Web-based Traffic Data Visualization and Analysis Tools

Traffic Data Analytics for WIM and Class Continuous Counts

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16. Abstract

The overarching goal of the Web-Based Traffic Data Visualization and Analysis Tools project is to develop Geographical Information System (GIS) based visualization tools to help State highway agencies to meet their traffic data needs. The initial scope of this project identified the following planning needs as opportunities for development of pilot, web-based traffic data visualization and analytics tools: (1) mechanical empirical pavement design methodologies using axle load spectra; (2) State freight strategic plans; and (3) enhancing the truck size and weight program to efficiently utilize the infrastructure facilities.

The final deliverable of this initial phase of the Pooled Fund Web-based Traffic Data Visualization and Analysis Tools project is a deployed web-based tool suite that automatically generates vehicle volume, classification, and weigh-in-motion (WIM) reports, and accommodates traffic data in the Traffic Monitoring Guide (TMG) data formats, and Highway Performance Monitoring System (HPMS) traffic data attributes. The web-based application generates quality data summaries to meet the needs of transportation planners including: (1) data quality review and control functions; (2) GIS data visualization capabilities and analysis and (3) GIS data output controls.

The tech stack that was identified by the Pooled Fund Project technical panel was an open-source Javascript web-based software. This Javascript tech stack was chosen because of its ability to perform via the web, requires no local install/re-install, has the ability to provide instantaneous analytics and visualizations and its only requirement is a modern web-browser (Explorer 9+, Chrome, Firefox). As such, it was designed to require no executable software. Therefore, there is no executable version of this software. Access to the code, however, is available via Github for anyone at FHWA or any state DOT to download in order to set up the hosting infrastructure. The Github code repository is located here: https://github.com/availabs/tdaReact.git

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1 PREFACE

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2 CONTENTS

3 EXECUTIVE SUMMARY

The University at Albany's Albany Visualization and Informatics Laboratory (AVAIL) on behalf of the Federal Highway Administration, and six state Departments of Transportation (DOTs), including Connecticut, Michigan, North Carolina, Ohio, Pennsylvania and Texas conducted a Pooled-Fund Project, entitled: Web-Based Traffic Data Visualization and Analysis Tools.

The overarching goal of the Web-Based Traffic Data Visualization and Analysis Tools project is to develop Geographical Information System (GIS) based visualization tools to help State highway agencies to meet their traffic data needs. The initial scope of this project identified the following planning needs as opportunities for development of pilot, web-based traffic data visualization and analytics tools: (1) mechanical empirical pavement design methodologies using axle load spectra; (2) State freight strategic plans; and (3) enhancing the truck size and weight program to efficiently utilize the infrastructure facilities.

The final deliverable of this initial phase of the Pooled Fund Web-based Traffic Data Visualization and Analysis Tools project is a deployed web-based tool suite that automatically generates vehicle volume, classification, and weigh-in-motion (WIM) reports, and accommodates traffic data in the Traffic Monitoring Guide (TMG) data formats, and Highway Performance Monitoring System (HPMS) traffic data attributes. The web-based application generates quality data summaries to meet the needs of transportation planners including: (1) data quality review and control functions; (2) GIS data visualization capabilities and analysis and (3) GIS data output controls.

The tech stack that was identified by the Pooled Fund Project technical panel was an open-source Javascript web-based software. This Javascript tech stack was chosen because of its ability to perform via the web, requires no local install/re-install, has the ability to provide instantaneous analytics and visualizations and its only requirement is a modern web-browser (Explorer 9+, Chrome, Firefox). As such, it was designed to require no executable software. Therefore, there is no executable version of this software. Access to the code, however, is available via Github for anyone at FHWA or any state DOT to download in order to set up the hosting infrastructure. The Github code repository is located here: https://github.com/availabs/tdaReact.git

The suite of web-based traffic visualization and analytics tools developed for the initial phase of this project are described in this report. These tools are explicitly designed to be extensible to include emerging national level standardized transportation planning datasets, e.g. the National Performance Measurement Research Dataset (NPMRDS) as they become available for inclusion and new performance measures are defined and deployed nationwide.

4 INTRODUCTION

4.1 PROJECT SCOPE

Transportation planners need an effective data visualization analysis tool that can assure quality traffic data for their transportation program and project development. To meet transportation planning needs, infrastructure (pavement and bridge) preservation needs, and weight enforcement needs, an integrated traffic data analysis tool with both data quality control functions and data visualization capabilities is to be designed for ease of use by all agencies. Fundamentally, the designed tool is to be a user friendly web-based application handling traffic characterization data to generate quality data traffic performance summaries that meet pavement design input, freight analysis, truck weight load trend analysis, bridge load trend analysis and other needs.

4.1.1 Objective

The objective of this work is to develop a web-based user friendly vehicle volume, classification, weigh-in-motion (WIM), and speed traffic data visualization analysis tool; where it accommodates traffic data in the Traffic Monitoring Guide (TMG) data formats, Highway Performance Monitoring System (HPMS) traffic data attributes, and Mechanical-Empirical Pavement Design Guide (AASHTOWare ME) global traffic data loading formats. The resulting product will offer: (1) data quality review and control functions; (2) GIS data visualization capabilities and analysis and (3) GIS data output controls to meet pavement design, freight analysis, and truck weight and load trend analysis, bridge load trend analysis and related truck travel data analysis.

The work involves investigating proven technologies and systems, e.g. “Travel Monitoring Analysis System (TMAS), Vehicle Travel Information System (VTRIS), Environmental Systems Research Institute (ESRI) Mapping, HPMS, Google map and SAS” to design and develop specific requirements that will process and generate quantitative analytical reports using easily assessable visualization output tools.

State Departments of Transportation (DOT), local agencies, universities and private industry may voluntarily contribute advice related to this research as non-paid participants. Periodic reviews will be arranged to keep participating States and agencies up-to-date on current developments.

4.1.2 Deliverables Based On Original Scope

The contractor shall provide a copy of the finished executable software program to the FHWA PC and all participating TA State members of this pooled fund study.

The contractor shall deliver to the FHWA PC and all TA State members contributing funds and participating in this pooled fund study a functional requirement document with methods in which traffic data attributes are processed including all specifications, source codes, etc. related to the all tasks.

The contractor shall validate and verify the system is performing all functions correctly described in the tasks.

The contractor shall provide to the FHWA PC and all TA member States contributing funds and participating in this pooled fund study a copy of all related documented processes and related programming associated with the work.

The contractor shall be available to assist the FHWA PC and all TA member States contributing funds and participating in this pooled fund study with the initial installation if needed.

The contractor shall maintain the system and provide technical assistance to the FHWA PC and all TA member States contributing funds and participating in this pooled fund study for a period of 1 year after the period of performance ends.

4.1.3 Period of Performance

The period of performance for this Transportation Pooled Fund Program (TPFP) contract shall be 18 months. The contactor is to carryout active development for a period of no less than 12 months. The contractor shall maintain the developed system, provide technical assistance to the FHWA's PC and all TA members contributing funds and participating in the study for a period of no less than 1 year after the period of performance ends.

4.1.3.1 Project Timelines

Table 1 Deliverable Timeline Chart from Scope of Work

TASK NUMBER	**DELIVERABLES**
Task 1	Kick-Off Meeting with PC Monthly progress reports, quarterly TA meetings
Task 2	Coordinate TA in-person kick-off forum Draft forum summary report Final forum report
Task 3	Identify Pros and Cons of various related technology. Deliver optimal recommendations Final approved business design document
Task 4	Develop System Requirements Document all processes and requirements
Task 5	Establishing An On-Line User Friendly Data Tool To Generate Appropriate Reports and Outputs Test and evaluation fix bugs verification of Technical support

Table 2 Project Timeline in Gantt Chart Format

Task Num	Task Description	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15	Feb-15	Mar-15	Apr-15	May-15	Jun-15	Jul-15	Aug-15
1	Kickoff Meeting																		
2	TA Panel Forum																		
3	Optimal Recommendations																		
4	System Requirements																		
5-A	Establish Online Data Tool																		
5-B	Test Tool																		

5 METHODS

5.1 SYSTEM REQUIREMENTS

5.1.1 Scope

Based on the Pooled-Fund objective and general project scope, the following scope of work was devised for developing and deploying a Web-based Traffic Data Visualization and Analysis Tool.

The contractor shall design a system that shall incorporate the following:

- Accommodation of various data formats including but not limited to linear referenced data (LRS) TMG weight, class, volume, and speed, AASHTOWare ME standard traffic input tables, bridge, weather and speed probe.
- Data validation process using various quality control techniques including but not limited to TMAS, Long-Term Pavement Performance, and VTRIS.
- Diverse data queries for specific analysis including but not limited to w-tables, truck weight roadway groups and load spectra.
- Export function for data in formats including but not limited to standard software; (i.e. Microsoft Excel, DBF, CSV, TMG, GIS / SHP, LRS, ESRI, Google).
- Data analysis process using proven statistical methods including but not limited to cluster analysis,
- Data linking capability for all roadway attributes and bridges of national significance and capability to associate corresponding data with HPMS LRS, TMAS, VTRIS W-Tables, National Highway System, National Highway Planning Network , land use, weather and current related developmental impacts.
- Graphical display features for all traffic and related attributes using standard universal GIS mapping formats and specifications. (e.g. shapefile or geodatabase for ArcMap) with the appropriate data, data categories, symbology, line weights, colors, etc. to produce a specific graphical representation.
- Recognition of legacy data output for upload into the study product, with option to export results into existing systems.

The first step in the scope of work was to identify pros and cons of various related technology and deliver optimal recommendations in the form of a Business Design Document.

5.2 FINAL APPROVED BUSINESS DESIGN DOCUMENT

5.2.1 Available Data Systems

AVAIL reviewed and assessed all relevant publicly available transportation datasets for their potential uses in developing the Web-Based Analysis Tool.

5.2.1.1 Traffic Monitoring Analysis System (TMAS)

Overview – The Travel Monitoring Analysis System allows states to report data from Continuous Count Station (CCS) to the Federal Highway Administration for use in reporting, to facilitate data sharing across

states, and for creating reports and use in FHWA programs such as Traffic Volume Trends. TMAS performs quality control functions to assess the integrity of its datasets.[1]

Table 3 Data System Qualities, TMAS

Data System: TMAS			
Volume Reports	**Classification Reports**	**Weight Reports**	**Related Data**
State TVT Report	Class by Day by Hour by Site	Weigh Station Characteristics	Automatic Traffic Recorder Data,
Station by Hour	Class by Station with no data in weight columns	Comparison of Weighted vs. Counted	Volume Counts
MADT by Month with AADT by Station/State	Class by Station Monthly by Day	Average Empty, Loaded, and Cargo Weights	Classification Counts
Volume data upload by State and Month	Station multi-year by month	Equivalency Factors	Weigh In Motion (WIM) Data
	Class by HPMS6 vehicle types by State	Gross Vehicle Weights	Station Files
TMAS ANA (analysis) reports such as growth factor, Peak hours and state timeliness.		Overweight Vehicle Report	
		Distribution of Overweight Vehicles. SAWA and ATS (WGT8 and 13 repsetively)	

5.2.2 Highway Performance Monitoring System (HPMS)

Overview – The Highway Performance Monitoring System is a national level highway information system that includes data on the geographic extent, condition, performance, use and operating characteristics of the nation's highways. HPMS offers high quality geospatial data which can be easily entered into a GIS mapping technology.[2]

Table 4 Data System Qualities, HPMS

Data System: Highway Performance Monitoring System (HPMS)
HPMS Road Network Spatial Data
Annual Average Daily Traffic (AADT) Counts for Each segment
Annual Average Daily Truck Traffic (AADTT) Counts

5.2.2.1 Freight Analysis Framework (FAF)

Overview - The Freight Analysis Framework (FAF) integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by seven

[1] U.S. Department of Transportation, Federal Highway Administration, "Traffic Monitoring Guide, 2013" http://www.fhwa.dot.gov/policyinformation/tmguide/tmg_fhwa_pl_13_015.pdf

[2] U.S. Department of Transportation, Federal Highway Administration, "Highway Performance Monitoring System," https://www.fhwa.dot.gov/policyinformation/hpms.cfm

modes of transportation. FAF provides estimates for tonnage, value, and domestic ton-miles by region of origin and destination, commodity type, and mode.[3]

Table 5 Data System Qualities, FAF

Data System: Freight Analysis Framework (FAF)
FAF Road Network Spatial Data
Tonnage by road segment and commodity type
Ton-miles by road segment and commodity type
Dollar value of freight by road segment and commodity type

5.2.2.2 RITA - National Transportation Atlas Database

Overview – The National Transportation Atlas Databases 2013 (NTAD2013) is a set of nationwide geographic databases of transportation facilities, transportation networks, and associated infrastructure. These datasets include spatial information for transportation modal networks and intermodal terminals, as well as the related attribute information for these features. Metadata documentation, as prescribed by the International Organization of Standards, is also provided for each database[4]. When combined with the geospatial assets included within HPMS, a more complete picture of our transportation network can be drawn.

