Road Condition Reporting System (RCRS)

Version 008.000.xxx

Technical Design Document

May 10, 2011

Document Revision Information

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1.0	05/10/2011	Bob Wagner	Initial Draft
1.1	06/17/2011	J Brawn	Review, edits, and comments
1.2	06/23/2011	Bob Wagner	Edits

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1.0 Introduction

1.1 Purpose

This document provides detailed information to support the design, implementation, and maintenance of PennDOT's Road Condition Reporting System (RCRS). Specifically, this document describes the infrastructure, security, programming, and administrative perspectives of the system. This document serves as a guide for the design/development team. The Bureau of Planning and Research (BPR) will also use this document for system administration support. Lastly, BPR will use this document as a reference point for future maintenance and enhancement coding.

A set of release notes has been created for this release and can be found on the RCRS website under About RCRS. Click on the version number to review these notes.

1.2 Roles & Responsibilities

The Process Owner (PO) and Point of Contact (POC) are the Bureau of Highway Safety and Traffic Engineering (BHSTE), specifically Mike Pack. He is the PennDOT Project Manager for RCRS.

BHSTE's role in this project is to serve as PENNDOT's Process Owner and also to facilitate training of users and drive interest in the system with internal administrative and general users of the Commonwealth. They are responsible for the validity of the data as well as the application usage practice.

BHSTE in coordination with BPR is responsible for the maintenance and upkeep of the system, making sure it is running and accessible, as well as changes to the system in regard to bug fixes and enhancements. BPR and BHSTE's PennDOT and contract staff will serve as the developers of the application and also as the system administrators for the web and database servers being used by RCRS.

1.3 Relationship to Other Plans

The RCRS Technical Design document has the following associated documents. The documents include:

- *Requirements Document*
- *Database Design – see the Data Dictionary application for the database information*
- *Prior Release Design Documentation*

- *Testing Plan*

- *Testing Plan – Regression Testing*

- *Test Plan - Automated Regression Testing Plan*

1.4 Methodology

BPR has developed and adopted an Application Development Life Cycle which enforces a standard method for gathering and capturing requirements, designing and coding an application, and deployment of an application. This standard has been used to develop RCRS since its inception in 2006.

RCRS is built using Microsoft's Visual Studio 2008, .NET 3.5 Framework, Oracle 10g Release 2 along with Oracle Spatial, Crystal Reports 2008, and Intergraph's WebMap. The architecture of RCRS is built upon BPR's Common Components (C^2) framework which follows BPR Application Development Standards and BSCoE Coding Standards.

The mapping engine is a web service based architecture that is at the heart of C^2. This shared set of services provides a robust interface to the mapping software and standard implementation of common code libraries.

1.5 Policy

This original application is the result of a Management Directive from Highway Administration for reporting road closures. Please see the RCRS Process Owner for more detailed information regarding this directive. This directive has no bearing on the construction or layout of this site, just that it exists.

Direction and needs for this site's functionality and use are provided by upper management of PennDOT, feedback from the user community, and on the need for better user experience, usability, and efficiency. The main direction of the release was based on actions and shortcomings found during daily use, along with new business needs identified by BHSTE during requirements gathering. The PA 511 system is a key stakeholder in the data set captured and utilized in this application and this designation for the PA 511 system enables this other business unit to determine what data it RCRS needs to capture and provide.

2.0 Design Overview

PennDOT is responsible for managing road closure and event information, winter road condition information, and overall situation awareness for state owned and maintained roads across the Commonwealth. This section describes the background of the use of the system and the design methods used to meet all the requirements enumerated by the Process Owner.

2.1 Background

Road closure and winter road condition data is sensitive to both time and accuracy. RCRS tracks the various attributes of event and condition data and reports it to PennDOT personnel via email, text message, web interface, feeds to PA 511, and new external users, as needed.

This major release of RCRS focuses on the main operation and data maintainability of event and condition data controlled by PennDOT. Functionality was added to designate and define the major road network (511 Network) within RCRS, provide analysis reports, and overall better reporting of data and collection.

The goal of RCRS is to provide an accurate source of information for state road closures and road conditions. Executive PennDOT management has identified the development of this system to be a top priority for BHSTE and Bureau of Maintenance and Operations (BOMO). RCRS is a collaborative effort between BPR, BHSTE, BOMO, the Press Office, the Engineering Districts, and the County Offices.

