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GradeDec

# Users' Manual



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**Federal Railroad Administration**

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# Introduction

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## Introduction to *GradeDec*

*GradeDec* is a web-based decision support tool that assists federal, state and local authority decision makers in evaluating the benefits and costs of highway-rail grade crossing upgrades, separations and closures.

*GradeDec* employs benefit-cost methodologies that are used to evaluate highway-rail grade crossing investment alternatives at the corridor level or in a region. The modeling frameworks in *GradeDec* were developed by the Federal Railroad Administration and include research findings of the Volpe National Transportation Systems Center and the National Cooperative Highway Research Program. *GradeDec* analyses effectively support the planning and investment decision processes.

*GradeDec* forecasts the transportation and non-transportation effects of highway-rail grade crossing investments and estimates the economic value of these effects over the useful life of the project in dollar terms. The benefit-cost of an investment is calculated by comparing the time-stream of expected economic benefits with the time-stream of investment-related and other costs, after adjusting for the opportunity costs of capital. Known as “discounting”, this adjustment enables decision makers to inspect future benefits and costs in terms of their *present-day* value. This is a standard way of giving due weight to nearer-term versus distant (thus less valued) outcomes.

*GradeDec*'s underlying methodology is consistent with the current benefit-cost methodologies employed by the United States Department of Transportation Agencies (Federal Railroad Administration, Federal Highway Administration, Federal Transit Administration, and the Federal Aviation Administration) and with Executive Order 12866, which governs the principles of federal infrastructure investment. The model is transparent in all of its assumptions and the model inputs are readily accessible to users who may want to adjust model inputs to reflect local circumstances.

*GradeDec* addresses two types of risk. First, accident risk is the probability of an accident occurring at a crossing. The principal metric of

accident risk is the number of annual predicted accidents at a crossing (or in a corridor or region) by severity category (fatal, injury or property damage only). Accident risk is measured in *GradeDec* using one of three distinct models:

- The New Accident Prediction and Severity (APS) Model – a recently-developed model that uses advanced statistical methods and recent crash and grade crossing inventory data
- The U.S. Department of Transportation’s Accident Prediction and Severity (APS) model – a standard model that was derived in 1986.
- The High-Speed Rail (HSR) model for high-speed rail corridors, developed by Volpe Center researchers specifically for high speed rail corridors.

*GradeDec* users may select the model best suited for their analyses.

*GradeDec* also has capabilities for risk analysis, distinct from accident risk, which is concerned with quantifying uncertainty associated with forecasts. This second type of risk allows for the assigning of probability distributions to input variables of the analysis and determining the effects of uncertainty on the outcomes.

*GradeDec* is designed to minimize the data needs and technical expertise required of the user while at the same time providing reliable benefit-cost results. With information about a series of grade crossing improvements along a particular corridor, the range of anticipated accident reductions, train crossing delay improvements, and travel demand forecasts generate preliminary benefit-cost results for a given confidence interval. Depending on the user’s needs, requirements, and abilities, one can select either an extensive default database that will minimize input requirements, or the user can customize the analysis by inputting project specific localized data. In this way, *GradeDec* functions as both a high-level preliminary model and a micro-level localized model.

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## Why *GradeDec*

Growing requirements for highway-rail grade crossing investments and dwindling fiscal resources point to the need for a new tool for investment analysis. *GradeDec* determines the effects rail corridor investments will have on safety and highway delay and queuing. Improvements will result in the following economic benefits:

- Improvement in safety and reduced accident costs;
- Reduced travel time costs;
- Improved air quality;
- Reduced vehicle operating costs;
- Network benefits.

*GradeDec* uses risk analysis to evaluate highway-rail grade crossing investments and the results of an analysis include probability distributions for all of the model outcomes. These outcomes are viewed with *GradeDec*'s user-friendly displays of charts and statistics.

For a corridor or regional analysis, *GradeDec* can evaluate up to 600 grade crossings simultaneously. The user can view model results in total for the corridor or region, or by individual grade crossings. For example, the user can view the safety benefits of each grade crossing improvement along the corridor and the probability range associated with those benefits. Likewise, the user can view the highway vehicle operating costs savings or environmental benefits for each grade crossing.

*GradeDec* conducts comprehensive statistical simulations in order to provide a probability range for the net present value, and other results, associated with each rail corridor-level investment plan. This enables the user to assess the risk associated with each plan. Additionally, *GradeDec* conducts risk sensitivity analyses based upon the probability ranges and informs the user which factors will have the greatest impact on the outcomes. For each result the user can display a "tornado chart" that shows the eight most significant factors contributing to risk. This information is essential for planning contingencies and working to mitigate risks.

*GradeDec* is deployed as a web-based decision support tool unlike its predecessor versions, which were desktop applications. Web deployment addresses the following issues:

- Users are moving to secure systems and in some cases a requirement to install dedicated software is a barrier to use. *GradeDec* does not require any special software, other than an Internet connection and a web browser.
- *GradeDec* does not require special hardware or even a special operating system (it will run on client computers running Windows, Linux, Unix or Mac operating systems).
- Modifications and improvements to the software are immediately deployed for all users.
- FRA's most recent grade crossing data is always available to the application.
- User analyses and data run on a central database thus minimizing the need for users to track and maintain their data on their computer (users have the option of storing their data locally at the end of a session and restoring their data for use when beginning a new session).

# Technical Description and Requirements

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## A Web-Based Application

*GradeDec* 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.

The technical description of the system that follows is presented in the form of "FAQs" (frequently asked questions). This section concludes with the "Terms of Use" that apply to system users.

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## Using *GradeDec* - FAQs

### How do I access *GradeDec*?

Open your web browser to the address (URL) <http://gradedec.fra.dot.gov>. Navigate to the Log In link in the top right. When the logon screen appears, enter your email address and password and click "Login." New users should click the Register link for New User Registration.

### How do I use *GradeDec*?

After logging on, you can access all the features of *GradeDec*. You navigate to the different functional areas of the system, each represented by a web page, by clicking on links of the main navigation menu (left side of the page).

You develop your data and conduct your analysis by selecting options on the web pages of *GradeDec*. When you make entries and click on selections in the web browser, a request is sent over the Internet to the *GradeDec* server. The server performs all the calculations and data transformations and then sends back to your browser an updated page that reflects your selections.



## Where do my data reside?

During a *GradeDec* session, your data reside on the *GradeDec* server. You may choose to leave your data on the server between sessions, or you can store it locally on your own computer and delete it from the *GradeDec* server. When you start a new session, you can restore your data to the *GradeDec* server and continue your analysis.

## Are my data secure?

See “Data Security” in the *GradeDec* Terms of Use below.

## Terms of Use

The following are the *GradeDec* Terms of Use:

### 1. Purpose and Intended Use

*GradeDec*, system for highway-rail grade crossing investment analysis, is an online service provided by the Federal Railroad Administration (FRA). It is available to the general public and its intended users are: U.S. Department of Transportation employees; state and local authorities for transportation planning and policy; railroads; consultants, academics and others engaged in grade crossing policies and issues. The intended use of the system is for the development of analyses that support grade crossing management and investment decisions.

### 2. General Disclaimer

Use of the *GradeDec* web application, documentation, or data is without warranty of any kind by FRA. To the maximum extent permitted by applicable law, FRA further disclaims all warranties, including without limitation any implied warranties of merchantability, fitness for a particular purpose, and noninfringement. The entire risk arising out of the use or performance of the *GradeDec* web application, documentation, or data remains with the user. To the maximum extent permitted by applicable law, in no event shall the FRA or its contractors be liable for any consequential, incidental, direct, indirect, special, punitive, or other damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or other pecuniary loss) arising out of the use of or inability to use the *GradeDec* web application, documentation, or data, even if FRA has been advised of the possibility of such damages.

### 3. Applicability of Models, Supplied Values and Assumptions

*GradeDec* includes modeling frameworks, sample analyses and default values for a range of model parameters and input variables. FRA does not guarantee that these are well-suited for a particular analysis or situation. It is the user's responsibility to validate all inputs and assumptions for the analyses generated by *GradeDec*.

#### **4. Non-Endorsement of Results**

Results that are obtained from *GradeDec* analyses are solely the responsibility of the user and are not endorsed by FRA.

#### **5. Availability of Service and Outages**

FRA seeks to provide *GradeDec* as an "always on" service. However, there may be service outages due to any of the following factors: disruptions in the power supply, disruptions in the data communications network, equipment failure or system maintenance. FRA is not liable for damages that might result from service outages.

#### **6. Possible Discontinuance of Service**

FRA reserves the right to discontinue this service, temporarily or permanently, and without advance notice. FRA is not liable for damages that might result from the discontinuance of service.

#### **7. Data Security**

##### **a. Transmission**

*GradeDec* uses secure socket layer (SSL) technology in accordance with the latest standards and protocols. Your data are secure in transmission between your local computer and the *GradeDec* server.

##### **b. Storage on the *GradeDec* server**

User analysis data resides on the *GradeDec* server computer during an analysis session, and the user has the option of allowing data to remain on the server between analysis sessions. FRA will take reasonable measures to ensure the integrity and privacy of the user's data. However, FRA does not guarantee that the integrity or privacy of data will not be compromised due to either technical failure or the actions of an unauthorized third party. FRA is not liable for any damages that might result from the loss of data or their access by unauthorized parties. The user has the option of storing analysis data offline on the user's computer between sessions, deleting it from the *GradeDec* server computer, and restoring it to the server for use in subsequent sessions.

#### **8. Denial of Access for Misuse**

FRA reserves the right to deny access to a party that seems to be misusing the system. Misuse of the system includes, but is not restricted to: hacking, deliberately circumventing system security, overloading, attempting to deny service to others, attempting to use system resources for purposes other than the system's intended use.

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# Software and Hardware Requirements

## Computer, Operating System and Web Browser

*GradeDec* is designed for use with any computer and operating system running most popular browsers current since 2017.

The required hardware is the same as that required to run the web browser on a specific platform (type of computer and operating system).

And, of course, all browsers require a mouse (or other pointing device) and an Internet connection.

## File Formats

Some of the optional features of *GradeDec* involve the transfer of files between the *GradeDec* server and your computer. The following are the file formats used in these transfers:

- ZIP files are used when downloading data for storage between sessions. The user has no need to access these files locally.
- PDF, or portable document files are used with *GradeDec* reports. In order to view and print these files, you should have Adobe Acrobat Reader or other compatible software installed on your computer in order to read and print these files.

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## Overview of this Manual

The remainder of this document describes how to conduct a *GradeDec* analysis and use the pages that are encountered during an analysis. The manual concludes with a glossary of terms and an index.

Note that the *GradeDec Model Reference Manual* is the companion piece to this *User's Manual* and may be required to fully understand some of the features and processes of *GradeDec* that this manual describes.

In the text, the following conventions are used:

- Bold text is used to refer to a page in *GradeDec* (e.g., **Data Management page**). The same bold text will be used when referencing the links to these pages from the main navigation menu.
- Italics are used to designate drop down list options and selections in *GradeDec* (e.g., *Add new crossing*)

# Using *GradeDec*

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## Introduction

This chapter gives general guidance on working with *GradeDec*. The first section describes the principal modes of use for *GradeDec*. The section that follows describes the management of data in *GradeDec*. The final section describes the steps taken to conduct an analysis for each of the modes of use.

The subsequent chapter, "*GradeDec* Page-by-Page", provides detailed descriptions of all the features of *GradeDec*.

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## Modes of Use

*GradeDec* 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*. These are:

- Safety analysis, and
- Full investment analysis

### 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.

## Full Investment 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* 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* used in each type of analysis.