Table 6 Data System Qualities, RITA National Transportation Atlas Database

Data System: RITA National Transportation Atlas Database
U.S. Border Crossings
Intermodal Terminal Facilities
National inventory of navigable inland waterway locks
National Bridge Inventory
U.S. Army Corps of Engineers Ports
Travel Monitoring Analysis System (TMAS)
Freight Analysis Framework Regions
Metropolitan Planning Organizations
Freight Analysis Network
Hazardous Material Routes
Highway Performance Monitoring System
National Highway Planning Network

5.2.2.3 Others – MEPDG, VTRIS

The AASHTO Mechanistic-Empirical Pavement Design Guide (MEPDG) provides the highway community with a state-of-the-practice analysis tool for evaluating pavement structures using mechanistic-empirical

[3] U.S. Department of Transportation, Federal Highway Administration, "Freight Analysis Framework" http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/

[4] U.S. Department of Transportation, Research Innovation Technology Administration, National Transportation Atlas Database, "Liner Notes," http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_atlas_database/2013/liner.html

principles, using project specific traffic, climate, and materials data for estimating damage accumulation over a specified pavement service life. MEPDG is applicable to designs for new, reconstructed, and rehabilitated flexible, rigid, and semi-rigid pavements. Performance and distress predictions models are used to aid the pavement designer in determining the desired pavement section[5]. AVAIL is currently using the MEPDG analysis tool software inputs in the Web-Based Analysis Tool.

Vehicle Travel Information System (VTRIS) validates, facilitates editing, summarizes, and generates reports on vehicle travel characteristics. It also maintains the permanent database of the Station description, Vehicle Classification, and Truck Weight measurements in metric units. It allows repetitive data averaging and report generation with different options without additional source data processing. It allows input of ASCII traffic data as well as import of state-submitted data in internal VTRIS formats. The reports and graphs - final products of VTRIS functionality can be created in both metric and English units[6]. AVAIL is not using VTRIS because it has been superseded by the TMAS program.

5.2.2.4 Emerging Speed Data Source: NPMRDS

The National Performance Measure and Reliability Data Set (NPMRDS), which is provided by the FHWA to all state and local transportation agencies, gives an unprecedented level of data coverage for understanding travel times and congestions on America's road network. The NPMRDS data is available at the TMC (traffic messaging channel) level, meaning road segments generally 1 to 3 miles long, allowing for problem segments along a corridor to be identified at the granular level as opposed to assigning problem segments to larger lengths of highway or whole corridors.

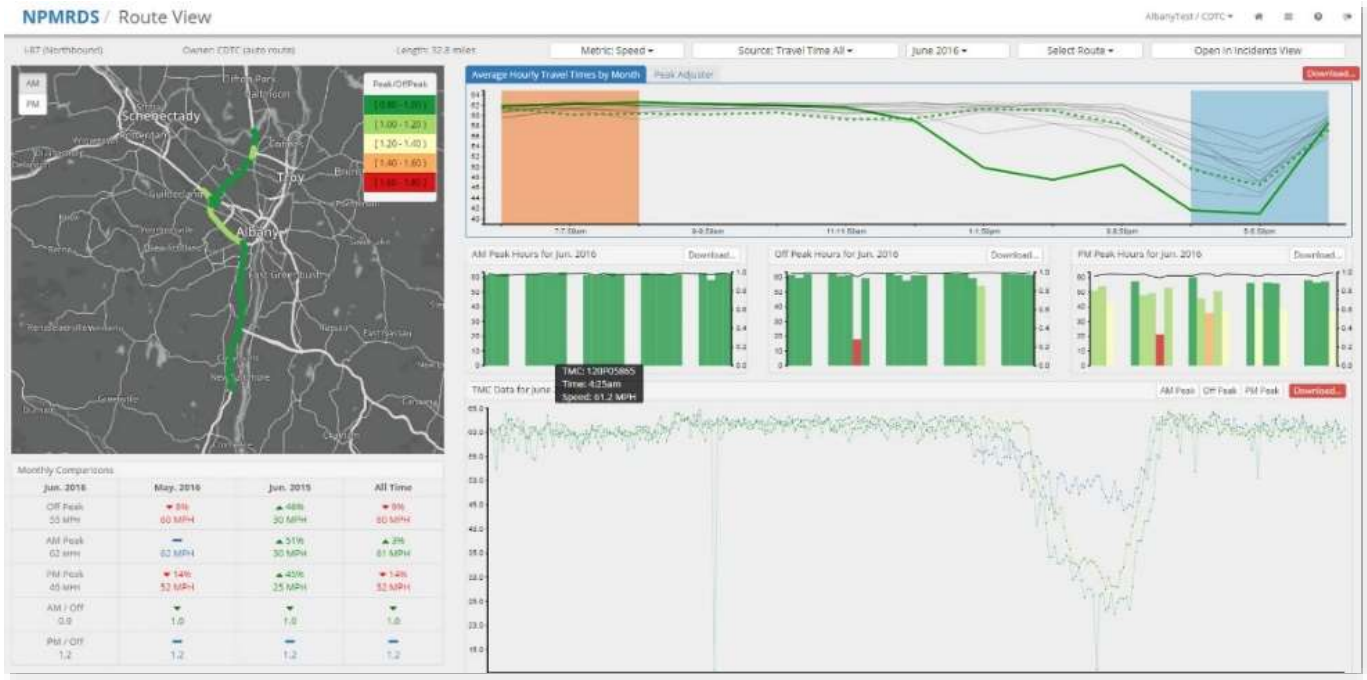


Figure 1: Screenshot from the Congestion and Reliability Performance Measurement Dashboard, Developed by AVAIL for New York State Department of Transportation - Route/Corridor Speed and Congestion Analysis Dashboard.

[5] AASHTO, Mechanistic-Empirical Pavement Design Guide, http://me-design.com/MEDesign/Documents.html#
[6] U.S. Department of Transportation, Federal Highway Administration, "VTRIS User's Guide – Manual," http://www.fhwa.dot.gov/ohim/ohimvtis.cfm

5.2.3 Software Systems

The Web-Based Analysis Tool is comprised of a number of software components integrated into a web portal. The development of such a tool requires scrutinizing software options to determine which is best for organizing and visualizing the available data sets.

The AVAIL team categorized software needs into classes based on function. Organizing data requires *Databases*, Visualization requires *GIS/Mapping* software and *Data Analysis/Visualization* software. The *Web Framework* must be capable of coordinating the database with the GIS/Mapping software and it should be easy to develop, agile, compatible with existing systems and transferrable between web applications.

Finally, the *User Interface* is then designed by a team of web-programmers and designers to optimize device flexibility, multimedia adaptability, advanced language for programmatic element formatting, device responsiveness, system performance, and to emphasize bandwidth and resource efficiency.

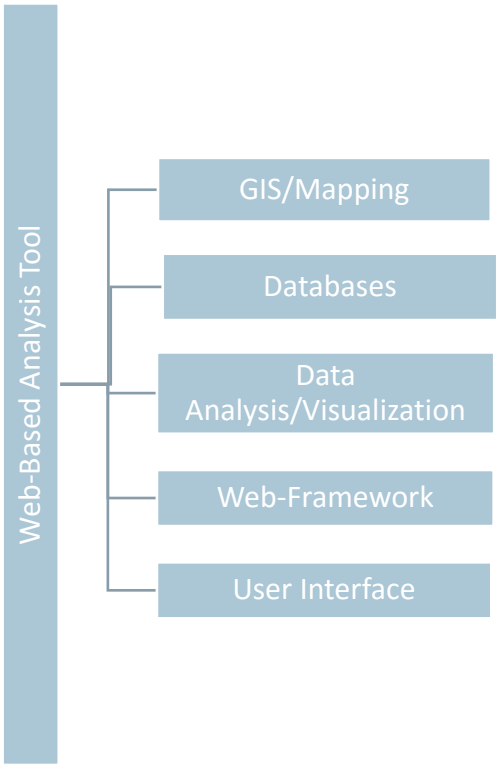


Figure 2 Web-Based Analysis Tool, Software Structure

5.2.4 Software Assessment

AVAIL explored existing data storage and software options to determine which software would maximize performance in a web-based environment for allowing multiple users to simultaneously conduct complex traffic data analyses. Each software item was analyzed for its effectiveness according to an assessment

matrix measuring performance in six areas: Cost, License Type, Documentation, Extensibility/Agility, and Complexity and defined below:

- Cost – the range of costs for acquiring licenses to use software at various scales.
- License Type – the portability and flexibility of the license.
- Documentation – an assessment of the availability of documentation for both use and development of software items. This includes both published and community documentation.
- Extensibility/Agility – Customizability, system design takes future growth into consideration, customizable, speed of development, ease of adaptation, and platform transferability.
- Complexity – How difficult is the software to develop, adapt, and understand.

