BullReporter: User Guide

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1. Introduction

**BullReporter** is a Weigh-in-Motion (WIM) data analysis and reporting tool published in an MSI package for easy installation. It is a part of the Bull-Converter/Reporter software stack designed and implemented to resolve WIM data incompatibility issues caused by deployment of multi-vendor WIM systems in state DOTs. This tool has been adopted and used by the Office of Transportation System Management (OTSM), a branch of the Minnesota Department of Transportation (MnDOT) central office.

A brief historical background is first described. BullReporter was one of the tools (packages) developed under a MnDOT sponsored research project entitled, "Development of Data Warehouse and Applications for Continuous Vehicle Class and WIM data." This project was started in 2006 and managed by the Office of Transportation Data & Analysis (TDA, presently part of OTSM), and Dr. Taek M. Kwon at the University of Minnesota, Duluth (UMD) was the principal investigator (PI) of this project and led the project. This project was formulated to resolve the following issue. MnDOT was operating multiple different types of WIM systems manufactured by different companies, which resulted in collecting different types of raw WIM data with completely different formats. Some manufacturers did provide a decent software tool for data analysis and reporting but it did not work for the WIM data produced by other manufacturer's systems. Incompatibility of data and tools is expected from the competitive business point of view, but it became a serious problem when uniform data analyses and reports are needed from all-vendor systems. Therefore, the main objective of the project was to create a single WIM analysis tool that could be used for all types of WIM data, regardless of differences in manufacturers or different models from the same company.

In order to achieve the goal of creating one tool for all WIM data, a three-layered software stack architecture was devised. The main advantage of layered architecture is that each layer can evolve independently of other layers as long as the layer-to-layer interface is clearly defined and conformed. Figure 1 illustrates this three layered software stack referred to as the Bull-Converter/Reporter stack. At the bottom (below the software stacks), WIM hardware systems from different vendors translate signals from sensor-crossing vehicles to raw vehicle records. This hardware typically consists of charge amplifiers, analog-to-digital converters, and a microcomputer. This raw data is captured by the first layer software that continuously runs and accumulates to a raw daily data file which spans from 0th hour to 23rd hour of the day. The format of this data is vendor dependent, and each vendor generally provides this function as part of the WIM system. This raw data files are archived by MnDOT and it is recommended to others due to the following reason. Many diagnostic details are vendor hardware dependent, and an effective way of keeping this information is through archiving these raw data files, because archived raw files can tell the history of how the machine performed. In addition, the raw data files can be later used for extracting more detailed WIM information that was not present in the standard csv files.

The second layer of this stack is the uniform conversion layer, and BullConverter serves this layer which translates the vendor dependent raw daily WIM data files to standard daily csv files. After the raw daily files are converted to the standard csv format.
called Bull-CSV, they are only recognized by site IDs and the differences between vendors no longer exist.

The third layer is the application layer and it is served by the BullReporter which only needs to understand the standard csv files and produces a wide range of analyses reports. Since Layer-3 is an application layer, other types of analysis tools may be integrated such as a query tool based on GIS using the standard csv files or Excel based tools.

With this three-layered software stack, adding a new vendor machine becomes simple. It only requires addition of a new conversion tab in BullConverter. Also, BullReporter can add more reporting functions independently of BullConverter, as reporting needs change over time.

![Diagram of Bull-Reporter/Converter software stack architecture](image)

**Figure 1: Bull-Reporter/Converter software stack architecture**

### 2. Installation and Operation

Installation of BullReporter is simple and easy. Download the latest BullReporter from the following web site and then double click the downloaded MSI file.

http://www.d.umn.edu/~tkwon/Download/mndotDownload.htm
If you have an old version installed on your PC, it should be first removed using the "Add or remove programs" tool from your PC Control Panel and then install the new version. After installation if it does not run, please check and make sure that your PC is installed with .Net Framework 4.0.

BullReporter operation is also simple. If it is the first time use, please set Sites information first using the Site Def tab and the csv site folders according to the file structure described in Section 3. There are three tabs available for generating reports, which are Reports 1, Reports 2, and FHWA Reporting. Reports are generated by first selecting a csv Site Folder, a Report Type, and an Output Format, and then pressing the "Create Report" button.

It should be noted that BullReporter is updated frequently, and it is recommended to check and upgrade to the newest version.

3. Overall Folder Structure

Since WIM data will grow to requiring a large storage, it is recommended to be stored in a shared network drive, first to avoid duplication among users and second to utilize reliability of RAID. This section describes the basic folder structure and filename conventions recommended. The root folder name of your organization WIM data can be any name but inclusion of three letters "WIM" is recommended. Under this root folder, creation of four subfolders are recommended, i.e.,

```
WIM/
  IMAGES
  Processed
  Raw
  Rawcsv
```

An example created at UMD is shown in Figure 2.