**Table 1 GradeDec Modes of Use**

Mode of Use	Purpose	Functional Pages in <i>GradeDec</i> to Use
Safety analysis	Calculate accident risk and impacts of improvements, identify improvement programs, analyze safety regulatory impacts Support safety and regulatory compliance decisions.	<b>Data Management, Import, Crossings, Parameters</b>
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.	<b>Data Management, Import, Crossings, Parameters, Scenario, Simulation, Results</b>

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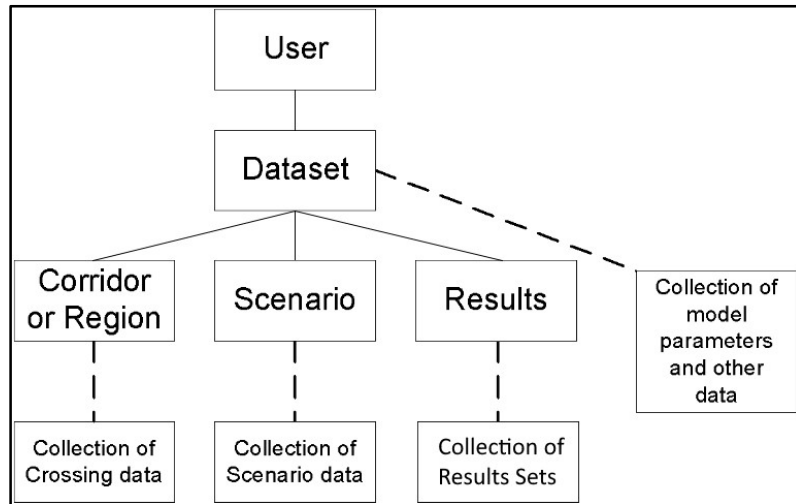
## The Data Hierarchy in *GradeDec*

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

Every active session of *GradeDec* 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* model calculations. You navigate among different data collections by making selections on the **Data Management 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 1 Data Hierarchy in GradeDec**



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 **Data Management 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 Hierarchy at New User Logon**

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

Suppose the user then changes the Schema selection in the **Data Management page** to “Regional Schema”. The data hierarchy will then be populated with the following values (changed values in italics):

**Table 3 Data Heirarchy After Changing Model**

<b>Data Hierarchy Node</b>	<b>Value</b>
User	Your user id
Dataset	“Initial dataset”
Schema	“ <i>Regional Model</i> ”
Region	“ <i>Montgomery, MD</i> ”
Scenario	“ <i>Strong highway growth</i> ”
Result	“ <i>Placeholder – Regional Model</i> ”

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* 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 **Data Management page**.

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

### **User**

When you log in to *GradeDec*, 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.

### **Dataset**

User data for analyses are organized in datasets in the *GradeDec* database. A user may create and maintain up to 30 datasets. A dataset is a comprehensive container of data collections used in *GradeDec* 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*.

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

## 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 crossings device and supplementary safety measures.

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

### Schema

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

### Corridor

A corridor has a set of defining values (these can be viewed and modified in the data grid at the bottom of the **Data Management page** – see Section 2.1 Data Management 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 Schema node is set to the corridor schema. 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 **Data Management page**. After selecting a corridor, view or modify its crossings data from the **Crossings** page.

### Region

A region has a set of defining values (these can be viewed and modified in the data grid at the bottom of the **Data Management page** – see Section 2.1 Data Management 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 Schema node is set to the regional schema. 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 **Data Management page**. After selecting a region, view or modify its crossings data from the **Crossings** page.

### 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 a dataset may contain as many as 30 scenarios for each model.



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

## Results

*GradeDec* sets the defining values of a results set automatically when you run a simulation. You can set the description for a results set.

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

# Steps in Conducting a *GradeDec* Analysis

## Overview

The following table shows a sample set of steps that you would undertake to conduct each of the two analyses. The sections that follow walk you through these steps in a sample analysis. Additional detail is provided in the “*GradeDec Page-by-Page*” chapter, including screen snapshots.

**Table 4 GradeDec Modes and Sample**

Mode of Use	Functional Steps	Page
Safety analysis	(Optional) Create and select a new dataset	Data Management
	Create and select a new corridor (or region)	Data Management
	Set values for corridor (or region)	Data Management
	(Optional) Set default crossing device cost data	Defaults
	Import data from Grade Crossing Inventory	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	Data Management
	Create new scenario	Data Management
	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

## Safety Analysis

In this example you will set up an analysis for 10 crossings in a freight rail corridor in Lincoln County, Nebraska.

### *(Optional) Create and select a new*

#### *dataset*

If you skip this step, then in subsequent steps you will be using the default or other existing dataset.

On the **Data Management page**, click on the button “Create New Dataset” on the row with “Selected Dataset”. This will open the **New Dataset** dialog. 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 (e.g., “Sample analyses”) and then click create. This will transfer you back to the **Data Management page**. From the dataset drop down list, select the dataset that you just created and click “Submit”.

### *Create and select a new corridor*

#### *(or region)*

This section will assume that the Corridor Schema is suitable for your analysis.

Select the “Corridor Schema” (or ensure that it is selected) by clicking the appropriate toolbar button.

On the **Data Management page**, click on “Create New Corridor” to the right of “Selected Corridor”. This will open the **New Corridor** dialog. On this page select “Create a new, empty corridor”. Enter a name for the new corridor (e.g., Lincoln 1) and then click “Submit”. This will transfer you back to the **Data Management page**.

From the “Selected Corridor” drop down list, select the corridor that you just created, and click “Select Corridor”.

## ***Set values for corridor (or region)***

### ***characteristics***

In the table at the bottom of the **Data Management** 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.

In this example, set:

- Daily Passenger Trains to 0
- Daily Freight Trains to 108
- Daily Switch Trains to 1
- Rail TOD (time-of-day) distribution to Uniform
- Signal Synchronization to false by leaving it unchecked

**Set the values in the table by clicking on the “Edit” button, which will open the table for editing. Enter your changes and save them by clicking the “Update” button.”**

### ***(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.

### ***(Optional) Set default crossing***

#### ***device cost data***

If in your analysis of safety you have no interest in the costs of improvements, then skip this step.

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.

### ***Import data from Grade Crossing***

#### ***Inventory***

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

- State: *Nebraska*
- County: *Lincoln*
- Area: *Whole County*

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. Select the corridor: *UP Nebr Eastern 4 Crossings*. This is the corridor with crossings in the selected area for the UP railroad, Nebraska division, Eastern subdivision. In this example there are four crossings.

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 for full description), or you can just click on “Import crossings data” to import your data to your Lincoln 1 corridor. After clicking import, your browser will automatically shift to the **Crossings** page.

### ***Verify and refine data, assumptions and choice of alternatives***

In the **Crossings** page you can browse the imported data and make any modifications that you need. Also, in the “General” section you can view and modify the choices for the improvement alternative.

### ***Calculate predicted accidents, view/print reports and charts***

When you are satisfied with the data and the alternative selections, on the “APS model” section click on the “Calculate predicted accidents” button in order to calculate the predicted accidents for each crossing and for the whole corridor.

You can generate a report for viewing and printing by selecting the option under “Crossings” on the Main Menu. You can view a chart of the predicted accidents by selecting the “View chart” link in the “APS Model” section of the **Crossings** page.

## **Full Investment Analysis**

For a full investment analysis, complete the steps above for the safety analysis. Then perform the following steps.

### ***Create new results set***

On the main navigation menu, click on the link **Settings** to return to the **Data Management page**. On the **Data Management page**, click on the “Results Set” toolbar button . Then, on the “Selected results set” line, click the ”Create New Result Set” button. This will open the **New Results** dialog. On this page, enter the name of the new results set “Lincoln UP, Base” and then click the “Submit” button. Your browser will create the results set and shift back to the **Data Management page**. Now from the drop down list select the newly created results set.

### ***Create new scenario***

Now click on the "Scenario" toolbar button. Then click the "Create New Scenario" button on the "Selected Scenario" line. This will open the **New Scenario** dialog. Select "Create a new scenario by copying an existing scenario" and select from the drop down list the sample "Base scenario" scenario. Enter a name for the scenario (e.g., Lincoln base) and click on "Create". Your browser will create the scenario and shift back to the **Data Management page**. Now from the drop down list select the newly created scenario.

You can leave the year settings (Start year: 2018, last year near term: 2022, end year: 2042) at their default values or modify them if you wish. These values determine the first and last years of the analysis time horizon and the periods in which the respective near-term and far-term growth rates are applied.

### ***Modify the scenario data with forecast values and assumptions for your analysis***

Click on the **Scenario** link of the main navigation menu. Your browser will transfer to the **Scenario** page. This page will display the scenario that you selected. This scenario is pre-populated with the sample values copied from the "Base scenario". Modify these values to suit your analysis.

The scenario data variables are organized by topic areas: rail operations, highway, social costs and prices. You select a topic area by using the drop down list on the top-center of the page. You view a variable within a topic area in the table in the lower part of the page. Clicking the "Edit Distributions" and "Edit Values" buttons allows you to edit the variable data in the table.

The data for the scenario variables are either a fixed value or several values that define a probability distribution. Click on the "Edit Distributions" button to select the type of probability distribution using the drop down lists (skewed bell, normal, uniform or triangle – or set the variable to be a "Fixed Value"). After setting the probability distribution types for all the variables on the page, click "Update". Then click the button "Edit Values", which will open the table to allow editing of the values. **After entering the values for the probability distributions on the page, click the "Update" button to save your entries.** Be sure to always click "Update" to save your entries before navigating away from your current page.

### ***Verify or modify parameters and other data values***

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 "Model Parameters". Select from the drop down list a table of values to view. If for your analysis you have local information that is better suited than the

standard values supplied with *GradeDec*, then edit the model values here (see the *Model Reference* for documentation of the equations in *GradeDec*).

***Set the simulation parameters and  
run the simulation***

Browse to the **Simulation** page by clicking on the link on the main navigation menu. On this page set the parameters for running a risk analysis of the benefit-cost of the program of improvements defined in **Crossings**, with the probability distributions described in **Scenario**. You can run your simulation with the default values, or modify them and take advantage of the options on this page. When ready, click on the "Run Simulation" button. When completed, your browser will shift to the **Results** page.

***View results table and charts,  
print report***

On the **Results** view your analysis results on the tables and charts that this page makes available.