Table 7 AVAIL Software Assessment Matrix

Software	Cost	License	Documentation	Extensibility / Agility	Complexity	Overall Score
GIS/Mapping						
ArcGIS Online	$2500-$17,500+ per year	Commercial	4	1	1	1
OpenLayers	Free	MIT	2	3	2	3
D3.js	Free	MIT	1	5	3	5
Leaflet	Free	MIT	3	1	5	4
Database						
MySQL	Free	GPL	4	N/A	3	3
PostGIS	Free	GPL	2	N/A	3	4
Apache Hadoop	Free	Apache 2.0	3	N/A	1	1
Google BigQuery	Query Based	Google SLA	3	N/A	5	5
Amazon RedShift	Query Based	Amazon License	3	N/A	3	4
Data Analysis						
D3.js	Free	MIT	2	5	3	5
HighCharts	$600-$3500	Commercial	4	2	4	4
Web Framework						
pHp	Free	GPL	5	3	5	5
Ruby on Rails	Free	MIT	5	4	3	3
Node.js	Free	MIT	5	5	3	3
ASP.Net	Free	Apache 2.0	5	2	4	2
JSP on Tomcat	Free	Apache 2.0	5	1	1	1

Poor	Fair	Good	Very Good	Excellent
1	2	3	4	5

5.2.5 User Interface

AVAIL determined that the User-Interface should be designed using agile programming code and be based on sound principles and best practices:

- HTML 57
  - Core markup language – designed for device flexibility and multimedia
- CSS 38
  - Advanced language for programmatic element formatting
- Responsive Design
  - Focused on optimal design independent of device or platform
- Emphasize bandwidth and resource efficiency
- Easy to use
- Vivid data visualization

5.2.6 Optimal System Recommendations

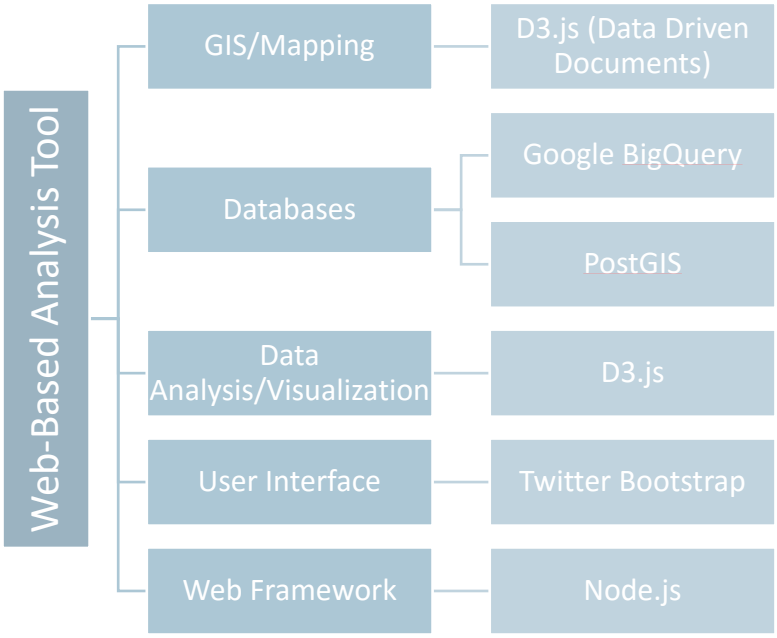


Figure 3 Web-Based Analysis Tool, Software by Function

5.2.7 GIS Systems, Data Analyses, and Visualization Systems

AVAIL recommends using D3.js to serve two Web-Based Analysis Tool functions. D3js has dynamic qualities not found in any other software:

[7] World Wide Web Consortium, "HTML5," http://www.w3.org/TR/html5/
[8] World Wide Web Consortium, "CSS3," http://www.w3.org/TR/2001/WD-css3-roadmap-20010523/

1. D3.js allows for the building of custom visualizations and maps in a way that no other system can do. It allows for easy interaction with data. Interactive maps.
2. D3.js provides superior performance. By using D3.js AVAIL can visualize vector tiles which greatly increases the scalability of data in web based GIS applications. This allows for tracking hundreds of thousands of objects instead of just thousands.
3. By choosing D3.js as a both visualization tool and GIS mapping software, AVAIL can develop seamless interactions between spatial and non-spatial visualizations.
4. D3.js allows AVAIL to innovate with new types of data visualizations in ways that would be impossible with High Charts or other types of more traditional libraries.

5.2.8 Databases

AVAIL recommends using a combination of two software options to achieve the best possible database structure for this project. AVAIL chose to use Post-GIS and Google Big Query:

1. Post-GIS allows AVAIL to store, access and export any spatial data format.
2. Post-GIS offers advanced spatial analytical tools.
3. Google Big Query does not serve the function of spatial data.
4. Google Big Query allows AVAIL is an order of magnitude improvement over traditional databases for storing and analyzing data sets greater than 5GB in size.
5. The ease of use, documentation, and support made Google Big Query best in class for processing large datasets.

5.2.9 Web Frameworks

AVAIL recommends Node.js for Web Framework:

1. Node offers cross platform compatibility.
2. Node allows for ease of cross platform installation and setup.
3. Node is an extremely agile framework that also for the quickest possible development and implementation.
4. Using Node allows for full-stack JavaScript development. It is the only framework that allows AVAIL to use a single language, JavaScript, for both server and client side development. The popularity of JavaScript broadens the pool of possible contributors.

5.2.10 Business Design Document

5.2.10.1 Proposed System Architecture

The code being used by AVAIL is open source and it is being designed so that it can be integrated into a number of different enterprise structures. Ultimately, the software architecture informs the choice of software and vice versa. AVAIL made all software decisions by keeping in mind both end user experience and database query capacity. Without a sound database structure, GIS mapping and visualization are not possible. Advances in programming software allow cutting-edge user interface design and visualization to work in coordination with dynamic database and server side software.

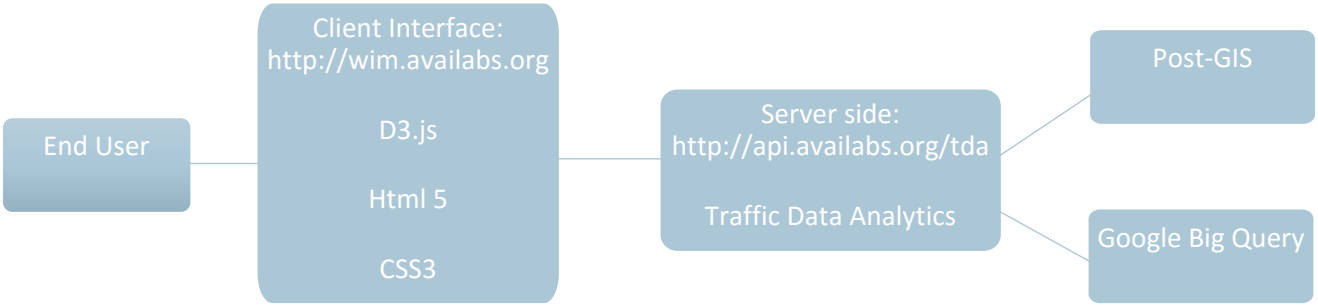


Figure 4 Web-Based Analysis Tool Software Architecture with Software Names

5.2.10.2 Deployment

There are two options for handing off the administration of the Web-Based Analysis Tool. The first is to deploy the software onto participating state DOT servers. The second option is for AVAIL to maintain the Web-Based Analysis Tool with a service contract.

5.2.10.2.1 Individual Deployment

As part of the project, AVAIL will make installation and setup instructions for all modules to be deployed on UNIX-based and Windows-based systems. Each pooled fund study participating state will have the option to deploy the software on their own infrastructure or hire a third party to host the Web-Based Analysis Tool platform. For the duration of the project plus one additional year, AVAIL will make this platform available for all pooled funds study members as a web portal at http://wim.availabs.org.

5.2.10.2.2 Software as a Service

AVAIL is offering to host and support the software systems and data in perpetuity with an annual contract. This allows the individual DOTs to avoid incurring internal IT costs such as the purchase of additional hardware, or training their in-house IT staff in the use, development, and management of the developed software, in order to integrate with current and future systems.

5.2.11 System Requirements Summary

AVAIL conducted a system requirements assessment of current data and software systems for applicability in building the Web-Based Analysis Tool. Additionally, AVAIL completed the process of recommending a software architecture for the Web-Based Analysis Tool. Finally, AVAIL recommends two approaches for future deployment of the Web-Based Analysis Tool to all pooled fund study participants. With this report the AVAIL team has met the requirements of Task 3A, 3B, and 3C as described in the scope of work.

5.3 System Development and Testing

5.3.1 Establish Web-Based User Friendly Data Visualization Tool to Generate Appropriate Reports and Outputs

The contractor shall develop tools that display / report:

- Highway specific estimates of truck volumes and loadings by time of day, day of week, week of year and year to year.
- Monthly truck class adjustment factors.
- Heavy vehicle travel monthly trends.
- Axle loading trends.
- Highway ton-miles of freight moved each month.
- Flow maps linking all roadways seamlessly locally, regionally and nationally.
- Truck weight road groups locally, regionally and nationally.
- Load spectra by standard truck class and axle group type.
- Loading trends for bridge stress.
- Size & Weight and Enforcement

5.3.2 Test Tool, Fix Bugs, and Verify that Fixes/Functions are Working

The contractor shall test tools, fix bugs and verify that fixes and functions are working. AVAIL created a Software Development Log in a shared Google Spreadsheet as a means of testing the tool and documenting all bugs and design issues The Software Development Log also tracked the repair of those fixes and design implementations so that the Technical Working Group could stay abreast of progress.

5.3.2.1 Software Development Log

The following table is the complete, unabridged, Software Development Log for this project.

#	Page / Tab	Problem	Type	Type 2	Date Submitted	AVAIL Update	Fixed
1	Homepage	State icons don't respond to clicking	Software Development	Software Bug	9/4/2014	AVAIL has identified some of the problem associated with this bug. 9/25/14	11/10/14 fixed
2	Entire Site	Server is slow, site crashes, kicks users off.	Software Development	Software Bug	9/4/2014	AVAIL changed host servers and processes run much faster now	11/10/14 fixed
3	State Maps in IE	In IE, problems with station selection because the scroll over for each station obscures the selector	Software Development	Web Browser Compatibility	9/26/2014		11/10/2014 fixed
4	Single Station Page	Slow Server due to big data queries	Software Development	Software/Server Bug	10/1/2014	AVAIL has split visualizations out into tabs	11/10/14 fixed
5	State Map, Charts and Graphs problems in IE	Charts and Graphs contain bugs	Software Development	Web Browser Compatibility	10/1/2014	AVAIL is working on IE compatibility	11/10/2014
6	State Map	AADT Graph Usability Better connected graphs	Design	Software Design	9/4/2014	Graphic Design is complete for a full software redesign	11/10/2014
7	interphase	pull downs and functions are not visible in ei11	Bug	Web Browser Compatibility	11/10/2014	AVAIL fixed IE compatibility	2/4/2015
8	color scheme	graphics on the freight flow diagrams hard to read	Design	labeling	11/10/2014	Fixed in software update	8/15/2015
9	truck volume maps	interactive labels overlapping fixed graphics	Bug	labeling	11/10/2014	Fixed in software update	8/15/2015
10	main page	enforcement and HPMS are not displaying pulldowns	Bug	main page interactions	11/10/2014	Fixed in software update	8/15/2015
11	truck volume maps	to the user, it's not intuitive that you need to click off class types	Design	need note or something tell the user how to interact with the graphic	11/10/2014	Noted in User Guide	11/15/2015
13	enforcement or TMAS	need to call it one thing or another	Design	labeling	11/10/2014	Fixed 11/15/15	11/15/2015
14	square icons on main map pages	need to change the graphic	Design		11/10/2014	Redesigned in Software Update	8/15/2015
15	seasonality bar selection tool	selection tool bar wraps around on page,	Bug	design	11/10/2014	Redesigned in Software Update	8/15/2015
16	log in issues with Chrome	Version 38.0.2125.111 m	Bug		11/10/2014		
17	State Maps in IE	I would still like to see a polygon selection tool to select regional sites	Design		11/25/2014	Selection of multiple stations was removed from site design	11/15/2015
18	Weight Distribution Options	Can we add options to look at loading for single axle, tandem axle group, tridem axle group, quad axle group by vehicle class? Can the data be arranged per standard AASHTO load bins for each axle/group type? Can two or more data stations be averaged together by class? Can the tabled data be downloaded?	Design	Development	11/25/2014	Implemented except for two or more stations averaged together	12/15/2015

19	Vehicle Classification Options	Can we add an option to look at monthly volume adjustment factors (MAF) by vehicle class? Example: MAF = selected month truck vol. (CL 9)/average of sum of truck volumes (CL9) over the 12-month period. Again, can more than one station be averaged together?	Design	Development	11/25/2014	Out of scope	12/15/2015
20	Vehicle Classification Options	Can we add an option to look at vehicle class by % of all vehicles in the traffic stream? Again, can more than one station be averaged together? Need dynamic calculation based on which vehicle classes are selected (typically would exclude Classes 1-3).	Design	Development	11/25/2014	Out of scope	12/15/2015
21	TMAS data management	not showing class data	bug		7/10/2015	Fixed	
22	nation-wide / statewide page	slow to load	Bug		7/10/2015	Investigated. Some improvements	8/15/2015
23	statewide	switching between datasets	bug		7/10/2015	Fixed	
24	All	slow to load	bug		8/15/2015	Fixed, moved data processing from client to server side.	9/15/2015
25	All	maps are slow to zoom or slip	bug		9/15/2015	Fixed, moved HPMS onto its own tab. Removed it from all other page loads	9/15/2015
26	WIM/Class	reintroduce colored stations	Design	Development	12/15/2015	Implemented	1/25/2016
27	nation-wide / statewide page	Load state of user	Bug		12/17/2015	Fixed	1/25/2016
28	Overview Tab	Data errors on WIM and Class Graphs	Bug		12/17/2015	Fixed	1/25/2016
29	Site wide	Graph Y Axis	Design	Labels	12/17/2015	Fixed	1/25/2016
30	Site wide	Graph Colors	Design	Colors	12/17/2015	Updated	1/25/2016
31	Maps	Station ID cards cutoff	Bug		12/17/2015	Fixed	1/25/2016
32	Class/WIM Tabs	Filters don't work	Bug		12/17/2015	Fixed	1/25/2016
33	HPMS Tab	HPMS road network doesn't show up properly. There is a glitch on load	Bug		12/17/2015	Fixed	1/25/2016

Table 8

6 FINDINGS

The following objectives were tested during the development of the project.