2.2 Impact on PennDOT Infrastructure

The RCRS application requires the use of the Internet Explorer web browser and Adobe's SVG Viewer for the mapping component. Since it is an Intranet-only application, the assumption is that users will be viewing the application in Internet Explorer. If a user does not have the SVG viewer installed, a link will be provided to download the plug-in. Furthermore, internal users can always call the Help Desk or the Bureau of Planning and Research for assistance.

2.3 Technology Forecast

The C^2 framework may need to be updated if GeoMedia WebMap is upgraded to Version 6.2 or 7.0 which replaces SVG with Flash. Adobe discontinued support of the SVG Viewer on January 1, 2009. Adobe does

not currently have plans to remove the SVG Viewer from their download area and it cannot be hosted on PennDOT public Internet sites. Although mentioned here, this work is considered outside the scope of this application.

Some more issues and technology forecast information can be found in the Emergency Contingency document.

2.4   Constraints

There are no constraints defined for this release's development of the application and the upgrades being performed. The only identifiable constraint may be, in the future, if a new function would need to be added to the map that is not present in the mapping web service (i.e. exporting to an ESRI Shapefile). If new functionality, as mentioned, would need to be added to the mapping web service, this would cause other applications to be changed or be redeployed. This entire process would have to be coordinated with the BPR development team, as the web service is utilized across business units within and without PennDOT.

3.0 System Architecture

This section describes the system and/or subsystem(s) architecture for the project.

3.1 Performance Requirements

RCRS does not have any formally defined time requirements for processing. The two identified issues with the application when it comes to speed of processing are: 1) map generating time, and 2) report generation.

The map time is determined and influenced by the processing on the server at the time of the request, the amount of data being loaded in the map, and also the area of the map or scale being requested and drawn. Although no formal requirements have been defined, maps that are drawn and rendered with 15 seconds are seen as acceptable.

The report generation is dependent on the amount or timeframe of data being processed and served up. The current data reports are quick. The issue comes in with the historical or analysis reports that are handling past data. Constraints have been added to these reports to limit the timeframe the user can request, but this is still not enough. The solution would be to archive data and remove it from the "live" tables. The reporting engine would then need to be overhauled to accommodate this.

3.2 Environment

RCRS is an Intranet-only application and will be developed using the BPR GIS development environment on the development team PCs. The testing environment is the BPR GIS Intranet system test web server, located at the PennDOT Server Farm. The production environment is the BPR Intranet production web server, located at the PennDOT Server Farm as well. Each application environment will interact with a corresponding database server (GISZ, ORAXT, or ORAW) maintained by BPR.

The external XML data feeds to outside vendors are on the Internet. The test feeds and testing harnesses are on the PennDOT System Test Internet web server located in the PennDOT Server Farm. The production feeds and test harnesses are located on the PennDOT Production clustered web server environment hosted at the PennDOT Server Farm.

3.3 Workstations

3.3.1 Hardware Requirements

RCRS does not have any specific hardware requirements for the workstations. The PennDOT Standard Build for a workstation is all that is necessary.

3.3.2 Software Requirements

The following are the required software installs needed for this application to operate on client machines:

- Internet Explorer version 8.0
- Adobe Acrobat Reader 6.0+
- Adobe SVG Viewer version 3.0+

3.3.3 Network Requirements

RCRS is built on the assumption that users have a high speed network connection. All of the requirements for this system are based on the availability of a high speed network connection for execution and map delivery.

3.3.4 Settings

RCRS is built to start with a set screen size, but the window is resizable. The minimum screen size for the application is 1024 x 768 pixels. If set any smaller than that, the application will not be able to be viewed correctly and efficiently. There are some custom settings to Internet Explorer outside of the default settings for this application to function properly. The required changes to the settings are listed below:

Browser Setting	Where to set…	Set to…
Text Size	View menu Text Size	Medium
Check for newer versions of stored pages:	Tools menu Internet Options… General tab Temporary Internet files Settings	Every visit to the page
Underline links	Tools menu Internet Options… Advanced tab Browsing:	Always
Use Smooth Scrolling	Tools menu Internet Options… Advanced tab Browsing:	Checked
Show pictures	Tools menu Internet Options… Advanced tab Multimedia:	Checked

Figure 1: Browser settings

The RCRS Users' Manual contains the steps and browser settings needed to run RCRS correctly.