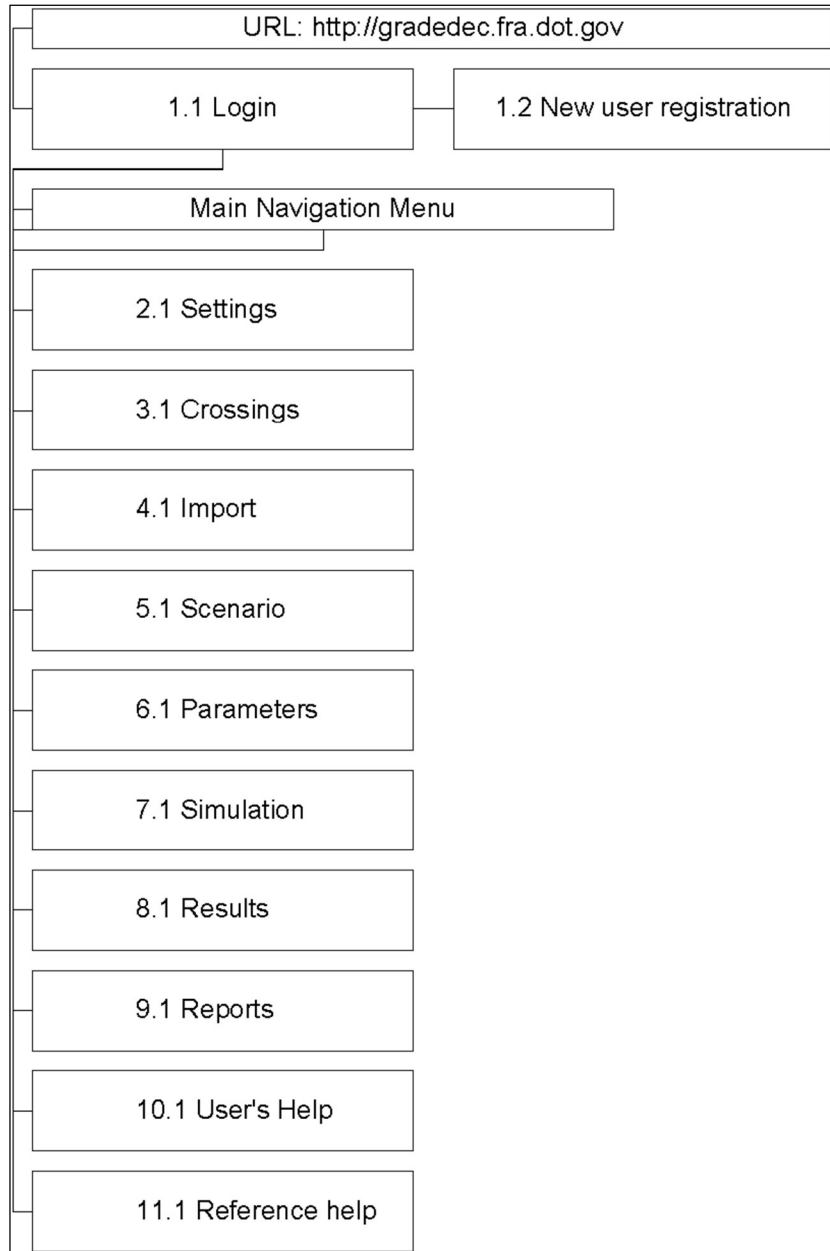
# *GradeDec* Page-by-Page

---

## Introduction

The figure below shows the pages in *GradeDec* and the means for accessing each page (pages directly connected to the main navigation menu are accessed from it. Access other pages from the connecting page to its left in the figure). The following descriptions of pages each contain an Overview and a Features section.

**Figure 2 Key to Pages in GradeDec**





---

## 1.1 Login Page

Figure 3 View of Login Page (Login and registration section)

The screenshot shows a login form with a light gray header labeled "Login". Below the header, there is a text input field for "Email Address". Underneath the email field is a checkbox with the text "I understand, agree with, and will comply with the system's [Terms and Conditions of Use.](#)". Below the checkbox is another text input field for "Password". At the bottom left of the form is a blue button labeled "Login". At the bottom right, there are two blue links: "Forgot Password" and "Migrate Legacy Account".

### Overview

After directing your browser to the *GradeDec* URL (<http://gradedec.fra.dot.gov>), the **Login** page appears. The **Login** page contains a toolbar with selections that offer information about *GradeDec*. When “Login” is selected in the top right, you will see the “Login” section as it appears above.

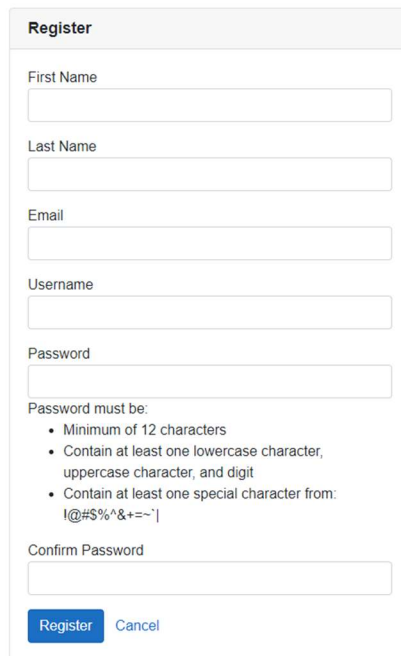
Enter your email address and password and click “Submit” to begin a *GradeDec* session.

First-time users should click the “Register” button on the top right in order to invoke to the **Registration** page for new user registration.

---

## 1.2 Registration Page

Figure 4 View of Registration Page



The screenshot shows a registration form titled "Register". It contains the following fields and instructions:

- First Name:
- Last Name:
- Email:
- Username:
- Password:
- Confirm Password:

Below the Password field, the text "Password must be:" is followed by a bulleted list of requirements:

- Minimum of 12 characters
- Contain at least one lowercase character, uppercase character, and digit
- Contain at least one special character from: `!@#%&+*~`]`

At the bottom of the form are two buttons: "Register" (highlighted in blue) and "Cancel".

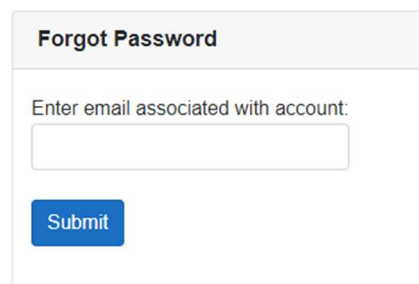
### Overview

On this page, first-time users register with *GradeDec*. Required information includes the user ID, password, first name, last name and an email address. The user ID and password must each be at least six characters in length. Please note and save your user ID and password in a safe place because you will need these for logging in to *GradeDec* in future sessions.

After entering your information, click "Submit". Missing or invalid information will result in red error messages on the page. If you see any such messages, correct as needed and click "Submit" again. After you register, your browser will be redirected to the **Data Management page**.

### Login Assistance

Figure 5 View of Login Assistance Page



The screenshot shows a form titled "Forgot Password". It contains the following elements:

- Text: "Enter email associated with account:"
- Input field:
- Submit button: "Submit" (highlighted in blue)

If you forget your password, you can go to the **Login Assistance Page**. On this form, you enter your *GradeDec* email address, click submit, and you will receive an email (sent to the email address associated with the registered user) with instructions on how to change the password.

Should you forget your *GradeDec* login credentials, send an email to [Karen.mcclure@dot.gov](mailto:Karen.mcclure@dot.gov). You will receive an email with instructions for resetting and accessing your account.

---

## 2.1 Data Management Page

Figure 6 View of Data Management Page

The screenshot displays the GradeDec web interface. On the left is a dark teal sidebar with navigation links: Settings, Crossings, Scenario, Parameters, Import, Simulation, Results, and Help. The main content area is titled 'U.S. Department of Transportation Federal Railroad Administration' and shows a 'Settings' form for a 'Corridor' object. The form includes dropdown menus for 'Dataset' (Fresh), 'Corridor' (Upton, IL), and 'Scenario' (Strong rail growth). Below these are buttons for 'Select Dataset', 'Create New Dataset', and 'Delete Dataset'. There are also buttons for 'Corridor Model' (Regional Model) and 'Corridor' (Scenario, Results Set). A 'More Options' dropdown is visible. At the bottom, a table titled 'Settings for the selected corridor' lists various parameters and their values.

Item	Value
Corridor ID	2
Description	Upton, IL
Daily Passenger Trains	0
Daily Freight Trains	96
Daily Switch Trains	4
Rail TOD Distribution	Day Flat
Rail TOD Distribution - Freight	Day Flat
Rail TOD Distribution - Switch	Day Flat
Signal synchronization?	<input type="checkbox"/>
Allow Capital Programming?	<input type="checkbox"/>
Effectiveness Factor, New Technology 1	0.5
Effectiveness Factor, New Technology 2	0.5

### Overview

With the **Data Management** page, use the controls on the page to set and manage the data collections for your analysis (see the section on “The Data Hierarchy in *GradeDec*”). You can also modify the defining values for data collections, set or restore defaults and launch the page to create new data collections or delete existing ones.

### Features

The Data Management page is divided into two main sections: 1) the object selection form (top of the page) and 2) the data grid (bottom of the page). Use the controls in the object selection form to select an object (corridor or region, scenario or results set) and edit the object’s characteristics in the data grid. Click the “Edit” button in order to make entries in the data grid and click “Update” to save your entries. The following subsections describe in detail the features of the page.

- **Select Dataset** drop down list – if you have more than one dataset, select the one to use with this control.

- **Select** buttons – By clicking one of these buttons, you select the item in the drop down list on the left. Item selection will cause the grid at the bottom of the page to be populated with data defining the selection.
- **Select Schema** toolbar – within the selected dataset, select the schema (Corridor or Regional) to use by clicking the respective button on the toolbar. The Corridor schema examines crossings along a designated rail alignment and calculates impacts in the corridor, while the Regional schema looks at all crossings in a specified region.
- **Select Corridor/Region, Scenario, Results Set** toolbar – this toolbar has three buttons, and one of these will always be selected. The toolbar selection determines: a) the options available in the **Object** drop down list, b) the “Create” and “Delete” object links. When selecting one of the options:
  - **Corridor or Region** (“Corridor” will be the first option if “Corridor Model” is selected in the **Select Schema** toolbar. If “Regional Schema” is selected then the first option will be “Region”). – Selecting corridor or region will populate the **Object** drop down list with the Corridors or Regions in the dataset. The “Create” link will display “Create new corridor/region” and the “Delete” link will display “Delete corridor/region”.
  - **Scenario** – Selecting “Scenario” will populate the **Object** drop down list with the scenarios in the dataset. The “Create” link will display “Create new scenario” and the “Delete” link will display “Delete scenario”.
  - **Results Set** – Selecting “Results set” will populate the **Object** drop down list with the results sets in the dataset. The “Create” link will display “Create new results set” and the “Delete” link will display “Delete results set”.
- **Object** drop down list – Select the corridor or region, scenario or results set for your analysis. Use the **Select** button to the right of the drop down list in order to execute your selection.