- Accommodation of various data formats including but not limited to linear referenced data (LRS) TMG weight, class, volume, and speed, AASHTOWare ME standard traffic input tables, bridge, weather and speed probe.
- Data validation process using various quality control techniques including but not limited to TMAS, Long-Term Pavement Performance, and VTRIS.
- Diverse data queries for specific analysis including but not limited to w-tables, truck weight roadway groups and load spectra.
- Export function for data in formats including but not limited to standard software; (i.e. Microsoft Excel, DBF, CSV, TMG, GIS / SHP, LRS, ESRI, Google).
- Data analysis process using proven statistical methods including but not limited to cluster analysis,
- Data linking capability for all roadway attributes and bridges of national significance and capability to associate corresponding data with HPMS LRS, TMAS, VTRIS W-Tables, National Highway System, National Highway Planning Network, land use, weather and current related developmental impacts.
- Graphical display features for all traffic and related attributes using standard universal GIS mapping formats and specifications. (e.g. shapefile or geodatabase for ArcMap) with the appropriate data, data categories, symbology, line weights, colors, etc. to produce a specific graphical representation.
- Recognition of legacy data output for upload into the study product, with option to export results into existing systems.

Based on the recommendations of the technical panel, the following objectives were removed from consideration for the initial phase:

- *Data Formats: speed, AASHTOWare ME standard traffic input tables, bridge, weather and speed probe.*
- *Data validation process using Long-Term Pavement Performance, and VTRIS.*
- *Data linking capability for all roadway attributes and bridges of national significance and capability to associate corresponding data with HPMS LRS, TMAS, VTRIS W-Tables, National Highway System, National Highway Planning Network , land use, weather and current related developmental impacts.*

6.1.1.1 Chart of Features by Completion

The following chart of data tool features lists all of the tool features recommended by the Technical Panel and FHWA, and includes percent level of completion.

Table 9: Data Tool Establishment Table of Features by Percent Completion

Data Tool Establishment			
Category	**Functionality Name**	**Data Displayed**	**Development**
Site Wide	Design		100%
Server	Site Wide Data Querying	All Data Sitewide	100%
Dashboard	U.S. Map	TMAS by state	100%
Dashboard	Data Drop Down (top right corner)	Controls all Datasets available for use by web-tool	100%
Dashboard			
State Map	State Maps	Station locations by WIM and Class	100%
State Map	AADT Year Change Bar Chart	Year over Year AADT Change by station	100%
State Map	AADT Line Graph	MADT (average, by year) (by Class) Traffic can be filtered by hour	100%
State Map	AADT Avg. by Station Bar Chart	AADT of all stations (by Avg of All years, or individual year) (by Vehicle Class)	100%
Single Station Overview	Info Tab	Basic Station Card information	100%
Single Station Overview	Info Tab	More station specific overview graphs	100%
Single Station Overview	Truck Volume Graph Tab	Volume by Time Graph	100%
Single Station Overview	Truck Volume Graph Tab	Weight by Time Graph	100%
Single Station Overview	Truck Volume Graph Tab	Weight Distribution Graph	100%
Single Station Overview	Calendar View	Traffic Volume by day by class	100%
Single Station Overview	Overweight Deployment Grid	Overweight Traffic Volume by day by direction	100%
Road Network Analysis	HMPS Road Network Map	Maps to include HPMS by route	100%
Road Network Analysis	Truck/Vehicle/Ton Miles Travelled by Month	no longer in scope	0%
Road Network Analysis	HPMS Corridor Analysis Tab	This was previously included in the site. No plans for reimplementation	100%
Enforcement Dashboard	Rank stations by forecasted overweight percent and count	Enforcement Chart	100%
Enforcement Dashboard	Maps of corridors showing most likely overweight segments	This is no longer in scope	0%
Enforcement Dashboard	Map of stations visualized by overweight percent or count	Enforcement Dashboard is included in Overweight Tab	100%
Data Management	Upload Data, Manage Data	Data uploader complete with data deletion tools	100%
Download Graphs/Maps	Site wide	Download to svg and png	100%

6.2 Final Web-tool Features

To request access the tool email AVAIL at availabs@gmail.com

All code for the project is open source and is hosted on Github at the following repository: https://github.com/availabs/tdaReact

6.2.1 Statewide Average Traffic and HPMS Graphs and HPMS View:

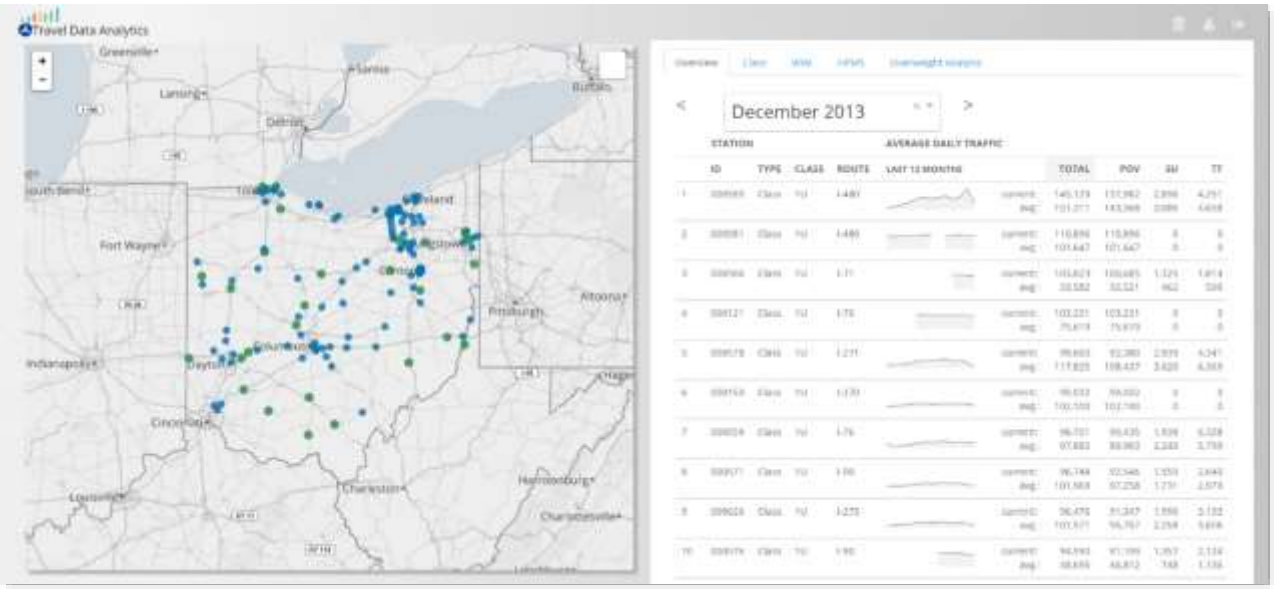


Figure 5

6.2.1.1 Overview Dashboard

Class counts and WIM weights and counts are organized by station into overview tables. Each row in the data indicates one continuous class count station or WIM station. The columns include:

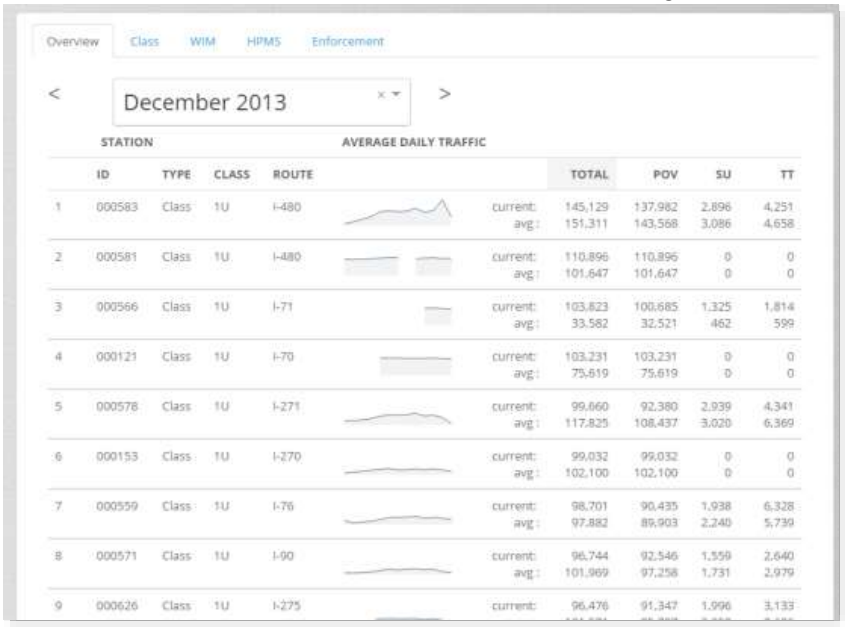


Figure 6

- Station ID and Type (WIM/Class)
- Class of the road the station is located on
- Route name
- A spark graph showing the counts recorded at this station over the last 12 months
- And a table of Avg. Daily Traffic showing the current month (top sub-row) over the avg of all months (bottom sub-row) for Total AADT, Personal Occupancy Vehicle, Single Unit and Tractor Trailer.

6.2.1.2 Single Station - Class Counts

Each row can be expanded in order to view single station information. When a user has clicked on a row, the data for that station automatically expands to show a class counts bar graph. The bars in this graph indicate the years of data currently in the system and represent the total raw counts for each year.