---

**Table:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Date modified</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>gsdata</em></td>
<td>2/22/2016 3:25 PM</td>
<td>File folder</td>
</tr>
<tr>
<td>IMAGES</td>
<td>4/27/2016 3:07 AM</td>
<td>File folder</td>
</tr>
<tr>
<td>Processed</td>
<td>5/9/2016 8:11 AM</td>
<td>File folder</td>
</tr>
<tr>
<td>Raw</td>
<td>9/23/2015 8:57 PM</td>
<td>File folder</td>
</tr>
<tr>
<td>Rawcsv</td>
<td>5/9/2016 8:09 AM</td>
<td>File folder</td>
</tr>
</tbody>
</table>

**Figure 2:** An example of WIM root-folder and subfolders.
The "WIM\Raw\" folder houses daily raw data files separated by subfolders with vendor names. An example is shown in Figure 3 created for four different vendors.

Under each vendor folder, site folders are created following the convention "Sitename_###" where ### is the three-digit site ID. An example is shown in Figure 4 screen capture. It should be noted that the site folder name convention as shown in Figure 4 is recommended, but not required.

BullConverter reads in vendor-dependent raw daily files, converts them to standard csv files, and then it saves them in the csv site folder. Under the "WIM\Rawcsv\" folder, vendor folders no longer exist in the "~\Rawcsv" folder and only site folders exist, which is automatically created by BullConverter. It should be noted that use of the folder name "Rawcsv" is not required, and a more meaningful name could be chosen. An example site folder names are shown using a screen capture in Figure 5. The site folder names under the Rawcsv folder must follow the convention "Sitename_###" where ### is a three-digit site ID. This convention is important and required to run BullReporter. For clarity, we call the "Rawcsv" folder as the csv root folder, and the site folders under the csv root folder are called csv site folders.
Each csv site folder contains standard csv files formatted in Bull-CSV format (refer to the BullConverter manual for details) for the corresponding site, and the filename follows the convention:

    yyyymmdd.###.csv

where yyyymmdd is an eight character string representing year, month, and day, and "###" is the three-digit site ID. Figure 6 shows an example of standard csv files under the csv site folder, Site_099. It should be noted that if the site name is not assigned yet, we use the site name "Site" which is the default site-name used by BullConverter and BullReporter.