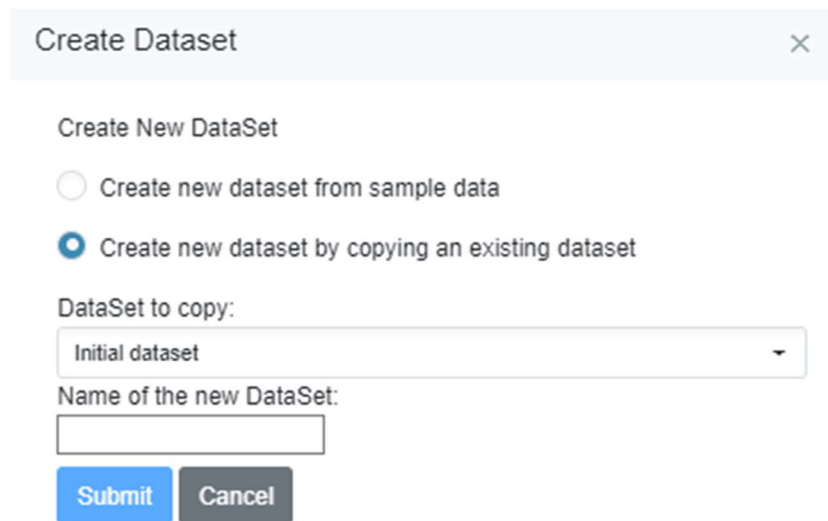
- **Data Collection** data grid (located at the bottom of the **Data Management** page) – After selecting a data collection with the drop down lists above, its defining values will appear in the data grid at the bottom of the page. You can edit some of the values in the table by clicking the “Edit” button. Some values are modified by the program and cannot be manually edited. After clicking the “Edit” button, editable values will show a control (a text box, drop down list, or check box) that can be modified. After making edits, click the “Update” button saves the edits, or click the “Cancel” button to delete the edits you made.
- **Create New Dataset** button - Invoke the dialog for creating a new dataset.
- **Delete Dataset** link – Delete the selected dataset (note that you cannot delete a default dataset – if it is default, then select a different dataset and set it as default (using “Save current selections as defaults” from the **Navigation Menu Submenu**) and then delete the originally selected dataset.
- **Create New Corridor, Region, Scenario or Results Set** button - Invoke the dialog for creating a new data collection (corridor/region, scenario or results set, depending upon which you have selected from the **Select Corridor/Region, Scenario, Results Set** toolbar).
- **Delete Corridor, Region, Scenario or Results** button – Delete the selected data collection (note that you cannot delete a default data collection – if it is default, then select a different data collection and set it as default and then delete the originally selected data collection).
- **More Options Submenu** – from this menu button (on the left side of the page) access the following:
  - Reload defaults – Some of your data collections are designated as “defaults”, which are set as “selected” when you begin your *GradeDec* session. This action restores set your default settings as the current settings.
  - Save current selections as defaults – This action will replace your default settings with the ones that are current.
  - Archive and download dataset – When you archive a dataset, you download a ZIP file to your computer that contains a replica of all the data in your dataset. The archived dataset is for storage and sharing with another user. It is not in a suitable format for offline modification of data. After downloading your dataset you can delete the dataset (if you so choose – see “Delete Dataset Link” above) from the *GradeDec* server database and restore the archived dataset to the server at a later date.

- Restore archived dataset – Select this action to upload and restore an archived dataset to the *GradeDec* server.

---

## New Data Collection (Dataset, Corridor, Region, Scenario, Results) Page

Figure 7 View of New Data Collection Page



Create Dataset

Create New DataSet

Create new dataset from sample data

Create new dataset by copying an existing dataset

DataSet to copy:

Initial dataset

Name of the new DataSet:

Submit Cancel

### Overview

Invoke this dialog from the **Data Management page** and use it to create a new data collection. Each page will request that you specify “Create new data set from sample data” or “Create new data set by copying a data set.” For a new data set, select the first radio button, to copy an existing data set, choose the second button. In both cases, you need to assign a new name to the data collection.

For a new corridor or region, selecting a “new from sample data” corridor or region, creates a placeholder region or corridor that contains no grade crossings. You must add grade crossings afterwards either manually (from the **Crossings** page or by importing data (through “Quick Import” on the **Crossings** page or from the **Import** page).

# 3.1 Crossings Page

Figure 8 View of Crossings Page with the Corridor Model

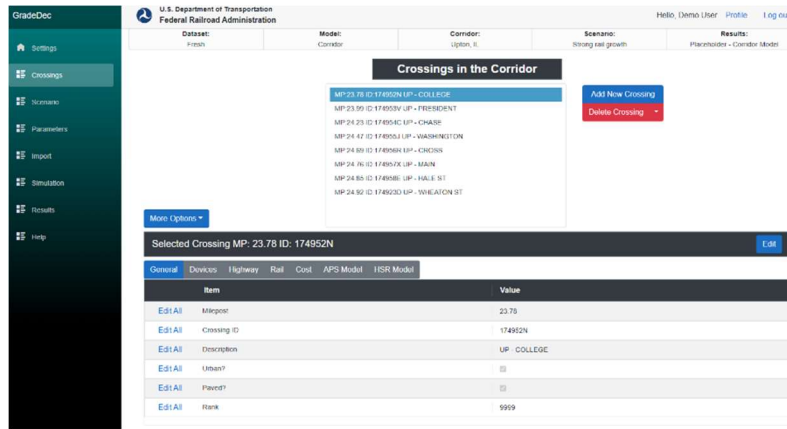
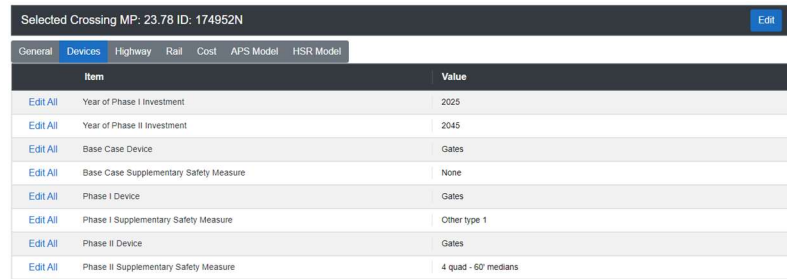


Figure 9 View of Crossings Page, with Corridor Model and Capital Programming, Devices Displayed



## Overview

Use this page in safety or investment analysis to:

- View crossing data.
- Add, modify and delete crossing data.
- Calculate predicted accidents using both the Accident Prediction and Severity Model and the High Speed Rail Model
- Print the crossings reports
- View charts ranking the crossings

The **Crossings** page shows data and permits editing data for the crossing selected in the list at the top of the page. The toolbar in the middle of the page permits selection of the section of data to view for the crossing. For the Corridor Model the toolbar shows the following sections:

- General
- Devices
- Highway

- Rail
- Cost
- APS (Accident Prediction and Severity) Model
- HSR (High Speed Rail) Model

For the Regional Model the toolbar shows the following sections:

- General
- Devices
- Highway
- Rail
- Cost
- APS (Accident Prediction and Severity) Model

Additionally, if the crossing variable (in the Highway section) called “Traffic Management Measure?” is set to “True” then the toolbar will include the following section:

- Highway (Alt.)

The items listed in some of the sections will vary, depending upon whether the user has set “Allow Capital Programming” to “True” for the corridor or region (on the **Data Management page**). Without capital programming, the user is selecting a Base Case and an Alternate Case, with all upgrades implemented in the base year for the alternate case. With capital programming, the user can set the year for implementing the improvement for each crossing. The user can also specify with capital planning two phases of upgrades (i.e., upgrade to gates in year 3 then grade separate the crossing in year 15).

## Features

The Crossings page is divided into two main sections: 1) the crossings selection form (top of the screen), and, 2) the data grid (bottom of the screen). Data entry and modifications to crossing data are entered on the data grid subsequent to clicking the Edit button. You navigate among topics for the crossings by clicking on the buttons in the middle of the page. Note that the Crossings page appears different depending upon whether the “Allow Capital Programming?” setting is set to true. See Figures 8 and 9 above. (You set the setting “Allow Capital Programming?” in the Data Management page by editing the data for the selected corridor).

If set to true, then in the General Information section, there will be data entry drop down lists for two alternatives (Phase I and Phase II) and their respective years for implementation. Also, on the toolbar at the top of the page the user can specify the year for comparing base and alternate



accident risk, which will account for the improvements in the alternate case for the year specified.

Several buttons on the form facilitate updates, calculations and navigation among crossings and are discussed below.

Other features can be accessed from the **Crossings** link in the navigation menu.

### ***The Crossing List Box***

This box displays a list of all the crossings in the corridor or region. You can select a crossing to view and edit by clicking on the crossing (which highlights the crossing in the box).

### ***Add New Crossing Button***

Click this button to create a new crossing with default data.

### ***Delete Crossings Split Button***

Click the “Delete Crossing” button to delete the currently selected crossing. Alternatively, clicking the dropdown arrow on the button displays the “Delete Multiple Crossings” menu option. This opens a dialog which allows you to select multiple crossings for deletion at once.

### ***More Options Dropdown Menu***

Access the More Options Dropdown Menu via the “More Options” dropdown button (on the left side of the page). The following describe the components of the menu.

- Quick Import - This page is invoked from the Navigation Menu Submenu under the Crossings option when the Crossings page is displayed. Use Quick Import to import a small number of crossings to the corridor or region, whose FRA grade crossing ID numbers you already know. Alternatively, the Import List toolbar option can be used to import multiple crossings at once from a CSV file.
- Download crossings to CSV file – This action downloads all crossings in the corridor/region to a CSV file. This file can then be reimported to another dataset/corridor/region via the Quick Import dialog.
- Set default costs (this crossing) - This action will apply the default costs (see the Parameters page) to the selected crossing in the corridor or region.
- Set default costs (all crossings) - This action will apply the default costs (see the Parameters page) to all of the crossings in the corridor or region.
- Generate corridor report - This action generates a report (.PDF file) containing information on accidents and safety in the region

or corridor for each crossing. It contains the predicted annual accidents in the base and alternative cases from trains, highways and both combined. The report contains highway and train characteristics such as the make up of highway traffic and the speed of trains.

- **Generate HSR Report** - This action generates a report (.PDF file) containing information on accidents and safety in the region or corridor for each crossing as produced by the HSR Model. It is similar to the corridor report discussed previously.
- **Generate capital plan report** - This action generates a pdf file (readable with Adobe Acrobat Reader) that shows the year-by-year capital expenditure and the crossing device status for each year of the alternative. This option only appears in the menu if you have checked (set to true) the option "Allow Capital Planning?" on the Data Management page for the corridor or region.

### ***The Data Category Toolbar***

Crossing data are divided into several categories for viewing and modification. The data category toolbar is used to select the data category. Clicking on a button in the toolbar causes the selected data to be shown in the data grid at the bottom of the page. The data categories are explained below.

### ***Crossing Data Grid***

Use the data grid to view and modify crossing data. The following describes the data categories and the features of the data grid.

### **Crossing Data Categories**

- **General Information** - The **Crossings** page contains general information about the crossing, locational factors and its physical characteristics. Using the mouse, click the Edit button and click on the field where you wish to enter data.
- **Devices** - The devices data block includes the base and alternate warning device type and supplementary safety measures for the crossing are the "before" and "after" improvement crossing types, respectively. For "Base Device Type" and "Alternate Device Type", use the drop down lists. If your corridor or region allows capital programming, then you can set a Phase I and a Phase II alternate and you must specify the years of implementation for each.
- **Highway** - The highway data category includes data entry boxes for the number of lanes, AADT and percentages of trucks (and of trucks, percent truck-trailers) and buses. The data category also

includes pull-down menus where the user specifies the time-of-day traffic distribution for auto, truck and bus traffic.

- **Rail** - In the rail data category the user specifies the number of tracks and train speeds. The user specifies the maximum timetable speed at the crossing and the average speeds traveled by trains of different types at the crossing. The regional model requires additional rail-related data inputs.
- **Costs** - The cost data category contains the cost data for the crossing in the base and alternate cases. You can enter the data manually for each crossing, or you can use the default costs by selecting "Set default costs" from the **Crossings** link in the navigation menu. Additionally, you can specify whether you would like to set the default costs to the selected crossing or all of the crossings in the model.

If a crossing device type is set to "Lights and Gates" and a supplementary safety measure is chosen, then the user can specify the costs for the supplementary measure in the appropriate boxes.

- **APS Model** - This data category contains one data entry box for the number of accidents at the crossing in the preceding five-year period (for the Corridor Model) and five boxes for each year (for the Regional Model). The other information on this section of the form is the predicted number of accidents for the crossing and the corridor (calculated based upon the data for the crossing and corridor). Predicted accidents are updated when the user presses the "Recalculate" link. The "Show chart" link provides the user with the "Crossing risk chart page" in a new window. This page has histograms containing the data found in the table found in the **Crossings** page. The rates and predicted accidents are calculated using the US DOT Accident Prediction and Severity Formulas and Resource Allocation Method (see the *GradeDec* Model Reference and Documentation). There are two versions of the APS calculation, indicated by the two options: APS and New APS. These provide the same kinds of predictions, using different statistical models.
- **HSR Model (Corridor Model Only)** - This portion of the data entry form shows the predicted accidents using the High Speed Rail Model. The predicted accidents on this block of the form are updated when the user presses the "Recalculate" link. The "Show chart" link provides the user with the "Crossing risk chart page" in a new window. This page has histograms containing the data found in the table found in the **Crossings** page.