4.0 System Design

4.1 Programming Approach

RCRS is built using Microsoft's Visual Studio 2008, .NET 3.5 Framework, Oracle 10g Release 2 along with Oracle Spatial, Crystal Reports 2008, and Intergraph's WebMap. The architecture of RCRS is built upon BPR's Common Components (C^2) framework which follows BPR Application Development Standards and BSCoE Coding Standards. The UI of RCRS also employs JavaScript for the client side processing, HTML, CSS. The GIS Mapping Web Service (PennDOTBPRWS), Geocoding Web Service, and the common code library are all contained with the C^2 framework which will be used for data access, error handing and mapping.

4.2 System Databases

The GIS Data Dictionary application is the main source of detailed database information and provides descriptions of each object.

The sections below only list new objects added for this release in the RCRS schema. Refer to the Data Dictionary for information on the remaining objects in the schema.

4.2.1 Data/Grants

The data resides in the Oracle database controlled and housed by BPR. Each instance of the application (development vs. system test vs. production) has its own database instance in Oracle (GISZ, ORAXT, or ORAW). The application has grants to access other tables/views that reside in other schemas.

RCRS has one main schema (RCRS) that houses all of the data used and updated by the application. There are two other support schemas used by the XML data feeds to outside vendors who display RCRS data on their sites (PA 511, RIMIS, and WebEOC). These schemas are RCRS511 and RCRS_FEEDS.

4.2.2 Users/Schemas

The user/schema named RCRS_ARCHIVE has been added to the Oracle database to support the new external archiving scheme. There is a new Oracle job that runs on the first of the month that calls the procedure ARCHIVE_OLD_DATA. This procedure copies the data that is older than

one month from the day the job runs to exact table structures in the RCRS_ARCHIVE schema. This schema holds old data that frees up space and storage in the live system. The only exception to the one month rule is for COUNTY MODES which only archive the previous year. One year's worth of data remains in the live database. The other tables defined in the ARCHIVE_OLD_DATA procedure keep only a month in the live system.

4.2.3   Stored Procedures, Functions and Triggers

The application uses various Oracle packages to retrieve, update, and manipulate data from the RCRS schema.

The RCRS is a heavy read/write application that relies on database triggers to complete the data processing performed by the web application. These processes use Oracle triggers to maintain certain columns.

4.2.4   User Privileges

The RCRS application uses only one database connection string which logs into the RCRS schema for the RCRS web application.

The user has the right to Read, Update, and Delete from all tables; Read on all views; and Execute on all packages within the RCRS schema.

Additional grants and privileges are laid out in the Data section.

The external web services have their own login and users that connect to Oracle to retrieve data. These connections (RCRS511 and RCRS_FEEDS) have SELECT only grants into the RCRS user/schema.

4.2.5   Database Scripts

All scripts used to generate the database and alter it for each version that has been deployed are located in the **webcode** repository under the corresponding version number. These scripts are used to prepare the schemas and objects in the data for that release/deployment.

\\bprmatrix\webcode\RCRS

4.3 System Database Processes & Uploads

There are several support tables and materialized views that need refreshed each week or nightly to support the RCRS application. These objects are updated by scheduled Oracle jobs that run each night or after the GIS weekend processing is complete. Below is a list of the refresh jobs:

4.3.1 ITS Device Update

This refresh is a nightly job that runs to add/update the database for the current active devices to the RCRS database schema so that statuses and messages can be captured for those devices within RCRS. The job's name is: ITS_DAILY_UPDATE_JOB.

4.3.2 Base RMS Data Update

This is a weekly refresh of the base materialized views of RMS data in the RCRS schema (i.e. Exits). This data is refreshed and compiled in materialized views after the BPR GIS weekend processing is complete on the Oracle servers. The job's name is: REFRESH_BASE_DATA_MV_JOB.

4.3.3 Road Network Data Update

This refresh is a weekly task that runs after the BPR GIS weekend processing on the Oracle servers and it refreshes all of the RMS data for the defined roadway network sections in RCRS. This ensures that all of the exit names, intersection names, etc. are up to date for the roadway sections on a weekly basis. The job's name is: REFRESH_ROAD_NETWORK_DATA_JOB.

4.3.4 Check for Overdue Events

This job runs every 5 minutes and checks for overdue events in the database and sends emails out to users based on the Chains of Command defined within the application. The job's name is: CHECK_OVERDUE_CLOSURES_JOB.

4.3.5 Check for Overdue Winter Conditions

This job runs every 5 minutes and checks for overdue winter conditions in the database and sends emails out to users based on the Winter Chains of Command defined within the application. The job's name is: CHECK_OVERDUE_CONDITIONS_JOB.

4.4 System Components

The following components are used in the construction and operation of the RCRS web application.