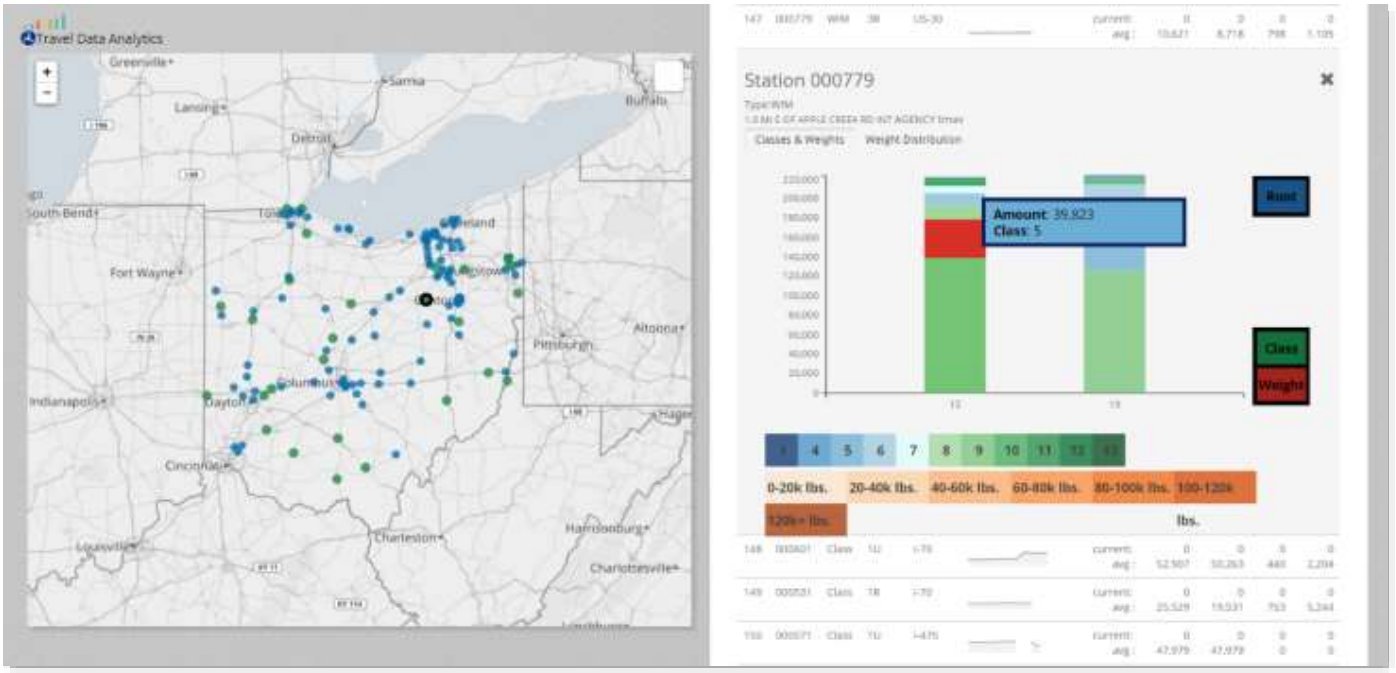


Figure 7

A user can filter the graph by classes 1 through 13. Additionally, a user can "drill" down into the data by clicking on one of the bar graphs. Each year bar drills down to its corresponding month bars, and those drill further down to their corresponding day bar graphs a raw continuous counts data.

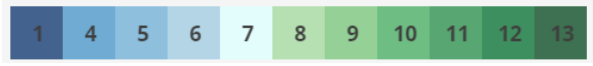


Figure 8

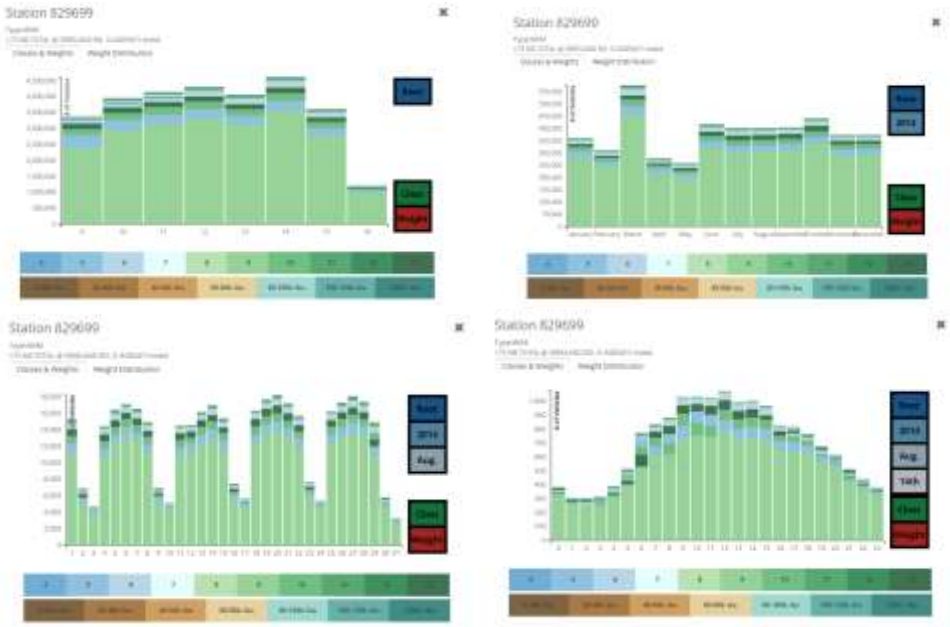


Figure 9

6.2.1.3 Single Station - Weight Counts

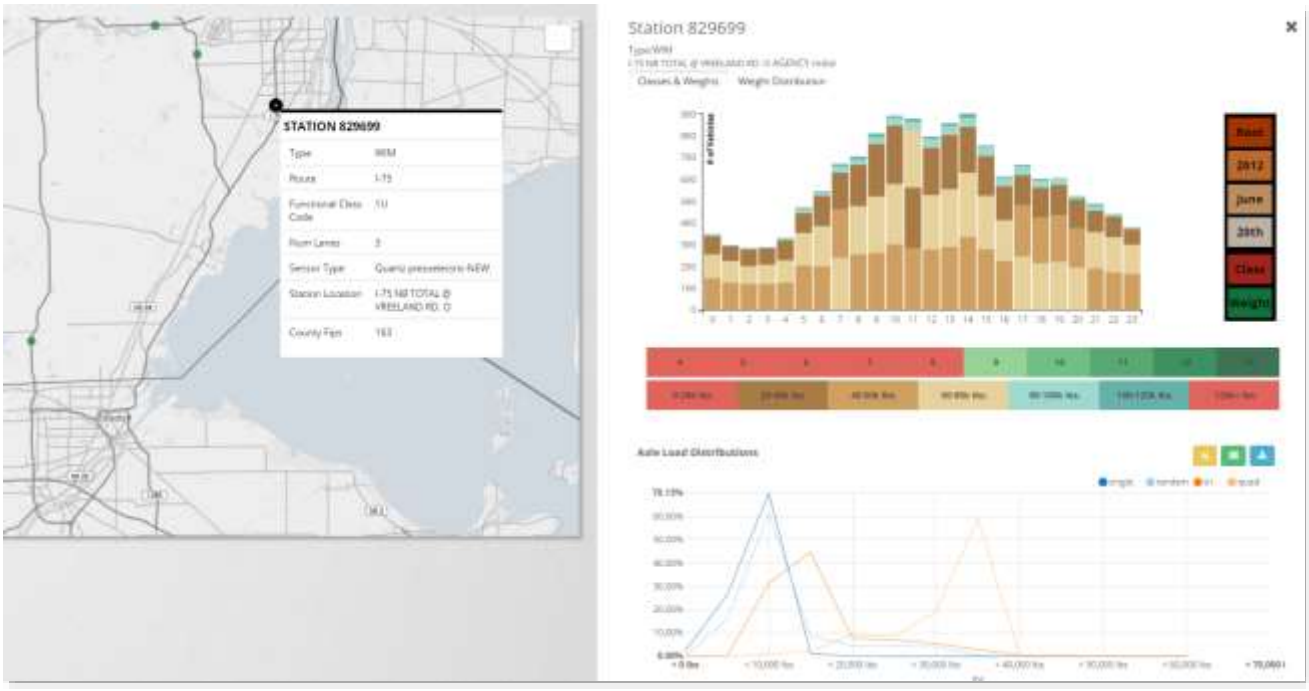


Figure 10

Users can also access weight related data counts from WIM Stations. When a station has WIM data, the dashboard automatically engages a series of WIM related tools.

The WIM Tools allow the user to dig deeper into the raw data by clicking on any bar to view data for the year:

Figure 11

The weight filters also allow the user to filter the graph by weight bin.

Figure 12

Filters can be combined together to highlight various data. For instance, Figure 10 shows a graph that is filtered to show counts of class 9 vehicles in the 80,000 to 100,000 pound weight bin.

6.2.1.4 Single Station - Weight Distribution (Load Spectra)

The WIM tools also include Load Spectra graphs and Axel Load Distribution graphs. They are located in the tab labeled "Weight Distribution." Similar to the stacked graph for Weight Counts, The Weight Distribution graph is filterable by weight bin. A user can click on the weight bin bars to remove them from the spectra graph.

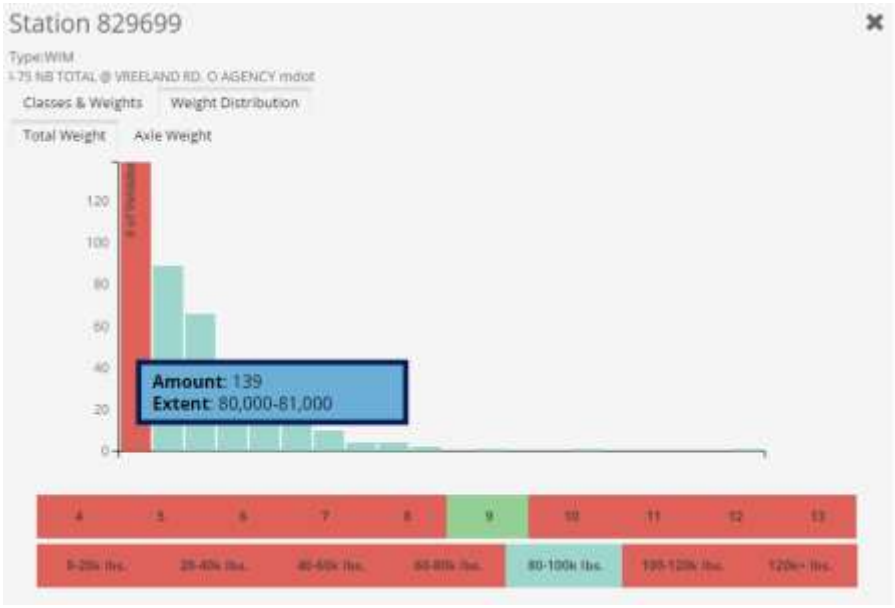


Figure 13

The time settings for the Load Spectra Graph are set by the Class & Weights tab. Click on the Classes and Weights tab to view the time settings. When years are listed the Load Spectra Graph is showing data for all-time. To navigate the single station calendar, a user clicks on a year to drill in to that year, a month to drill in to that month. The load spectra will show the graph that corresponds to these calendar filters.

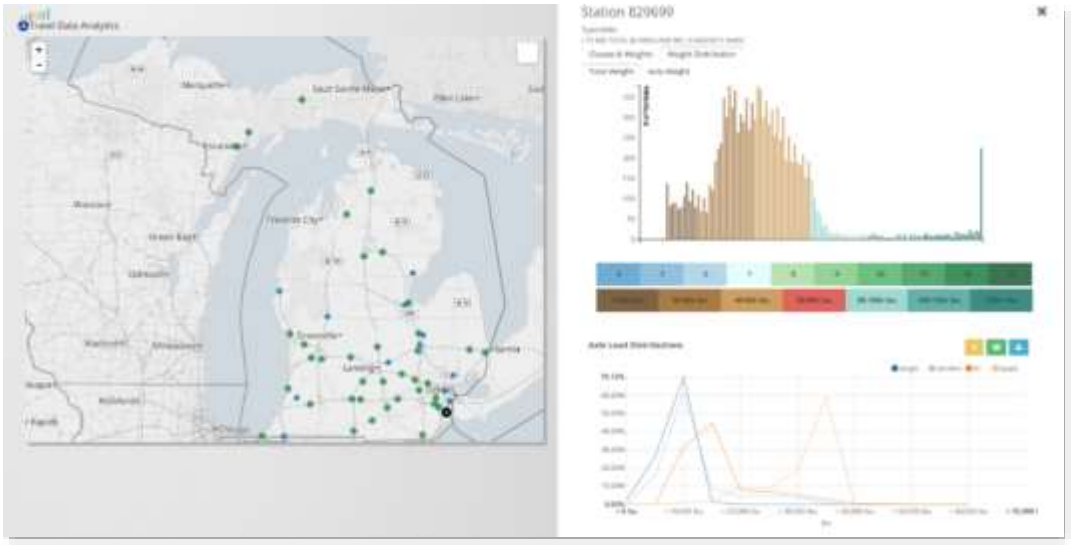


Figure 14

6.2.2 WIM Counts Corridor Comparison:

A user can use these tools to drill into a corridor to compare two stations on a given day. For instance, two stations on Interstate 75, one south of the Michigan/Ohio border, the other north of the border. The following two graphs have been filtered to show Weight Bin Counts and Axel Load Distributions for June 20th 2012.