## “Edit, “Update” and “Cancel”

### Buttons

You can modify the data for the selected crossing by clicking the “Edit” button:

**Note: For corridors, changing the milepost value to one that is identical to another crossing will result in the deletion of that other crossing when you click “Update”.**

**Note: For regions, changing the crossing ID value to one that is identical to another crossing will result in the deletion of that other crossing when you click “Update”.**

After entering or modifying the data for a grade crossing, press the “Update” button to save the new data in the crossings database or the “Cancel” button if you do not wish to save the changes made. If you move to another crossing in the item list or exit the **Crossing** page without pressing the “Update” button or the “Calculate Predicted Accidents” button, you will lose any information that you entered since you last pressed “Update”.

**Note: Pressing the "Update" button does not recalculate the predicted accidents and rates based upon new or changed crossing or corridor data. In order to recalculate the rates and save them in the crossing database you must press the "Calculate Predicted Accidents" button.**

## “View All”

On the left side of the data table next to each item is a link that says “View All”. When you click this link a page will pop up that enables you to view and enter data for the item for all crossings in the corridor or region. This page has an “Edit” button that enables editing, and “Update” and “Cancel” buttons for saving and exiting edit mode. The page will display the item for 20 crossings at a time. If your corridor or region has more than 20 crossings, you can view and additional crossings in the corridor or region by using the paging feature in the lower left corner of the “View All” page. When you have finished making edits with this page (don’t forget to click “Update” to save your edits) close this pop up page.

---

## Quick Import Page (invoked from the Crossings Page)

### Overview

This page is invoked from the Navigation Menu Submenu under the Crossings option when the **Crossings** page is displayed. The **Quick Import** page pops up as a separate browser window.

“Quick Import” allows the user to import data quickly from the National Grade Crossing Inventory into your selected corridor or region. In order

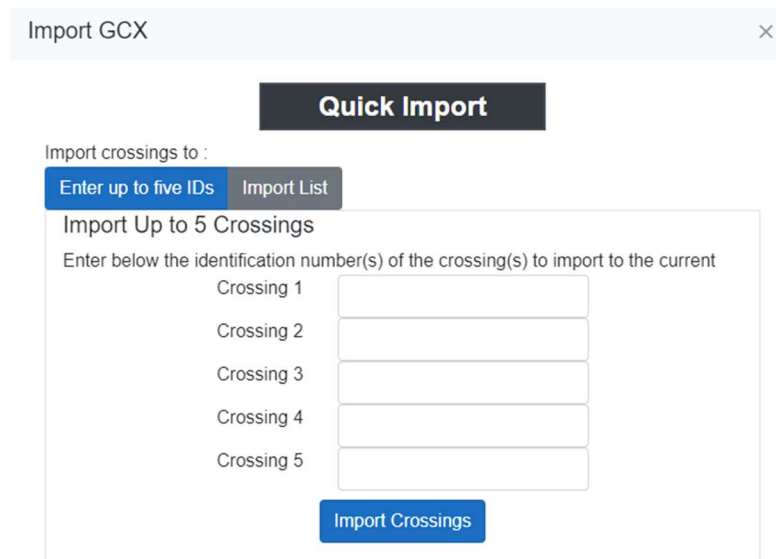
to use “Quick Import” you need to know the FRA IDs of the grade crossings that you seek to import. Unlike the “Import Page”, with “Quick Import” you cannot select crossings by geographic location and you cannot screen the imported crossings according to a number of criteria.

## Features

There are two methods for employing “Quick Import”, one is by entering up to five grade crossing IDs, and the other is importing based on a list that is stored in a text file. You select which of these two methods to use by:

### Option 1 - Enter Up to Five IDs

Figure 10 View of Quick Import Page



The screenshot shows a web interface for importing grade crossings. At the top, there is a light blue header bar with the text "Import GCX" and a close button (X). Below this is a dark grey button labeled "Quick Import". Underneath, the text "Import crossings to :" is followed by two buttons: "Enter up to five IDs" (which is highlighted in blue) and "Import List". Below these buttons is a white box titled "Import Up to 5 Crossings". Inside this box, there is a prompt: "Enter below the identification number(s) of the crossing(s) to import to the current". This is followed by five rows, each labeled "Crossing 1" through "Crossing 5" on the left and an empty text input field on the right. At the bottom of the white box is a blue button labeled "Import Crossings".

Use this option to enter up to five grade crossings. Enter the FRA grade crossing IDs into the boxes. Check the box if you want *GradeDec* to calculate predicted accidents for the imported grade crossings. Click “Import Crossings” after you have entered the information.

## Option 2 - Import List

Figure 11 View of Import List

Import GCX

**Quick Import**

Import crossings to :

Enter up to five IDs **Import List**

**Import Crossings Using a File with a List of IDs**

Prepare a comma separated value (CSV) file that contains a list of Grade Crossing IDs to import from the National Grade Crossing Inventory of Public Highway-Rail Grade Crossings. Along with each crossing ID, the list should specify a rank value.

The file should contain column headers in the first row (Rank and ID) followed by successive rows with the rank and the ID of each crossing to import. The rank value and its column header must be followed immediately by a comma. For instance, the Sample List File on the right shows the contents of a file with five grade crossings to import.

Rank,	ID
1,	003629K
2,	003630E
3,	003635N
4,	003637C
5,	003638J

You can create the CSV file using a text editor like Notepad, or by creating a spreadsheet with your list of crossings and saving it as a CSV file.

Enter below the full path and name of the file with crossing IDs to import:

**Choose** **Import Crossings**

No file selected.

Use this option to import any number of grade crossings for which you know the FRA grade crossing IDs. Prepare a comma separated value (CSV) file that contains a list of grade crossing IDs to import from the National Grade Crossing Inventory of Public Highway-Rail Grade Crossings. Along with each crossing ID, the list should specify a rank value.

The file should contain column headers in the first row (Rank and ID) followed by successive rows with the rank and the ID of each crossing to import. The rank value and its column header must be followed immediately by a comma. For instance, the Sample List File on the right shows the contents of a file with five grade crossings to import.

You can create the CSV file using a text editor like Notepad, or by creating a spreadsheet with your list of crossings and saving it as a CSV file.

Use the “Browse” button to select the CSV file that you have prepared. Click the “Import Crossings” button after you have entered the information.

# 4.1 Import Page

Figure 12 View of Import Page

Import Grade Crossings

Import Options and Criteria

Select State... Go

Select county(ies): View map \* Multiple selections will add whole counties

Go

Select subarea(s) within the selected county:

Go

Selected Areas

Create list of corridors in selected areas

Select corridor(s) in selected areas:

Go

View selected inventory records

Import Crossings Data

Import Grade Crossings

Import Options and Criteria

Options Criteria

Automatically fill crossing default costs?

Automatically select alternative type?

Calculate predicted accidents after import?

Base type	Alternative type
No device	<input type="text" value="Flashing lights"/>
Other stop	<input type="text" value="Flashing lights"/>
Crossbucks	<input type="text" value="Flashing lights"/>
Stop signs	<input type="text" value="Flashing lights"/>
Special procedures	<input type="text" value="Gates"/>
Wigwags, etc.	<input type="text" value="Gates"/>
Flashing lights	<input type="text" value="Gates"/>
Gates	<input type="text" value="New Technology"/>

## Overview

The purpose of this page is to enable the analyst to import data from the National Inventory of Highway-Rail Grade Crossings database into *GradeDec* for analysis. The page lets the user build a query based on geography, identified corridors and grade crossing characteristics. The page also enables the specification of automatic mapping to *GradeDec* fields. The following sections describe the different parts of the page and their functions.

## Features

### ***Importing Data from the National Inventory of Grade Crossings***

When the Import page opens in the browser use the following drop down lists to select the region under consideration:

"Select a State", "Select a County", "Select Area"

Choose the state first and then the county from the respective lists. After selecting the county, you should select an area, which is an area within the county (i.e., "the whole county", a specific city, or "not in any city"). After selecting the area, it will appear in the "Selected Areas" data grid.

### **For Corridor Schema**

After selecting the areas for inclusion, use the item list to select crossings that are identified as being in a specific corridor, using the shift or ctrl keys to make multiple selections. After making this selection, the records from the Grade Crossing Inventory to be imported will be viewable in the data grid at the bottom of the page.

### **For Regional Schema**

After selecting the areas for inclusion the records from the Grade Crossing Inventory to be imported will be viewable in the data grid at the bottom of the page.

Press the "Delete" link in the "Selected Areas" data grid to delete a selected area.

## Criteria

The "Criteria" section allows the user to restrict the crossings to import to those that meet specific criteria. The criteria include: average annual daily traffic, number of trains per day and number of accidents in the previous 5 years.

Note: While *GradeDec* allows you to import records that have no train or highway traffic, be aware that the absence of either at a grade crossing



will cause a computational error in the model (e.g., divide by zero). To avoid this, you should either exclude crossings with no traffic, or enter data manually for these crossings (assuming that this reflects actual conditions at the crossings).

## Import Options

Use this section to determine the automated filling of *GradeDec* fields when importing data. You can specify to use default cost data, or leave cost data blank for manual data entry. The base grade crossing type is the type specified in the National Inventory of Highway-Rail Grade Crossings database. The alternative grade crossing type can be automatically designated using the pull-down menus, or the user can specify that alternative crossing types will be manually entered.

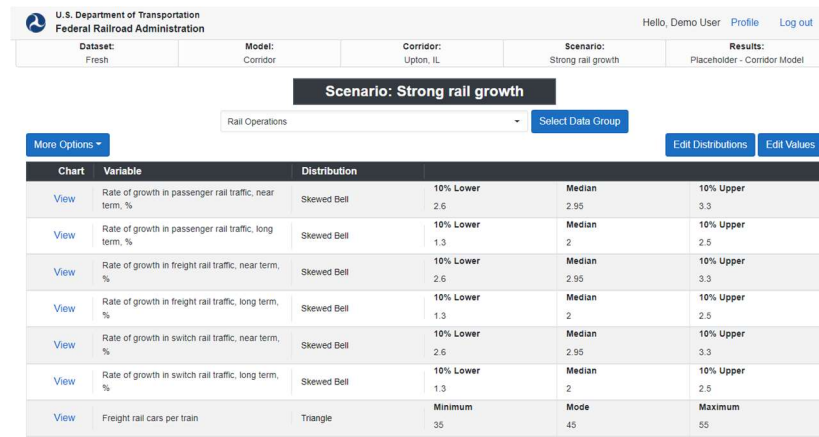
## Import Crossings Data

By clicking on the button “Import Crossings Data”, the selected records are imported to the selected corridor or region, and your browser transfers to the **Crossings** page. The instructions that you specified in the **Import** page for automatic field fill are executed and the new data records are appended to the existing records in the selected region. After importing, predicted accidents are calculated for all crossings as well as a summary for the corridor or region.

If upon importing data a record already exists with the same crossing ID as a newly imported crossing, the existing record in the region is overwritten by the imported data.

## 5.1 Scenario Page

Figure 13 View of Scenario Page



### Overview

The Scenario Input Screen is where you view and edit scenario data for an analysis. Scenario data for a model input variable can be either a fixed value or several values that describe a probability distribution.