The "IMAGES" folder stores digital photos of vehicle records. BullReporter provides a function that allows query of vehicle records in which the report includes digital photos of vehicles along with the vehicle record data (see a partial screen capture of a sample report shown in Figure 7). The thumbnail pictures in the report are hyper linked to the
original high resolution photos, and it is linked to the photo in the IMAGES folder. The IMAGES folder is structured using the format.

```
IMAGES\yyyymmdd\####\n```

`yyyymmdd` = date string,
`####` = four digit numeric site ID, and
all digital photos are in jpeg format.

Example: IMAGES\20150501\0032\n
**View Vehicles Report, WIM #032**

Dates: 5/1/2015 - 5/1/2015
Classes: 8,9
GVW Above: 80 kips; Steer Above: 5 kips; Speed Above: 25 mph,
Hour Range: 12-14

![Digital photo application in view vehicles report](image)

**Figure 7: Digital photo application in view vehicles report**

The "WIM\Processed\" folder is optional, and it is intended to store processed data or reports. Presently, the site ID numbers are limited to only three digits, but this limitation is expected to be lifted in the future, and it will be changed to accept any length of numeric number string as a site ID.

**Important note.** Among the folder requirements and name conventions, the absolutely required folder is the "WIM\Rawcsv\" folder, and the site folders under this folder must conform the site folder name convention. All site-folder names should follow the example shown in Figure 5, and csv filenames should follow an example shown in Figure 6. BullReporter requires setting of a csv site folder from which all reports are generated. Before it runs any report, it checks the csv site folder-name and csv-filename conventions and rejects if the folder and file name conventions are not conformed. The rest of file structures are optional but recommended to organize and share the data through a network storage.
4. Vehicle Classification, Settings

BullReporter provides its own vehicle classification based on a classification scheme that user selects. A vehicle classification scheme is specified through a class definition file that defines rules on how each class is determined, and they have a filename extension either “.tye” (English units) or “.tym” (Metric units). These files are text files and located in the AppData folder. This folder is defined in a Windows environment variable, Environment.SpecialFolder.ApplicationData, and the folders in Windows-7 and -10 are located at:

C:\Users\username\AppData\Roaming\Bulldog\BullRreporter

where username is your user name on your PC.

The BullReporter AppData folder contains the basic classification definition files developed by MnDOT, which are min5.tye, min5.tym, min54.tye, and min54.tym. Sample files and folders in the BullReporter AppData folder are shown in Figure 8. These classification definition files can be edited using the rule specified in the documentation:

http://www.d.umn.edu/~tkwon/Download/ClassDefEditGuide.pdf

The AppData folder is hidden by default in the Windows, and the user must make it visible by setting Folder Options to “Show hidden files and folders” to see the contents.

<table>
<thead>
<tr>
<th>Name</th>
<th>Date modified</th>
<th>Type</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log</td>
<td>5/30/2013 2:26 PM</td>
<td>File folder</td>
<td></td>
</tr>
<tr>
<td>Reports</td>
<td>4/3/2016 9:03 PM</td>
<td>File folder</td>
<td></td>
</tr>
<tr>
<td>viewveh</td>
<td>4/10/2016 12:14 PM</td>
<td>File folder</td>
<td></td>
</tr>
<tr>
<td>min5.tye</td>
<td>1/23/2016 5:47 PM</td>
<td>TYE File</td>
<td>11 KB</td>
</tr>
<tr>
<td>min5.tym</td>
<td>1/23/2016 5:47 PM</td>
<td>TYM File</td>
<td>8 KB</td>
</tr>
<tr>
<td>min54.tye</td>
<td>1/23/2016 5:48 PM</td>
<td>TYE File</td>
<td>11 KB</td>
</tr>
<tr>
<td>min54.tym</td>
<td>1/23/2016 5:48 PM</td>
<td>TYM File</td>
<td>8 KB</td>
</tr>
<tr>
<td>Minn56.tym</td>
<td>3/17/2016 12:06 PM</td>
<td>TYM File</td>
<td>8 KB</td>
</tr>
<tr>
<td>Settings.xml</td>
<td>4/12/2016 10:35 PM</td>
<td>XML Document</td>
<td>4 KB</td>
</tr>
</tbody>
</table>

Figure 8: “~\AppData\Roaming\Bulldog\BullReporter\” folder contents

BullReporter also uses a “Settings.xml” file in the AppData folder as shown in Figure 8 to store user settings, which includes settings for directories, parameter values, site information, etc. This is an xml file and can be edited using a text editor such as a Notepad. However, normal users should not edit this file and be left for a system administrator if the user settings must be manually changed. It is mainly used to save user settings that ran last time.
For an administrator or advanced user, the “Settings.xml” file may be used in the following way. When a new versions of BullReporter program is installed, the installer overwrites the Settings.xml file in your computer using the default file in the installation package; consequently, you will lose all of your own settings when you install a new version. If you wish to keep your own settings after installation of a new version, your “Settings.xml” file must be copied to a safe temporary location and then copied back after installation of the new version.

5. Reports 1 Tab

The Reports 1 tab shown in Figure 9 presently includes 34 reporting functions that generate reports using the parameter settings on the multiple group boxes. All parameter settings are assumed to be related as logical AND, which narrows the range of data. The parameters are mostly used to obtain statistics of the selected data between the start and end dates. A reporting function is selected using the drop-down menu labeled "Report Type". User selects an Output Format from one of four choices: Notepad, Excel, PDF, or Graph. The Graph option is not available for some reports.

This user guide does not describe how each report is computed. There will be another documentation that will describe the details on each report type.
6. Reports 2 Tab

Reports 2 tab, shown in Figure 10 includes query functions that pull vehicle records out from csv files based on various limit conditions set. The common set of limit conditions are enclosed in the "Shared Search Conditions" group box and can be placed based on site, time period, lane, GVW, steer axle weight, speed, classes, classification scheme, errors, and warnings. Below the Common Search Conditions group box, there are report specific limit conditions that can be set. Each report specific group box becomes visible when a report type is selected. After all limit conditions are set, pressing the Create Report button generates the desired report. It is important to note that "View Vehicles" reports require IMAGES folder defined in Section 3.

It should be noted that all of the limit conditions are linked as logical AND, i.e., Condition-1 AND Condition-2 AND Condition-3..., etc. For example, setting "GVW Above: 7" and "Steer Above: 5" means that the reporting function will pick only the vehicles that simultaneously satisfy both conditions; that is, GVW is above 7 kips and steer axle weight is also above 5 kips.

Figure 10: Reports 2 tab
7. FHWA Reporting Tab

The 2001 Traffic Monitoring Guide (TMG-2001) issued by FHWA covers volume, vehicle classification, vehicle weights, and station description reports. This tab houses the functions that generate data reports that conform TMG-2001 from the WIM data in Rawcsv site folders. Data can be generated for a single day or a month. Also, there is a single button assigned to generate all three types of FHWA data at once for the selected month and site.

![Figure 11: FHWA reporting tab](image)

8. Final Comments

This user guide was written only to provide minimal information on how to use the BullReporter tool. The details on individual reporting functions and the parameters associated with will be described in another manual. However, most of the reporting functions are self-explanatory, and just trying out and inspecting the report should give users sufficient ideas on how the data was produced.