I-75 Michigan

I-75 Ohio

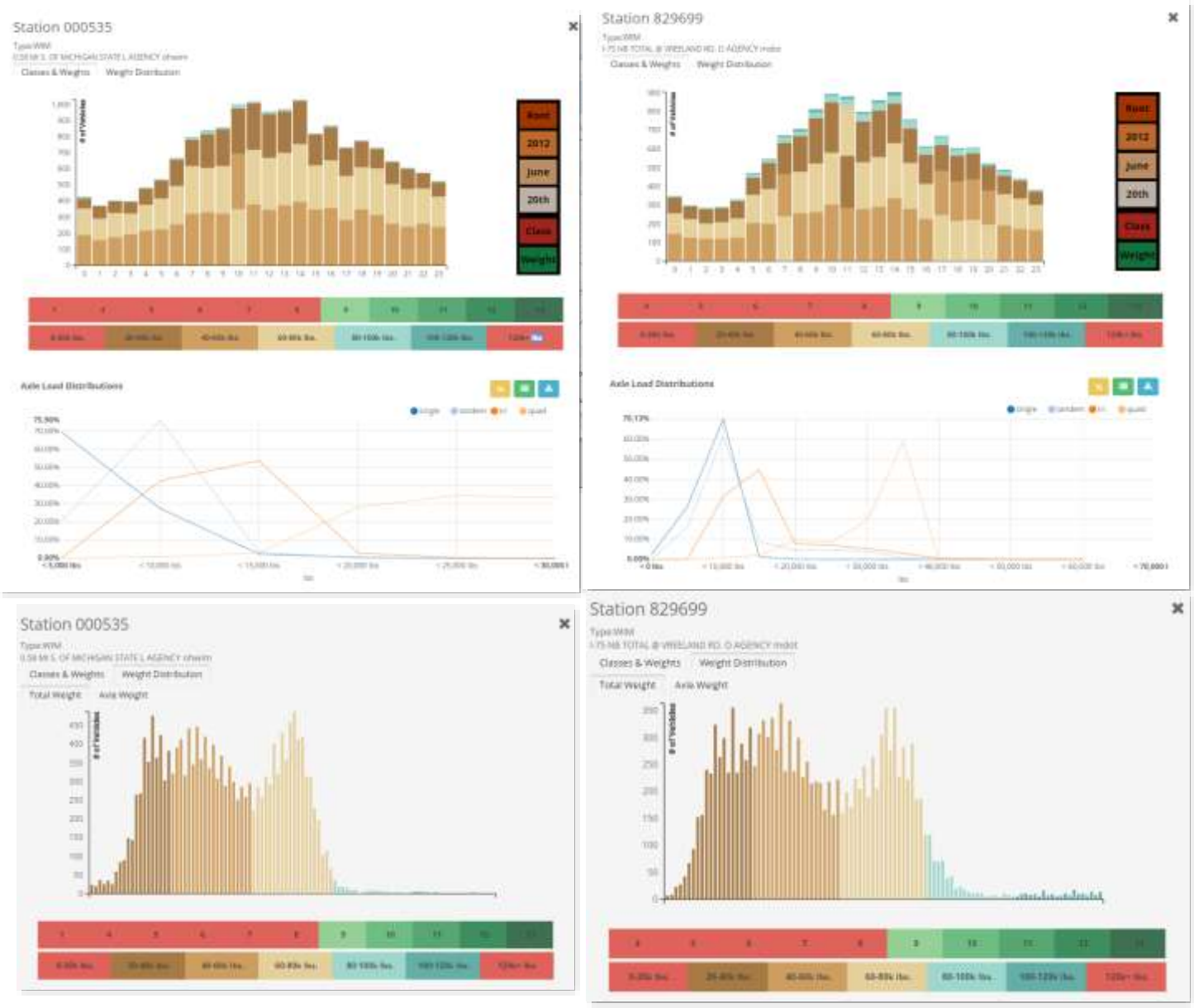


Figure 15

6.2.3 Class and WIM Tabs

The Class and WIM tabs show statewide counts and weights by station. When a user clicks on one of these tabs, the map shows all of the stations in the state for which there is data. They are represented by circles. The color of the circle corresponds with the Annual Average Daily Traffic for that station.

A user can access the station card information by scrolling over a station. The station card appears as a tool tip. The station also highlights yellow in the AADT graph on the right.

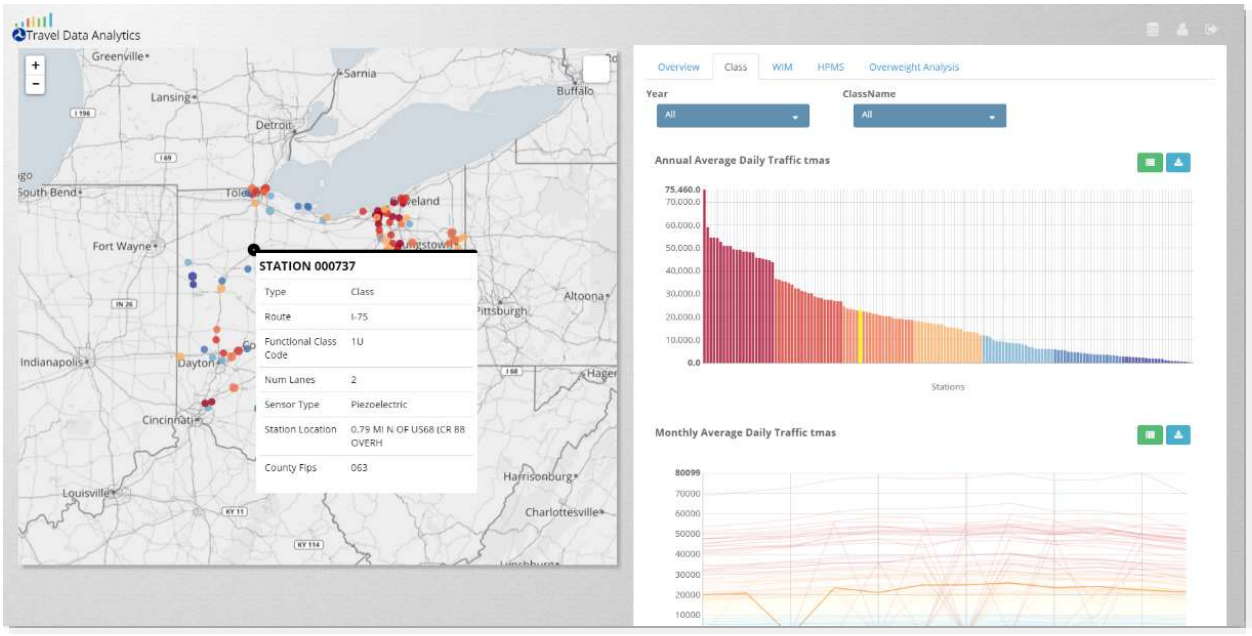


Figure 16

6.2.3.1 The Class Tab

On the Class Tab, the first graph shows Annual Average Daily Traffic. For this graph, AVAIL uses the class data and takes the simple average of all days (when data for a day is missing, the denominator is reduced by one) as per the Traffic Monitoring Guide:

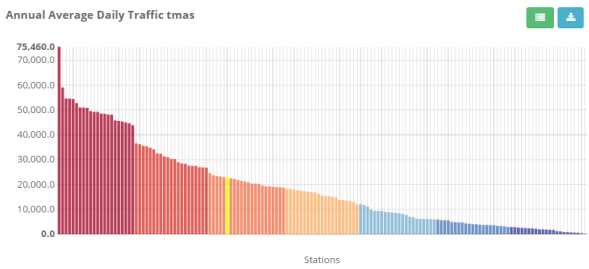


Figure 17

AADT – Annual Average Daily Traffic – The total volume of vehicle traffic of a highway or road for a year divided by 365 days. It is meant to represent traffic on a typical day of the year. The Traffic Monitoring Guide lists two basic procedures for calculating AADT. In the first of these techniques, AADT is computed as the simple average of all 365 days in a given year (unless a leap year). When days of data are missing, the denominator is simply reduced by the number of missing days:

Thi

$$AADT = \frac{1}{7}\sum_{i=1}^{7}\left[\frac{1}{12}\sum_{j=1}^{12}\left(\frac{1}{n}\sum_{k=1}^{n} VOL_{ijk}\right)\right]$$

Where:

VOL	=	daily traffic for day *k*, of DOW *i*, and month *j*
i	=	day of the week
j	=	month of the year
k	=	1 when the day is the first occurrence of that day of the week in a month, 4 when it is the fourth day of the week
n	=	the number of days of that day of the week during that month (usually between one

Figure 18

A simple average of all days; and

An average of averages (the American Association of State Highway Transportation Officials (AASHTO) method).

The second graph is Monthly Average Daily Traffic. Monthly Avg. Daily Traffic sums all traffic in a month and divides by the number of days in that month. For all of the days of data that are missing from a given month, the graphing algorithm reduces the denominator by one.

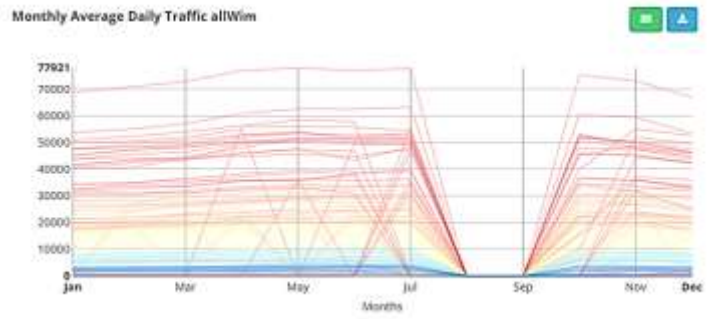


Figure 19

MADT = Sum of Traffic in Month / Number of Day of Data in Month

The Bottom graph on this page is the Seasonal Adjustment Factor graph. To calculate the Seasonal Adjustment Factor, AVAIL takes the Monthly Average Daily Traffic and Divides it by the Annual Average Daily Traffic. SAF=MADT/AAD**T**. The Seasonal Adjustment factor shows how much more or less traffic than average, a station sees in any given month.