- Database server
    - Oracle 10g
- Web Server
    - IIS 6.0
    - WebMap Cache directory must be set to have the ASP.NET and NETWORK SERVICE user able to write to that virtual directory for map production.
    - The Reporting folder in the Administration folder of the RCRS website must be set to have the ASP.NET and NETWORK SERVICE user able to write that directory for report generation.
- Client Web Browser
    - Microsoft Internet Explorer 8.0

4.5 Code and Object Sharing

- PennDOTBPR .NET Common Components Code Library
    - It contains reusable .NET components for data access, form controls, error handling, etc.
    - Mapping AOI Interface
        - A shared user control used to determine the map zoom level and Area of Interest.
- PennDOTBPR Common Components GIS Mapping Web Service
    - It contains GIS web methods for map creation and map controls. PennDOT BPR GIS Web Service is based on GeoMedia WebMap.
- PennDOTBPR Common Components GeoCoding Web Service
    - It provides web methods for geocoding.
    - Used by area of interest selection on the wizard.
- PennDOT BPR GIS Template

o It contains generic GIS functions, such as map creation, and zoom in/out.

o It's based on PennDOT BPR .NET Framework and GIS Web Services

• Common Calendar Date Picker User Control (oboutSuite 3.5 control)

o User control to pick dates from a calendar in the UI.

4.6 Source Code Control

Microsoft SourceSafe is the source code control used for RCRS. All of the source code used to create the application, database scripts used to create the GISIQ schema, and application documentation is housed in BPR. Below is an image of the hierarchy of RCRS within SourceSafe (located under the WEB folder of the root):
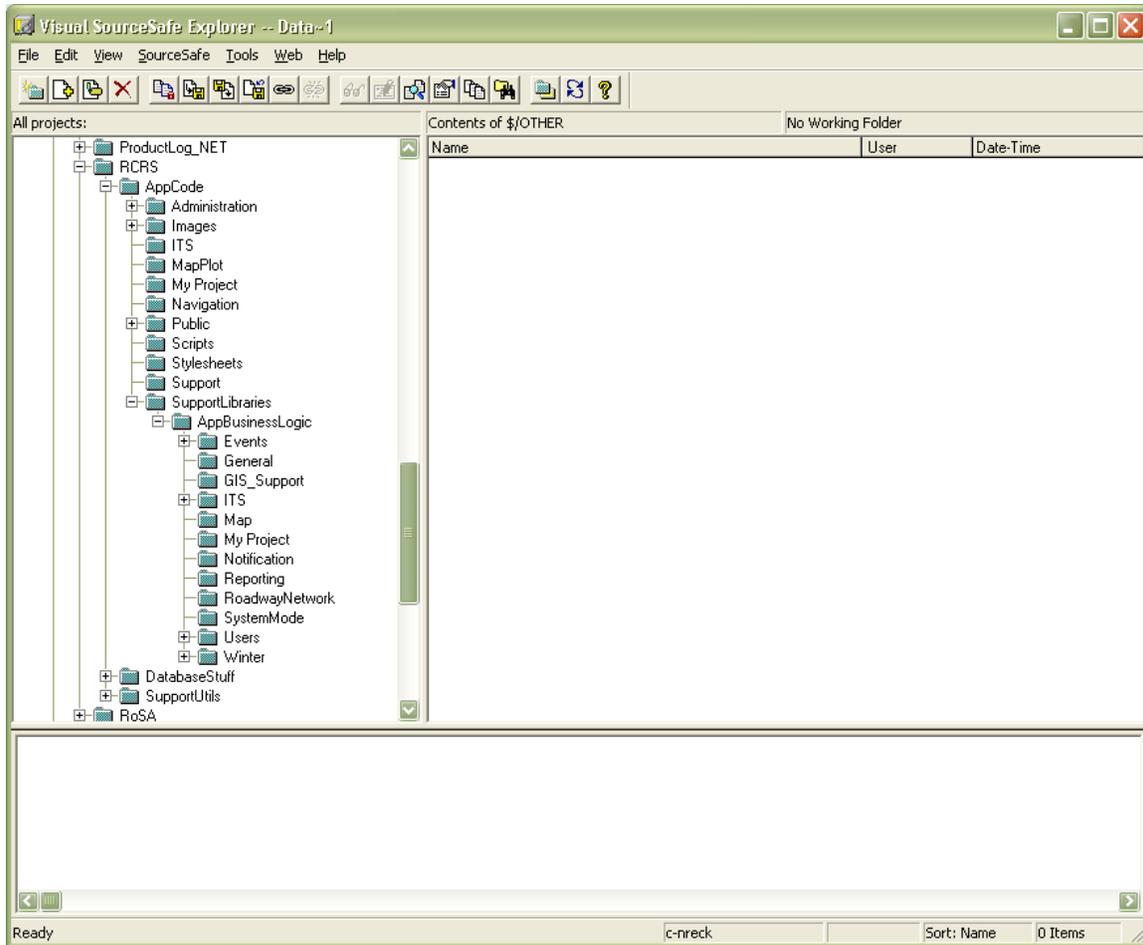
Figure 2: Source Code Control (Visual SourceSafe)

