1	0.5	0.35	0.05	
9	Time-of-day distribution of buses	0.1	0.4	0.4	0.1	
10						
11	of this, % trucks	28				
12	of this, % buses	2				
13						
14	Share of auto traffic	0.7				
15	Share of truck traffic	0.28				
16	Share of bus traffic	0.02				
17						
18	**Calculate Factor**					
19	Weighted highway time-of-day distribution	0.1	0.428	0.386	0.086	=SUMPRODUCT(D7:D9,$D$14:$D$16)
20	Weighted with time-of-day distribution	0.1558				=SUMPRODUCT(D19:G19,D6:G6)
21	Sum-of-squares, train distribution	0.34				=SUMPRODUCT(D6:G6,D6:G6)
22	Sum-of-squares, weighted highway distribution	0.349576				=SUMPRODUCT(D19:G19,D19:G19)
23	Exposure Correlation Factor	0.445683				=D20/MAX(D22,D21)

SAFETY BENEFITS (Module 6)
B. Predicted Accidents - Calculate Factors and Predicted Accidents

(Calculation for a gated crossing)

	B	C	D
2			
3			
4	**Exposure - "EI"**		
5	Average daily train operations	16	
6	AADT	4500	
7	Exposure correlation factor	0.44568277	
8	Exposure factor	43320.365	=1.35*D4*D5*D6
9	"EI"	37.1323	=((D7+0.2)/0.2)^0.2942
10			
11	**Day Through - "DT"**		
12	Total day through trains	10	
13	"DT"	1.3	=((B10+0.2)/2)^0.1781
14			
15	**Maximum Timetable Speed - "MS"**		
16	Maximum timetable speed	55	
17	"MS"	1	Fixed for gated crossings
18			
19	**Number of Tracks - "MT"**		
20	Number of tracks	2	
21	"MT"	1.35310	=EXP(0.1512*B19)
22			
23	**Number of Highway Lanes - "HL"**		
24	Number of lanes	2	
25	"HL"	1.152576649	=EXP(0.142*(B23-1))
26			
27	**Highway Pavement - "HP"**		
28	Paved=1, Not paved=2	1	
29	"HP"	1	Fixed for gated crossings
30			
31	**Constant**	0.000575	Fixed for gated crossings
32	**Adjustment factor**	0.4921	Fixed for gated crossings
33			
34	**Number of accidents - first estimate**	0.044469386	=B8*B12*B16*B20*B24*B28*B30
35	**Adjusting factor**	10.58543982	=1/(0.05+B33)
36	**Number of Accidents at crossing in 5 years**	0	
37	**Number of accidents - revised estimate**	0.030203062	=((B33*B34)+B35)/(B34+5)

SAFETY BENEFITS (Module 6)
A. Number of Accidents by Severity

	B	C	D
3	Maximum timetable speed	55	
4	**Maximum speed factor fatal accidents**	0.018321	=C3^-0.9981
5	**Maximum speed factor casualty accidents**	0.252962	=C3^-0.343
6	Number of through trains	12	
7	**Through trains factor**	0.799584	=(C6+1)^-0.0872
8	Number of switch trains	4	
9	**Switch trains factor**	1.150668	=(C8+1)^0.0872
10	If urban then 1, else 0	1	
11	**Urban factor fatal accidents**	1.429179	=EXP(C10*0.3571)
12	**Urban factor casualty accidents**	1.34447	=EXP(C10*0.296)
13	Number of tracks	2	
14	**Track factor**	1.259355	=EXP(C13*0.1153)
15	**Number of predicted accidents**	0.030203	
16			
17	**Fatal Accidents**	0.000796	=C15/(1+440.9*C4*C7*C8*C11)
18	**Casualty Accidents**	0.005142	=C15/(1+4.481*C5*C7*C8*C12)
19	**Injury Accidents**	0.004345	=C18-C17
20	**Property Damage Only Accidents**	0.025061	=C15-C17-C19

MODULE 7 SAFETY ANALYSIS USING THE HIGH SPEED RAIL MODEL

7.1 Introduction

This section covers safety benefits using the High Speed Rail Model (HSR) that was developed by the Federal Railroad Administration and the Volpe National Transportation Center. This model is only available for corridor analysis.

The HSR model was developed to assist in evaluating risk along corridors that are designated for new, higher speed rail service. These services will operate with speeds exceeding 80 mph. Two of the issues for higher speed rail that are not addressed by the Accident Prediction and Severity model are:

- Accident severity increasing with train speed, and
- Identification of casualties by mode.

The first issue is important because speed is a distinguishing characteristic of proposed new rail services and the safety and risk associated with them are basic concerns. Note that in the current version of GradeDec.NET (corresponding to the most recently published version of the HSR model), predicted accidents are not a function of the crossing's accident history (as is the case with

Identifying predicted casualties by mode is important because of the need to closely scrutinize the safety of new public carrier services.

As with the APS model, there are two levels of safety analysis for the HSR model:

The Crossing page shows predicted accidents and includes ranking charts for the base year data.

The simulation results report on the monetized safety benefits, corridor summary and by crossings, for the full forecast time horizon. The results also report the changes between base and alternate predicted accidents for selected years.

7.2 Analysis with the Crossing Page

In the Corridor and Regional Crossing page, you can evaluate the predicted accidents in the base year (this is the year that precedes the "Start" year of the analysis). Click on the tab in the toolbar "HSR Model". This shows a table of the predicted fatalities and injuries by mode, and, then number of accidents for the selected crossing and the corridor. The values here are calculated based upon the data for the corridor or region and each of the individual crossings.

At the end of this section there is a demonstration of the calculation of predicted accidents using the High Speed Rail Model.

Use the Summary Charts as described in the previous section.

7.3 Safety Analysis Component of Investment Analysis Results

The investment (benefit-cost) analysis includes safety benefits over the period of analysis along with non-safety benefits. If you complete all the steps in an investment analysis you can view the monetized safety benefit results of that analysis.

The following are the steps for completing the investment analysis and reviewing its safety results:

Run a simulation (see Module 9) after completing the following tasks. **On the Simulation Page, be sure to check "Use the HSR model?"**

Follow the steps in section 6.3 above.

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