Probability distributions are used to derive analysis results with Monte Carlo simulation. For a discussion of simulation see the section “About Simulation” in section “7.1 Simulation Page”.

This page possesses a number of features that let you easily visualize data and quickly develop probability distributions that best reflect available information and judgments on operations, future developments and social costs. These features include:

- Ease of navigation among variables
- Instant viewing of statistics and charts
- Instant validation and saving of ranges

*GradeDec* can store many different scenarios for analysis. Scenario data categories include: rail operations, highways, social costs and price inflation. Scenarios are initially defined and selected in the **Data Management page** (change to the Scenario view clicking the “Scenario” button in the “Viewing in table below the selected” line of the **Data Management page**). Remember that the data in the selected scenario are the data that will be used by the *GradeDec* model to conduct the benefit-cost analysis on the strategies and cases defined elsewhere in the model. If you wish to work with data from another scenario and use that data in the analysis, that scenario must be selected from the **Data Management page** (see section above on the **Scenario page**). You can vary the baseline assumptions for an analysis by creating multiple scenarios (for instance, one each for high, moderate and low traffic growth).

## Features

The **Scenario** page is shown above. The scenario input variables in *GradeDec* are organized into data groups according to a functional classification. The data groups are:

- Rail Operations
- Highway
- Social Costs
- Price Inflation

When you link to the **Scenario** page the Rail Operations sheet is loaded and the first variable in that sheet is selected and shown in the chart and tables. You browse among the different sheets using the drop down list in the upper right-hand corner of the form.

The remainder of this section describes each component of the **Scenario** page and their functions.

## Data Group Pull Down List

Use this drop down list on the left side of the upper toolbar to select the data group to view and edit.

The data groups accessible from the **Scenario** page offer the analyst great flexibility in specifying the present and future travel, cost, and policy environment that will affect a project. The content of the major groups are summarized below. Note that each data group allows the analyst to specify a range of uncertainty around any of the values entered for that group (see the Variable Data Grid below).

- “Rail Operations” and “Highway” data on this page (see Figure 13) interact with other model variables set on the Settings and Crossings pages to determine: the levels of rail and highway traffic; user costs, and benefits.
- “Social costs” data are entered in this **Scenario** page view. Most of the cost items (including discount rate, value of travel time, value of statistical life and injury, etc.) are self-explanatory and are set to default values taken from FRA sources, but can be edited by the user.
- The “Price Inflation” view includes data growth rates for general price inflation by year and growth rates for fuel price inflation by year. A real fuel price index is calculated from the nominal fuel price index divided by the general price index. The real fuel price index is applied to the fuel and oil components of the vehicle operating costs. All other cost and benefit components of the analysis are unaffected by inflation (i.e., future streams are calculated in terms of constant dollars

and relative prices excluding fuel and oil are assumed to remain constant).

## **Generate scenario report (Invoked from the More Options Dropdown Button Menu)**

This feature generates a report in pdf format (readable with Adobe Acrobat) of the **Scenario** page. Use this feature by selecting “Generate scenario report” from the “More Options” dropdown button.

## **Edit Distribution**

This feature allows for the distributions to be changed for each of the variables on the page. The probability distributions and their corresponding input values are described below. For each scenario input variable, you can specify a probability distribution. The choice of probability distribution type and the input values for the distribution determine the probability distribution for the input variable.

For each scenario input variable, you can specify a probability distribution. The input values and the choice of probability distribution type determine the probability distribution for the input variable.

After clicking “Edit” the types of probability distributions that appear in a drop down list and from which you can choose are:

- **Fixed Value (single input value required)** - When you choose fixed value, there is no distribution and the variable assumes a single, fixed value in a simulation. For a fixed value, no statistics are shown and only the middle percentile box is enabled for data entry. No chart is shown for a fixed value.
- **Skewed Bell (three input values required – 10, 50 and 90 percentiles)** - The skewed bell distribution is derived from three points: the 10% lower value, the 50% value (or, median) and the 10% upper value. For non-skewed input values (e.g., the distances between the median and the lower and upper values are equal) the distribution is normal. This distribution is useful when the exact form of the distribution is not known yet good estimates on the median and boundary values are available.
- **Normal (two input values required – mean and standard deviation)** - Use this distribution type when you have data indicating the variable is non-skewed and normally distributed.
- **Uniform (two input values required – maximum and minimum)** - With the uniform distribution every point on an interval is equally likely. Minimum and maximum input values are required for this distribution.

- **Triangle (three input values required – maximum, minimum and mode)** - All values for this distribution lie between the minimum and the maximum and its density function forms a triangle with its peak at the mode. Use this distribution when the variable and data indicate firm bounds on the maximum and minimum values and a most likely value.

When editing the distributions the page displays the “Update” and “Cancel” buttons, which are used to save or discard the edits you have made to the variable distributions.

## Edit Values

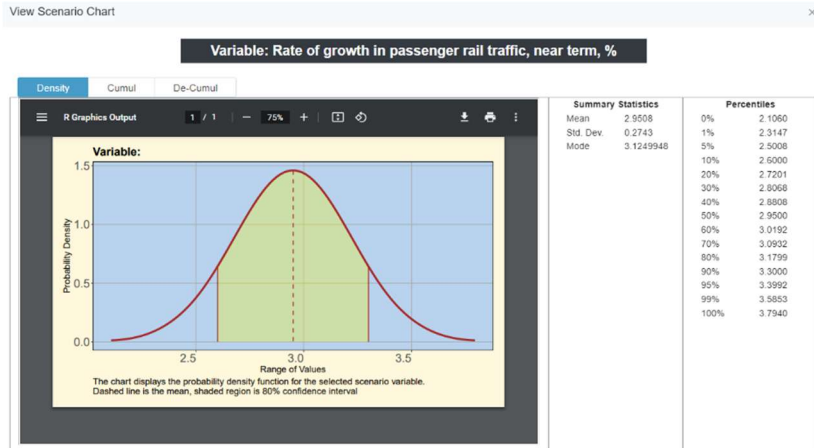
This feature allows you to edit the values that define the probability distribution for the variable. For each distribution type (including “Fixed Value”) there will be either one, two or three values that define the distribution. When editing values there will be headings and text boxes that correspond to the distribution for each variable (see [Table 5](#)). When editing the values the page displays the “Update” and “Cancel” buttons, which are used to save or discard the edits you have made to the variable distributions.

**Table 5 Probability Distributions and their Displays on the Scenario Page**

<b>Probability Distribution</b>	<b>First Value</b>	<b>Second Value</b>	<b>Third Value</b>
Fixed Value	Fixed value		
Uniform	Minimum value	Maximum value	
Skewed Bell	10 <sup>th</sup> percentile	50 <sup>th</sup> percentile	90 <sup>th</sup> percentile
Normal	Mean	Standard Deviation	
Triangle	Minimum value	Mode	Maximum value

# Scenario Input Variable Chart

Figure 14 View of Scenario Input Variable Chart



## Overview

Clicking on “View” for a variable on the **Scenario** page will cause the scenario input variable chart to pop up, showing a chart and data for the selected variable. The page contains a chart, a summary statistics table, a percentiles table and option buttons for selecting alternative chart types.

For a fixed value, the chart will display the message “No Chart for Fixed Value” and the tables will reflect the information for the single, fixed value.

There are three chart types and each shows a shaded region that represents the 80% confidence interval. A dotted red line marks the mean value of the distribution.

The x-axis on all the charts ranges between the values whose probabilities are 0.1 and 99.9 percent, respectively. The different chart types are selected using the option buttons below the chart (click “Refresh” after making a selection).

## Features

### *Density/Cumul/De-Cumul* option buttons

The selected option determines which of the three chart formats:

- Probability density
- Cumulative probability
- De-cumulative probability

are displayed for the selected variable (see the Glossary for definitions).

## Summary statistics tables

The summary statistics frame displays the mean, mode, and standard deviation of the distribution. See the glossary for the definitions.

## Percentiles

The percentiles frame displays the percentiles of the input distribution. A percentile indicates the probability that the value of the input variable would fall below the given value of the x-axis. For instance, in Figure 17, the chance that the sampled input value of “the rate of growth in passenger traffic, near term, %”, would fall below 3.3 is 90 percent, given the distribution specified by the users.

---

## 6.1 Parameters Page

Figure 15 View of Parameters Page

U.S. Department of Transportation  
Federal Railroad Administration

Hello, Demo User [Profile](#) [Log out](#)

Dataset: Fresh	Model: Corridor	Corridor: Upton, IL	Scenario: Strong rail growth	Results: Placeholder - Corridor Model
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### Model Parameters, Traffic Distributions, and Other Data

More Options ▾ [Model Parameters](#) [Other Data](#)

[Vehicle Emissions](#) [Fuel Burn Rates](#) [Eff. Rates Devices](#) [Eff. Rate Supp. Measures](#) [High Speed Rail](#)

#### Vehicle Emissions Rates

(grams of emissions per minute of idling) [Restore Defaults](#)

Vehicle Type	VOC	CO	NOx	PM	SOx	CO2	
Cars	0.0447166 <b>0.04471666</b>	1.1870834 <b>1.1870834</b>	0.0585833 <b>0.05858333</b>	0 <b>0</b>	0 <b>0</b>	41.06524 <b>41.06524</b>	<a href="#">Edit</a>
Buses	0.10825 <b>0.10825</b>	2.531666 <b>2.531666</b>	0.0888333 <b>0.0888333</b>	0 <b>0</b>	0 <b>0</b>	87.57894 <b>87.57894</b>	<a href="#">Edit</a>
Trucks	0.0575833 <b>0.05758333</b>	0.4271333 <b>0.4271333</b>	0.5627166 <b>0.56271666</b>	0.0382666 <b>0.03826666</b>	6.99372E-05 <b>6.99372E-05</b>	107.41070 <b>107.410706</b>	<a href="#">Edit</a>

\*Values in red are Federal Railroad Administration default values that indicate national averages

## Overview

The **Parameters** page is where you can view and modify model parameters and other data values in *GradeDec*. Parameters include:

- Vehicle emission coefficients;
- Fuel and oil burn coefficients
- Effectiveness rates, and,
- High-speed rail model coefficients

Other data include:

- Traffic time-of-day distributions
- Default costs of grade crossing devices


- Default costs of supplementary safety devices

See the *GradeDec Model Reference* for additional explanations.

The page enables the user to access model parameters other data values for reference and for editing, if necessary. In most applications it is unlikely that you will wish to modify the emission and fuel burn coefficients. You may wish to modify or add to the time-of-day traffic distributions if localized information is available that better characterizes these distributions. There may well be local guidance on grade crossing operating and maintenance costs and these should be modified as needed.

## 7.1 Simulation Page

Figure 16 View of Simulation Page



U.S. Department of Transportation  
Federal Railroad Administration

Hello, Demo User [Profile](#) [Log out](#)

Dataset: Fresh	Model: Corridor	Corridor: Upton, IL	Scenario: Strong rail growth	Results: Placeholder - Corridor Model
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**Simulation**

Run Simulation

Item	Value
Number of trials (3 to 9999)	10
Random Seed	1
Sampling Method	Latin Hypercube
Run central values only?	<input type="checkbox"/>
Run risk sensitivity analysis?	<input type="checkbox"/>
Safety Model?	<input type="radio"/> APS <input checked="" type="radio"/> New APS <input type="radio"/> HSR
Discount carbon dioxide at 3 percent?	<input type="checkbox"/>
Reallocate traffic if grade separated?	<input checked="" type="checkbox"/>

### Overview

Use the **Simulation** page to set the simulation parameters and begin a simulation. You should browse to this page only when you are ready to conduct a simulation, that is, after having made all required modifications to data, and after having selected the corridor (or region), scenario and results file.