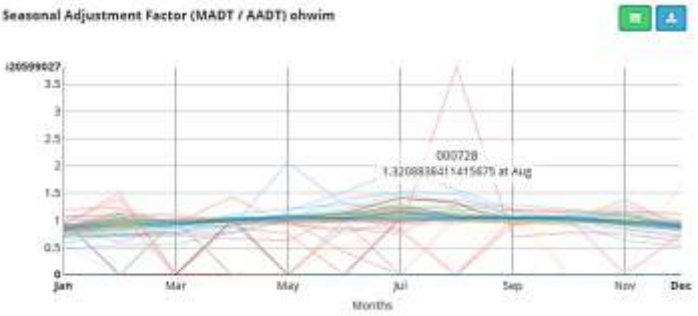


Figure 20

Every graph located on this tab can be viewed as either a graph or a table and can be downloaded as either a CSV or PNG file. The green icon is a table icon. You can view tabular data for the graph by clicking on it. The blue icon is to download an image of the graph or a comma separated values file of the tabular data. Figure 22 is an example of the tabular data of the MADT Graph:

Figure 21

Station Id	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
16421	1.10	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.89	1.16	0.94
109511	1.49	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	1.44	0.64
16411	1.17	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	1.14	1.07
16811	1.10	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	1.10	0.99

Figure 22

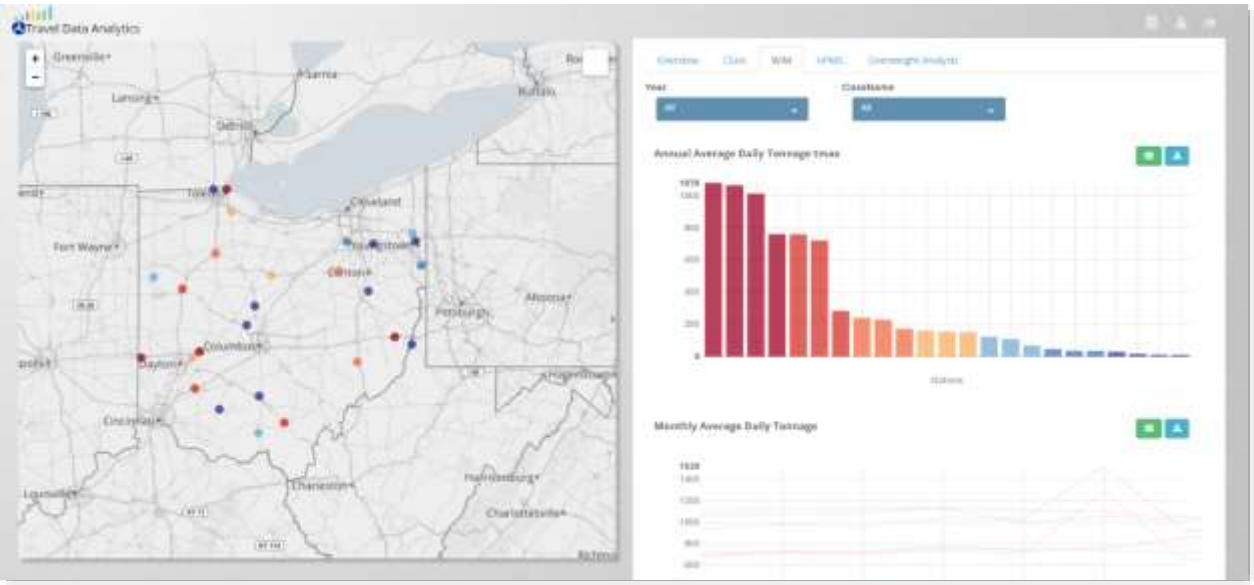


Figure 23

6.2.3.2 WIM Tab

The WIM Tab is organized similarly to the Class Tab. The first difference is that the stations appearing on the map, and those located in the graphs, are filtered to show only WIM stations.

The WIM Graphs are exact replicas of the Class Graphs but are generated using weight data (in tons) instead of counts data.

The Annual Average Daily Tonnage graph is an exact replica of the Annual Average Daily Traffic graph listed above. The algorithm for creating the AADTonnage graph is the same as the one used to make the AADTraffic graph except using Tons instead of Counts.

MADTonnage and Seasonality of Tonnage Graphs are replicas of the MADTraffic and Seasonality of Traffic graphs.

Figure 24

6.2.3.3 WIM and Class Tab Filters

Additionally, the WIM and Class tabs have Class, Year, and Direction Filters.

The Year filter is default to All. When All is selected the graphs show an average of all data in the system. By clicking on the Year filter a user can select data for a given year for which there is data. After selecting a year, a new filter will appear for selecting a given month.

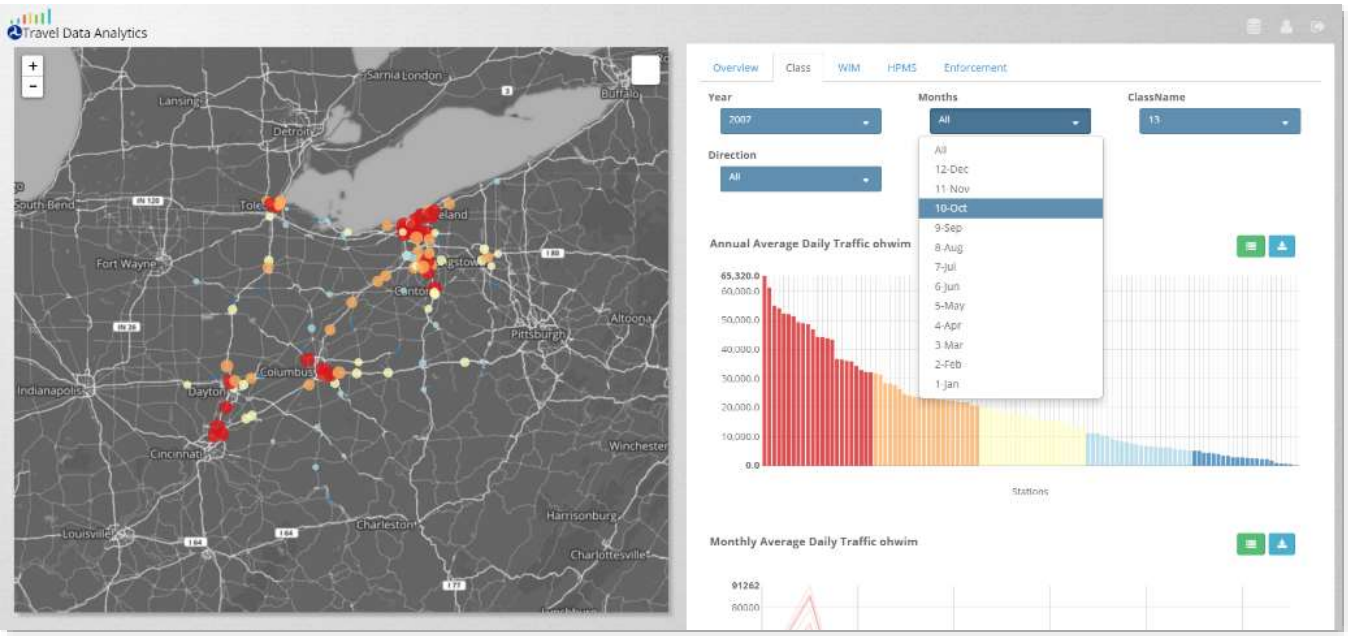


Figure 25

The ClassName and Direction filters also default to "All." When All is selected the graphs below show the AADTraffic or AADTonnage of all classes. Filter for Class 9 to see Class or WIM graphs of Class 9 vehicles. Filter by direction to see data from stations traveling in a given direction.

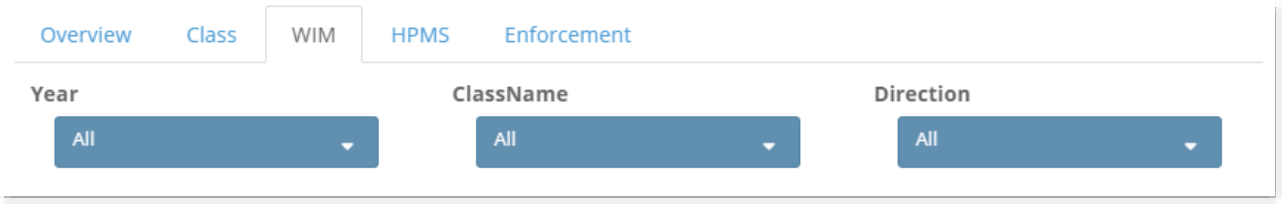


Figure 26

6.2.4 HPMS Tab

To view HPMS Data for road segments in a state, click the HPMS Tab.

Scrolling over an HPMS road segment, opens a tool-tip box displaying the HPMS road segment and AADT information (figure 28).

Users can zoom in to the map by putting the cursor on the map and scrolling in or out. Map tools include magnification (+/-) and layer switch (Terrain, Light and Dark Colored Maps and Satellite).

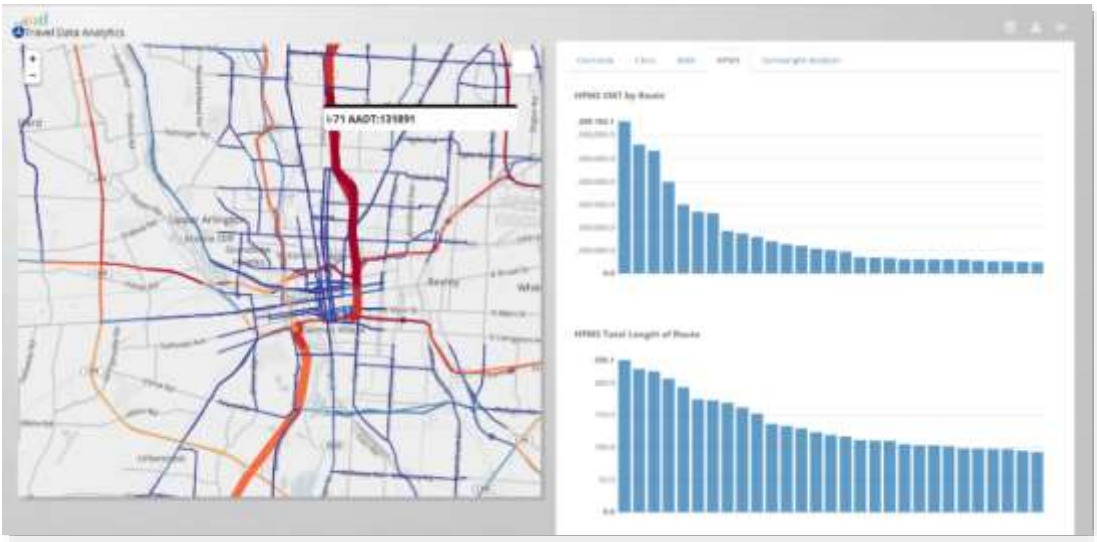
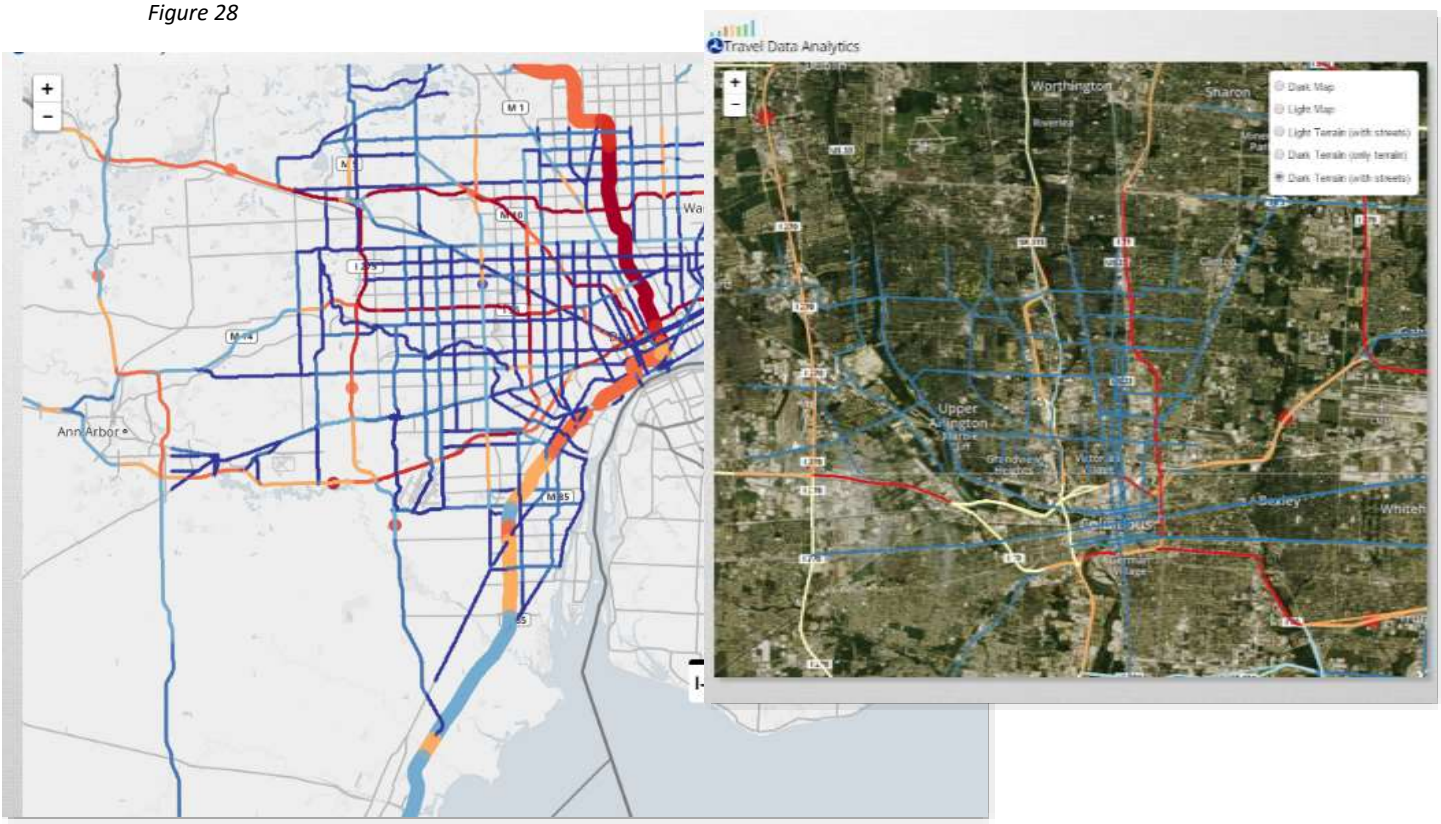