SourceSafe will house the most current version of the application code, even within the development of a release. Labels will be attached within SourceSafe to tag the full release versions of the code in the history.

A separate file server location has been created to house the compiled release code to be migrated to the testing and production environments. Each migration/release is assigned a version number by the developer and/or system admin personnel. This version number is determined by the caliber of the release/changes. This migration code area is used by system administration to migrate code to the test and production environments and also used to rebuild an application on a server in case of a server breakdown or catastrophic event. Below is an example of this code area:
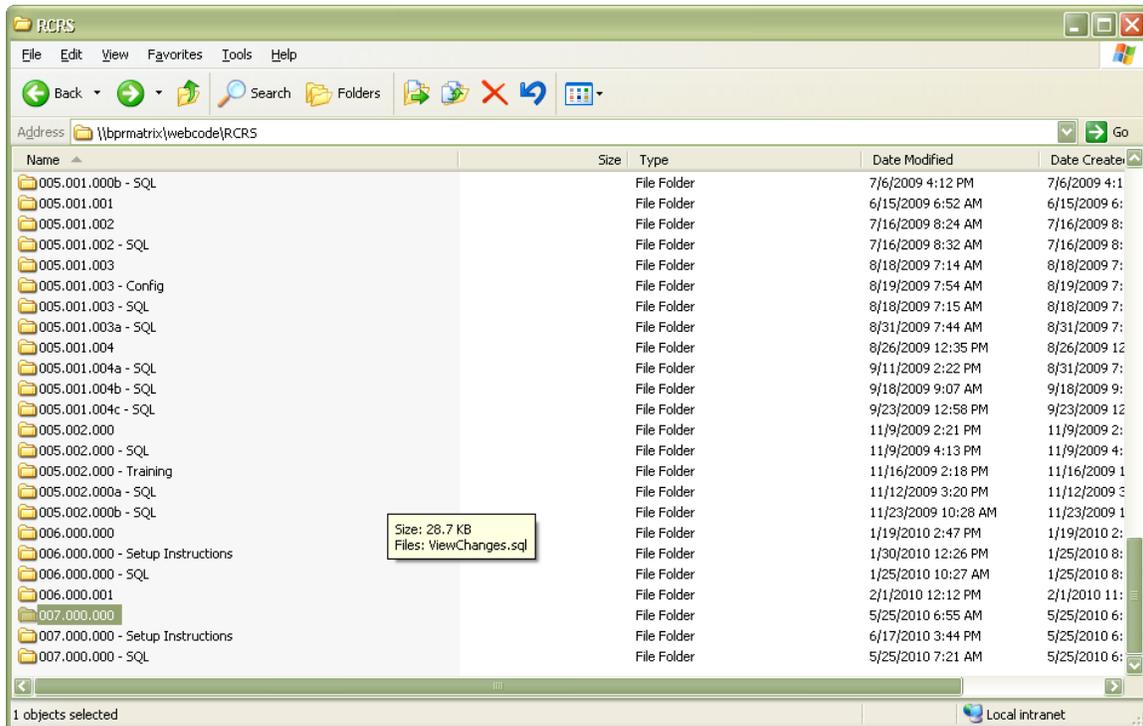
Figure 3: Webcode File Location

4.7   Exception Handling

RCRS has built-in exception handling to catch all unhandled errors generated by the application code. It uses the Exceptions component in PennDOTBPR Framework 1.0 to log all the exceptions. A separate database schema has been created to store the error log of all new applications and the RCRS development team uses this facility to track errors generated by the application. Each error that is not specifically

handled by logic in the application will create a database record in this error log table attaching the date, application, call stack, source, and message. All other errors that occur will be caught by specific error handling in the application and dealt with accordingly either by bypassing it or displaying a message to the user. BPR's Error Log Monitoring System (ELMS) can be used to view these errors.