In the data grid, note that the items “Reallocate traffic if grade separated?” and “HSR” option of the “Safety Model?” appear only with the corridor model and not with the regional model.

You also have the option of selecting the results that will be reported upon completion of the simulation page.



## Features

The **Simulation** page is used to run a simulation. Use the page to set the simulation parameters and initiate the simulation. The simulation parameters are discussed below.

### **About Simulation**

*GradeDec* uses simulation, or risk analysis, to generate result forecasts. By specifying probability distributions for scenario inputs, the user quantifies their variability and uncertainty. The impact of this uncertainty on the outcomes, as reflected in the *GradeDec* analytic model, is quantified using simulation.

With simulation, rather than solving the model once using "best guess" values for inputs, *GradeDec* solves the model for many independent trials. In each trial, a random sample is taken from the distribution of each scenario input. Each trial produces an outcome (i.e., a set of values for the result variables) that is as likely to be achieved as any other. By applying statistical analysis to a set of outcomes, *GradeDec* derives descriptive statistics for each result variable. Thus, for instance, *GradeDec* will tell us not only that "the answer is 50", but also that "with 90% probability the answer lies between 30 and 75". As opposed to point estimates or sensitivity analysis (where one variable is arbitrarily varied), risk analysis supports better decisions by explicitly reporting the probability distributions of the results.

Also see the section "Why *GradeDec*?" in the Introduction.

### **Data Grid Items**

The following describes the items found in the table of the **Simulation** page. Click the "Edit" button to make the appropriate modifications to the existing values.

#### **"Run central values only"**

Check this box to run your model using only the central values. The reported results will be point values without probability ranges. When this box is checked, the trials box and random seed box are disabled. Choosing this option will result in a minimum run time and is useful when analyzing large corridors or regions.

#### **"Discount carbon dioxide at 3 percent?"**

Selecting this option will discount carbon dioxide emissions savings using a three percent discount rate. All other benefit and cost components in your analysis will be discounted (regardless of whether this feature is selected) using the discount rate that you set in the Scenario Page (under the Social Costs section). This feature allows for future year benefits from

carbon dioxide emissions reduction to be valued more highly than if using a higher discount rate. Higher discount rates cause outyear flows to diminish more rapidly than with a lower rate.

## **”Number of Trials”**

Enter the number of trials for the simulation. The number of trials is the number of times that the program will sample from the scenario input distributions, solve the model and generate results. More trials will yield more stable results and will take more time to run. While a number of factors will determine the minimum number of trials needed to achieve stable results, 500 trials will almost always be adequate. You must use at least 3 trials to run a simulation.

**Recommended Practice:** To save time, when testing your data and assumptions, use a small number of trials (50 or less). When you are satisfied that there will be no more changes to the data, run a simulation with a large number of trials to arrive at your final result.

**Expert Option:** The user can select Latin Hypercube, the default, as the simulation method, or, alternately, the user can select the regular Monte Carlo method for simulation via the “Sampling Method” item. Latin Hypercube is a stratified sampling method and will usually converge to the true result distribution with fewer trials than the Monte Carlo method. If you wish to know more on this subject, a good technical reference is "Latin Hypercube sampling (A Program Users Guide)", by R.L. Iman J.M. Davenport and D.K. Zeigler, Technical Report SAND79-1473, Sandia Laboratories, Albuquerque (1980)

## **“Sampling Method”**

See “Expert Method” in the description for “Number of Trials”.

## **“Random Seed”**

The random seed determines the sequence of pseudo-random numbers that are generated by the simulation engine. Any positive integer value will generate a unique sequence of pseudo-random numbers for the simulation. Two simulations with identical data, number of trials and random seed will generate identical results.

Changing the random seed is an expert option. You may want to change the random seed to test the effects of the randomness of the sampling on the result distributions.

## **“Run Risk Sensitivity**

### **Analysis?”**

The risk sensitivity analysis, which is executed after the simulation, runs the *GradeDec* model with all the input variables except one set to their

mean values. The exception input variable is set to its 10 percent lower value and the model is solved. This input variable is then set to its 10 percent upper value and the model is solved again. This process is repeated for all input variables. The results of the sensitivity analysis are displayed in the tornado chart, which is invoked from the **Results** page.

By leaving this box unchecked, and thus the value false, your results file will not contain values for the tornado chart. **When there are numerous grade crossings in a region or corridor, the risk sensitivity analysis can greatly increase the time required to run a simulation.** You may prefer to sacrifice the risk sensitivity analysis in favor of shorter run times by not checking the box.

### **"Reallocate Traffic If Grade Separated?"**

This item appears on the Simulation page only when using the corridor model. In the *GradeDec* corridor model, there is an algorithm that re-assigns highway traffic from the adjacent grade crossings to an improved crossing with grade separation. This box is checked by default making its value true and by removing the check you choose to run your simulation without the re-assignment of traffic.

### **"Safety Model?"**

This item has three options in the Corridor Model and only two in the Regional Model. If "HSR" is selected, then the simulation uses the HSR model algorithms to calculate the safety improvements (i.e., risk reduction) at the crossings. Otherwise, it uses one of the two available Accident Prediction and Severity models. The *GradeDec* Model Reference and Documentation presents a fuller description of the models and their modes of usage.

# 8.1 Results Page

Figure 17 View of Results Page

	Variable	Mean Value	Standard Deviation
<a href="#">View</a>	Safety benefits, thous \$ PV (+)	19999	161.364
<a href="#">No View</a>	Travel time savings, thous \$ PV (+)	0	0
<a href="#">No View</a>	Environmental benefits, thous \$ PV (+)	0	0
<a href="#">No View</a>	Veh operating cost benefit, thous \$ PV (+)	0	0
<a href="#">No View</a>	Network benefits, thous \$ PV (+)	0	0
<a href="#">View</a>	Benefits from induced trips, thous \$ PV (+)	10.8699	1.10537
<a href="#">View</a>	Disbenefits from induced trips, thous \$ PV (+)	-7.95695	1.63549
<a href="#">No View</a>	Investment salvage value, thous \$ PV (+)	49.2082	0
<a href="#">View</a>	Total benefits, thous \$ PV (=)	20051.1	162.59
<a href="#">No View</a>	Total costs, thous \$ PV (-)	1113.17	0
<a href="#">View</a>	Net benefits, thous \$ PV (=)	18938	162.59
<a href="#">View</a>	Benefit-cost ratio	18.0127	0.14606
<a href="#">No View</a>	Rate of return (constant dollars), %	99.999	0
<a href="#">View</a>	Local benefits (not included in summary), thous \$ PV	996.943	287.453

## Overview

The results of a simulation are viewed in the **Results** page. When you browse to the page it displays the benefit and benefit-cost summary result group with the associated variables.

When a simulation completes, the browser automatically redirects to this page.

The purpose of this page is to navigate, view and print results and their associated tables and graphics.

## Features

### Navigating the Results

You navigate among the results by selecting the result variable group with the drop down list in the upper left-hand corner of the screen. After selecting the result variable group, use the up and down buttons in the toolbar to find the variable of interest. Alternatively, you can scroll or point-and-click to the variable of interest in the results data grid at the bottom of the page.

The results categories are:

- Benefits and Benefit-Cost Summary

- Benefits by Crossing – Safety
- Benefits by Crossing – Travel Time Savings
- Benefits by Crossing – Environmental (emissions reduction)
- Benefits by Crossing – Vehicle Operating Cost Savings
- Total Benefits by Crossing
- Total Costs by Crossing
- Intermediate Safety Results
- Intermediate Non-Safety Results
- Salvage value by crossing
- Maximum queue length, first year, by crossing
- Maximum queue length, last year near term, by crossing
- Maximum queue length, last year, by crossing

The summary shows the results of the analysis for the analysis period in thousands of present value dollars for all crossings. The intermediate safety results show the reduction in predicted accidents by accident type category (fatal, injury, property damage only) for the selected years (first, last year near term and last). The intermediated non-safety results show the reduction in delay and fuel consumption in each of the selected years. The other result categories show metrics for each crossing. The maximum queue length results show the maximum vehicle queue at the crossing for the base case device in the selected year.

### **“View” link**

In the data grid at the bottom of the **Results Page**, next to each results variable is a “View” link. If you click the “View” link, a new browser window pops up with the “View results table and chart” page, which displays: a chart with options, a statistical summary, and a percentiles table for the selected results variable. The “View results table and chart” page is described in the following section.

### **“Show Summary Chart” link**

This link is found near the top of the **Results** page. Clicking this link pops up a new browser window with the “Benefit-costs chart page”. This page displays charts on the benefits, costs and ranking of the crossings by benefit. See the section titled “Benefit-costs chart page” for more details.

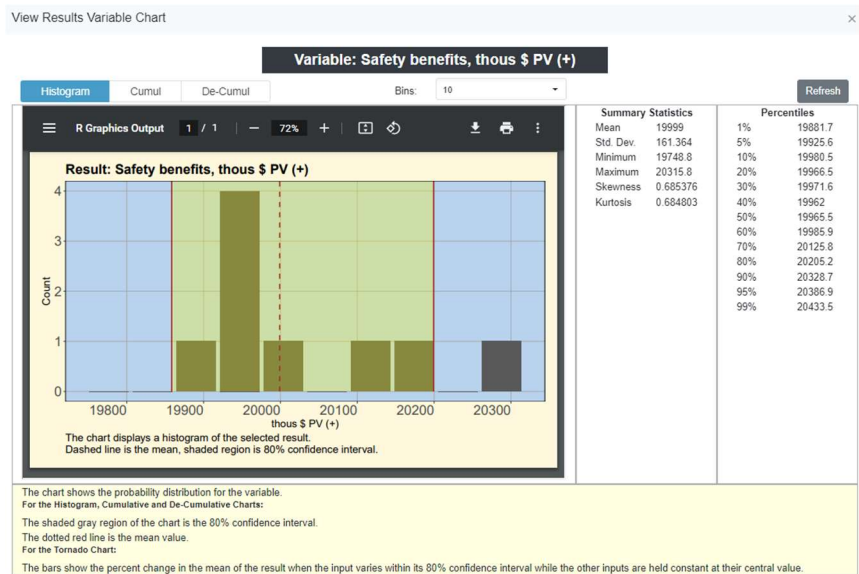
### **More Options Menu Button**

Access the “More Options” menu from the “More Options” menu button (on the left side of the page). The following describe the components of the menu.

- Generate results report - This action generates a report (.PDF file) containing all of the information that is accessible from the results page. The results report shows the summary statistics and percentiles for every result variable.

## View results table and chart

Figure 18 View of Results Variable Chart



## Overview

Clicking on “View” for an item in the data grid on the **Results** page will cause the “View results chart and table” dialog to open. The page contains a chart, a summary statistics table, a percentiles table and option buttons for selecting alternative chart types.

For a fixed value, the chart will display the message “No Chart for Fixed Value Result” and the tables will reflect the information for the single, fixed value.

There are three probability distribution chart types and each shows a shaded region that represents the 80% confidence interval. A dotted red line marks the mean value of the distribution. A fourth chart type is the tornado chart, which is displayable only if the user selected the “Run risk sensitivity analysis” option from the **Simulation** page.