4.8 Archiving

The RCRS application is a read-write system. Underlying support layers for the thematic maps are updated outside the application by the owner or other responsible party. There is a potential data loss from a service disruption and therefore a daily backup of data is performed on the database level.

There is no data archiving within RCRS itself. All data is stored in "live" tables. An archiving strategy needs to be developed to keep the system running efficiently.

4.9 Use of Tools Outside of Visual Studio.Net

Crystal Reports 2008 was used in creating the reports generated in the application. Database tools (TOAD) were used to administer the RCRS database schema. Corel Draw and Adobe Photoshop were used to create the graphics for the site.

5.0 Administration

Scheduled BPR Oracle jobs and weekly BPR GIS database processing of RMS updates dictate the performance and schedule in the maintenance of RCRS base data. These can be found in the System Database Processes & Uploads section.

RCRS administrators are responsible for the maintenance and accuracy of the data being captured and disseminated by RCRS. If an issue arises with data, they need to report it to the Help Desk or Central Office to be fixed. An example is a missing exit or an incorrect route name.

User accounts are maintained by administrators of the RCRS. The PennDOT Server Farm Help Desk is set up to handle most user account issues. Managers are responsible for adding accounts and making sure the account statuses are up to date (active or inactive).

6.0 Security

6.1 Network Level Security

RCRS requires a custom username and password controlled with the RCRS website and database to access the admin sections of the application. RCRS does not require user name and password authentication to log into the website's public pages (map, text list of current events, etc.). Network security is specifically handled by the network administrator and the default security setting for RCRS is to allow the user to read map, report and export data. Any data that is not open to Intranet users should be removed from the report views.

6.2 Application Level Security

There are 5 levels of users within the RCRS application. These users and their permissions are laid out in the Stakeholders documentation found in the project notebook area for RCRS.

6.3 User Level Security

The user level security information for RCRS is described in the Stakeholders documentation found in the project notebook area for RCRS.

7.0 Recovery

7.1 Backup Measures

As mentioned in Section 4.10 Source Code Control, a separate file system location houses the released version of the application since inception. If the site or server were to have a catastrophic error and need to be rebuilt, the latest version of the application can be pulled from this versioning location. For example, if the application is currently deployed in production as version 003.000.003, then a system administrator who is rebuilding the site would copy the entire site from the 003.000.000 folder to the web server and reset the IIS settings and permissions. The next step would be to copy files from the 003.000.001, 003.000.002, and 003.000.003 folders in that order to the site's folder on the web server. This would place the most up-to-date code on the web server.

7.2 Site Recovery

7.2.1 Natural Disaster

In the event of a natural disaster, there are no special procedures necessary beyond the standard measures in place to recover the application in accordance with policy and guidance.

7.2.2 Disk Drive Crash or Website Crash

In the event of a disk drive crash or a website crash, the standard backup measures would be used to restore the site. The application would be restored from its versioning location. There are no special data recovery instructions that would be necessary to restore the site.

7.3 Database Recovery

In the event that the database schemas used by RCRS would need to be recovered, this task would be performed by BPR's DBA team following their policies and guidelines. Once the latest backup of data was recovered and loaded, the RCRS process owner would need to test the application and verify that all facets are working properly.

The databases are backed up Monday through Saturday.

7.3.1 Natural Disaster

In the event of a natural disaster, BPR does have a reserve database server that houses the most recent weekly backups (3 months worth) that is in an off-site location as part of the COG plan. This server's configuration is also kept in synch with BPR's production Oracle servers.

7.3.2 Disk Drive Crash

In the event of a single disk failure, disk stripping with mirroring is used for performance and redundancy. The database continues to run without that disk. Defunct drives are rebuilt from their mirror images. In the event of a two disk failure, the database is recoverable to the last committed transaction through the use of transaction logs, which are used together with the last backup to provide full data recovery.

8.0 Glossary

This section will define the acronyms and business specific terms related to RCRS.

- BIS – Bureau of Information Services
- BHSTE – Bureau of Highway Safety and Traffic Engineering
- BOMO – Bureau of Maintenance and Operations
- BPR – Bureau of Planning and Research
- CCTV – Closed Circuit Television
- DE – District Engineer
- DMS – Dynamic Message Sign
- HAR – Highway Advisory Radio
- ITR – Information Technology Request
- ITS – Intelligent Transportation Systems
- PMO – Project Management Office
- RCRS – PennDOT's Road Condition Reporting System
- RTMC – Regional Traffic Management Center
- SOP – Standard Operating Procedure
- TCC – Transportation Command Center
- TMC – Traffic Management Center