The x-axis on all the charts ranges between the minimum and maximum values of the simulation trials. The different chart types are selected using the option buttons above the chart. To change the number of bins the data is sorted into, select the desired option in the dropdown menu and click “Refresh.”

## Features

### Histogram/Cumul/De-Cumul/Tornado option buttons

The selected option determines which of the three chart formats to display:

- Histogram;
- Cumulative probability;
- De-cumulative probability; or,
- Tornado (option available only if the risk sensitivity option was selected when you ran the simulation)

#### Histogram, Cumulative probability chart and De-cumulative probability chart

When you browse to this page a histogram chart of the first result variable is displayed with its values distributed into 20 probability bins. You can modify the granularity of the histogram by changing the number of bins using the “Bins” box in the toolbar.

Choose the “De-cumul” option button to view the de-cumulative probability chart. This chart shows the full range of values for the selected result and the probability of exceeding each value in its range.

The cumulative probability chart is displayed when you press the "Cumulative" option button on the form.

Click the “Refresh” button after making selections.

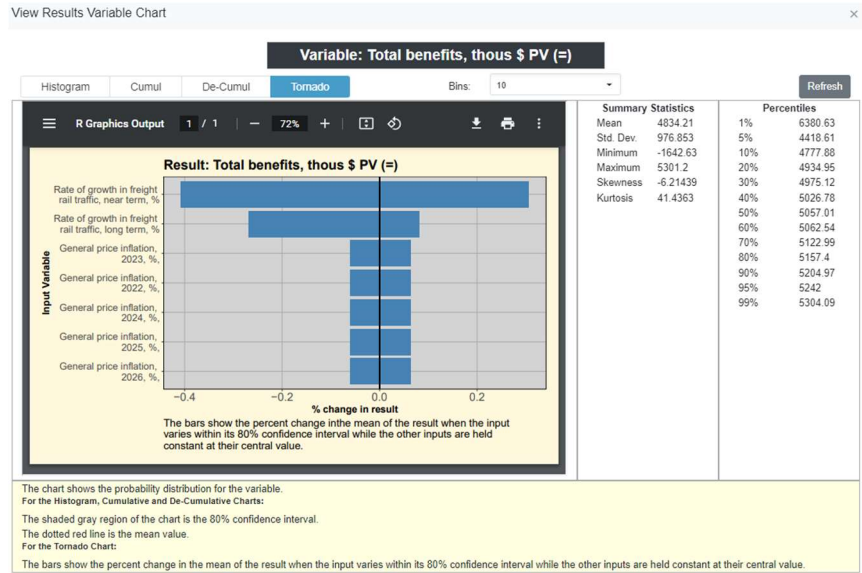
#### Tornado chart

An input variable contributes to risk by means of: a) its own variance, and, b) its structural role in the *GradeDec* model. For instance, an input variable with large variance may not be a significant contributor to the risk of a result while an input variable with small variance may cause the result to be very uncertain and risky. Without the analysis of risk sensitivity it is not easy to determine which factors are the significant contributors to the riskiness of a particular result.

The tornado chart shows the impact of each random variable input factor when all the other input factors are set to their mean values and the single input factor is allowed to vary within its 80% confidence interval. The tornado chart displays in order the ten input variables that are the major contributors to the risk of a result.

This analysis of sensitivity can guide the analyst to focus on refining the estimates on the range of input variables that truly matter, and help decisions makers plan for mitigating risks.

**Figure 19 A Tornado Chart**

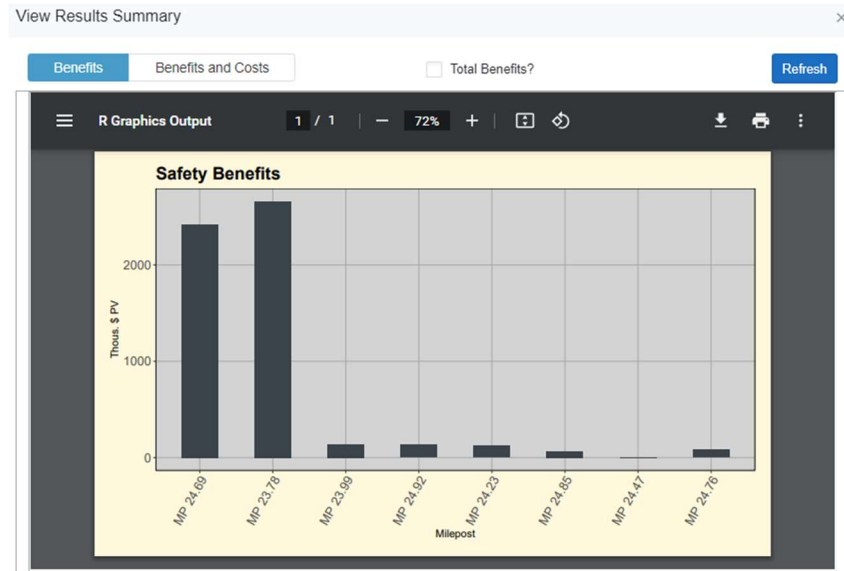


## Number of Bins

Select the number of bins for the histogram chart. You may choose a value between 10 and 50. Click the “Refresh” button after making a selection.

## Benefit-Cost Charts

**Figure 20 View of Benefits and Costs Summary Chart**





## Overview

The Benefit-cost chart opens in a dialog by clicking the “Show summary chart” button near the top of the **Results** page.

This page contains several charts that illustrate the benefits, costs and the rankings of the crossings by benefits. The user can choose to rank crossings either by safety benefits only or total benefits.

The charts on this page are designed to support resource allocation decisions. The charts illustrate the relative magnitude of benefits, how the ranked crossings compare with one another and the cumulative benefits from crossing improvements.

One chart also compares the ranked benefits by crossing with the costs by crossing. This view of the benefits and costs assists users to quickly identify high yield improvements and to develop improvement programs accordingly.

# Glossary of Terms

## **Bins**

The range for a simulation result variable, that is, the values bounded by its minimum and maximum values, is divided into equal portions called bins. The result value from each trial "falls" into one of these bins. Charting the result value's range on the horizontal axis and the probability of a result value falling in the bins yields the histogram chart.

## **Cumulative Probability**

### **Distribution**

A cumulative probability distribution is constructed by cumulating the frequency of the probability density function. A cumulative probability distribution is an "upwardly sloping" curve, where each point on the curve gives the probability that the variable will be equal to or less than the value on the x-axis. The y-axis of the cumulative probability distribution ranges between 0 and 1. The cumulative probability distribution equals zero for a variable's minimum value and rises to 1 at a variable's maximum value.

## **De-Cumulative Probability**

### **Distribution**

A de-cumulative probability distribution is constructed by subtracting (or de-cumulating) a variable's probability frequency starting with a probability of 1. A de-cumulative probability distribution is a "downward sloping" curve, where the curve gives the probability of the variable exceeding the value along the X-axis. The de-cumulative probability is 1 for a variable's minimum value and is 0 for its maximum value (i.e., the y-axis ranges between 1 and 0).

## **Deterministic**

The term deterministic indicates that there is no uncertainty associated with a given value, variable or model. Models that include random variables are called stochastic.

## Histogram

A histogram shows the frequency of a discrete random variable and is used to display the frequency distribution of Monte Carlo simulation result variables. In a histogram, the result values are gathered in bins and the height of the bars correspond to the frequency with which values fall in the respective bins.

## Kurtosis

Kurtosis is a statistical measure of a distribution's peakedness. Flatter distributions (with thin tails) are called platykurtic and peaked distributions (with fat tails) are called leptokurtic. The formula for kurtosis is:

$$\left( \frac{n(n+1)}{(n-1)(n-2)(n-3)} \frac{\sum_i (x_i - \bar{x})^4}{s^4} \right) - \frac{3(n-1)^2}{(n-2)(n-3)}$$

where  $\bar{x}$  is the mean of the observations,  $s$  is the standard deviation and  $n$  is the number of observations.

## Latin Hypercube

Latin Hypercube is an alternative statistical sampling method to the Monte Carlo method. This is a stratified sampling method, which means that the range for each input variable is divided into strata and one random sample is taken from each stratum. This method ensures faster convergence to the result distribution than with the Monte Carlo sampling method.

## Lower 10% Value

The lower 10% value is the 10th percentile value and is the lower limit of an 80% confidence interval as input by the user.

## Mean Value

The mean value for a collection of observations of a random variable is its expected value and equals the sum of the observations divided by the number of observations. For skewed distributions, the mean value is off the median value and is located in the direction of the distribution's skew.

## Median Value

The median value is the 50th percentile: there is equal probability that the value for a random variable will lie above or below the median.

## **Mode**

The mode of a probability distribution is the value for which the probability density function is at a maximum. The value has the highest probability (and is sometimes called "the most likely value", not to be confused with the mean or expected value).

## **Monte Carlo**

Monte Carlo is the method of sampling from random variables by taking a random number on the 0-1 interval, call it  $a$ , and finding the value of the random variable whose cumulative probability equals  $a$ . Repeated Monte Carlo sampling on a number of random variables that are inputs to a model and repeatedly solving the model to arrive at probability distributions for the result variables is called Monte Carlo simulation.

## **Probability**

Probability is the likelihood of the occurrence of a value or event.

## **Probability Density Function**

Same as probability distribution.

## **Probability Distribution**

A probability distribution or probability density function shows a continuous random variable's frequency of occurrence over its range.

## **Random seed**

The random seed is a number that initializes the generation of random numbers used in a Monte Carlo simulation. For the same random seed and the same number of trials given no change in the model or inputs, the results of two Monte Carlo simulations will be identical.

## **Risk**

The term refers to uncertainty in a forecast outcome. Colloquially, risk is often associated with undesirable or downside outcomes (as in "hedging against risk"). In a risk analysis, risk is reflected in the probability distributions of result variables.

## **Risk Analysis**

Risk analysis is a term applied to several methods for quantifying uncertainty in forecasts. The risk analysis method used in GradeDec 2000 is called Monte Carlo simulation.

## Simulation

Simulation is a numeric method for finding solutions to analytically complex problems by "simulating" repeated, real world occurrences.

## Skewness

Skewness is a measure of the asymmetry of a distribution. The probability density function of a skewed distribution has a longer tail on its skewed side. A right skewed distribution has skewness greater than 0 and a left skewed distribution has skewness less than 0. The formula for skewness is:

$$\frac{n}{(n-1)(n-2)} \frac{\sum_i (x_i - \bar{x})^3}{s^3}$$

where  $\bar{x}$  is the mean of the observations, s is the standard deviation and n is the number of observations.

## Standard deviation

The standard deviation, which is the square root of the variance, is the principal descriptive statistic after the mean value. Knowing only a distribution's mean value and standard deviation, an upper bound can be found on the probability of any value in a variable's range. The standard deviation reported for the results is the sample standard deviation, given by the formula:

$$\sqrt{\frac{n \sum x^2 - (\sum x)^2}{n(n-1)}}$$

where n is the number of trials.

## Trial

A trial is one solution of a model in a simulation. A simulation consists of many trials. In each trial, every input variable is populated with a data value sampled from the variable's probability distribution.

## Upper 10% Value

The upper 10% value is the 90th percentile of a probability distribution and the upper limit of an 80% confidence interval.

## Variable

A variable is a model element that can assume more than one value. A fixed-value input variable can assume only one value. A random variable can assume a range of values according to its probability distribution.

## Variance

The variance is a measure of the dispersion of values in a probability distribution, and is a measure of risk. The variance is the average of the squared deviations about the mean. The variance gives disproportionate weight to "outliers," values that are far away from the mean. The variance is the square of the standard deviation.

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