Figure 27

Figure 28



6.2.5 Overweight Analysis Tab

The Overweight Analysis Tab delivers insights into heavies as a percentage of total trucks by time of day.

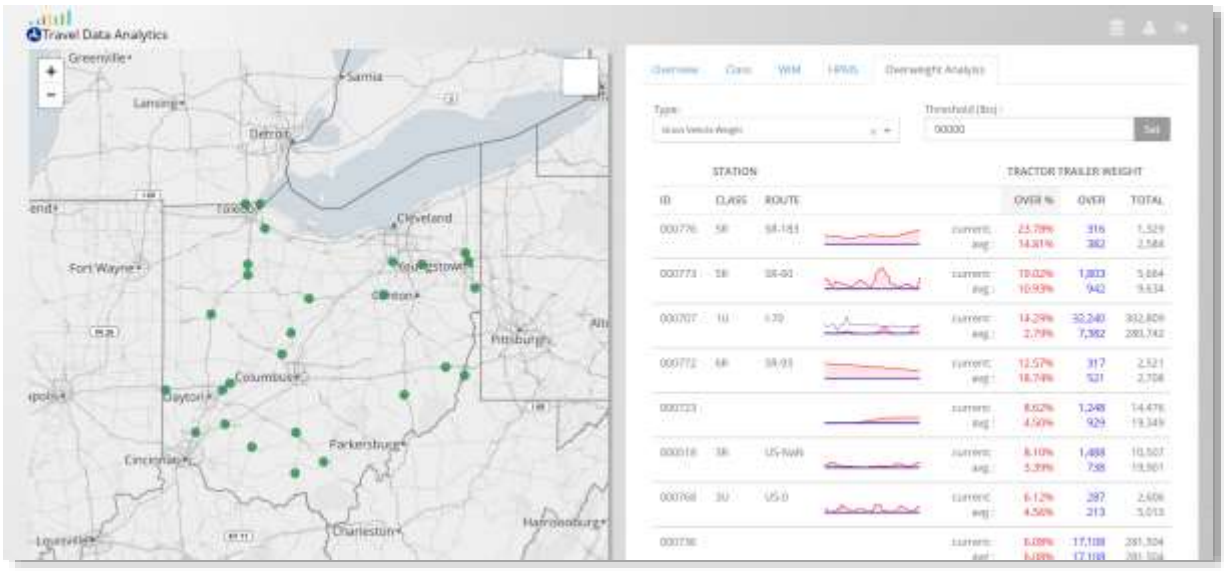


Figure 29

When a user clicks on the Overweight Analysis Tab, the map once again filters stations, leaving only WIM stations. The Overweight Analysis Table shows all of the WIM stations in the state. Similar to the Overview Table. The Overweight Analysis Table defaults to the latest month of data in the system, and shows a series of columns (Station ID, Route Class, Route Name, Overweight %, Overweight Total, and Total Counts). The rows correspond to WIM stations. Each row contains sub-rows showing overweight, overweight percent and total overweight for both the all-time average and the current month.

Figure 30

The spark line in the station row of the Overweight Analysis Table, shows the trend of overweight violations at this station over the last year ending at the selected month. The spark line shows overweight % (red line) and number of overweight (blue line).

At the top of the Overweight Analysis Table are settings for Overweight Type (Gross Vehicle Weight, Axle Weight and Bridge Formula) and an Overweight Threshold setting.

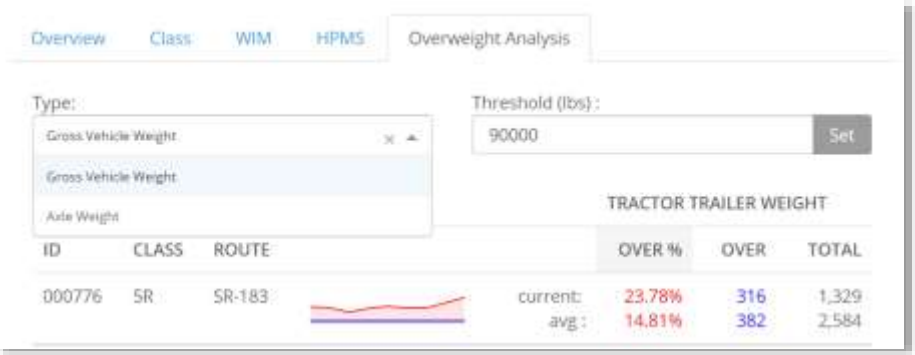


Figure 31

6.2.5.1 Single Station Overweight Analysis Graphs

A user can select a station to open up single station overweight graphs (Figure 32) and two overweight graphs appear.

The Heat Graph shows overweight truck information for an average day. This "heat graph" has day of week as a y-axis, Sunday (top) through Saturday (bottom), and the x-axis shows the hours in a day. The heat graph shows the hours of the day with the highest average of overweight violations.

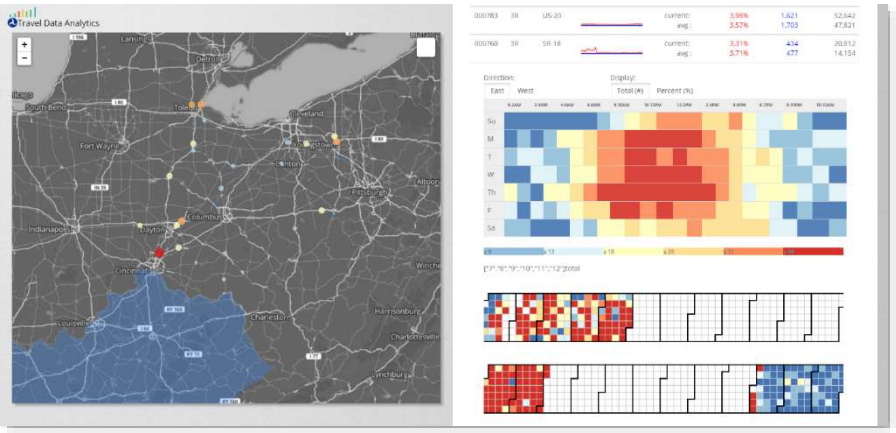


Figure 32

The Calendar Graph shows all of the available data for the chosen station, by day, month and year where days with highest numbers of violations are red and lowest are blue.

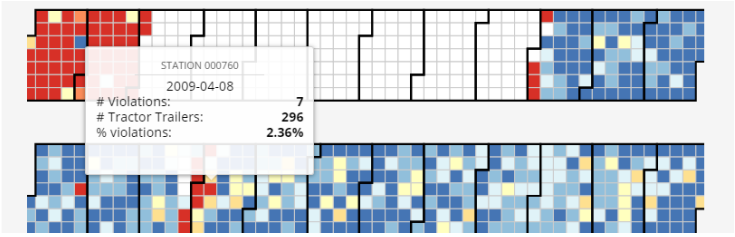


Figure 33

Both graphs can be viewed by Total (number of violations) and percent (number of violations/number of tractor trailer trucks).

Both graphs can also be filtered by direction of travel.

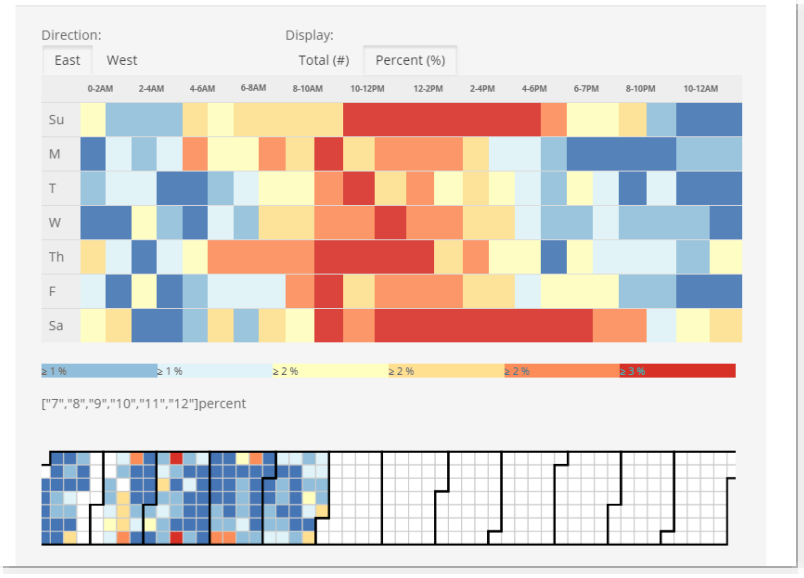


Figure 34

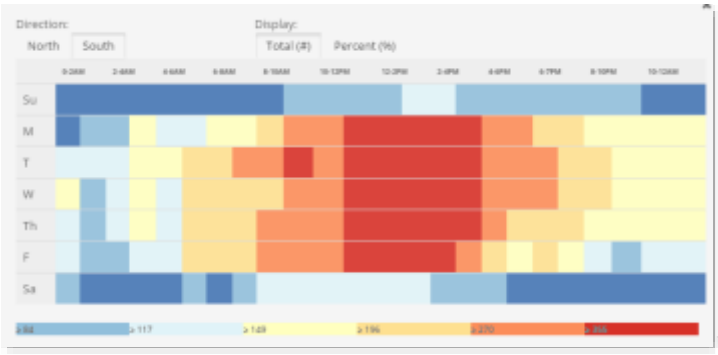
6.2.5.2 Overweight Enforcement Directional Comparison

The following directional comparison shows distribution of overweight vehicles by hour of day and day of week. The left column shows total overweight vehicles. The right column shows percent overweight. One can see quickly that most overweight vehicles occur during the weekday, northbound before noon and southbound after. The percent of all trucks that are overweight, however, has almost no pattern. Although it appears that early Sunday morning is a time where a high percentage of trucks on the road are overweight.

Northbound Total Overweight

Northbound Percent Overweight

Southbound Total Overweight



Southbound Percent Overweight

Figure 35

6.2.6 Data and User Management

The web-tool contains a number of data management features. All of these data and user management features are limited to Administrative Users.

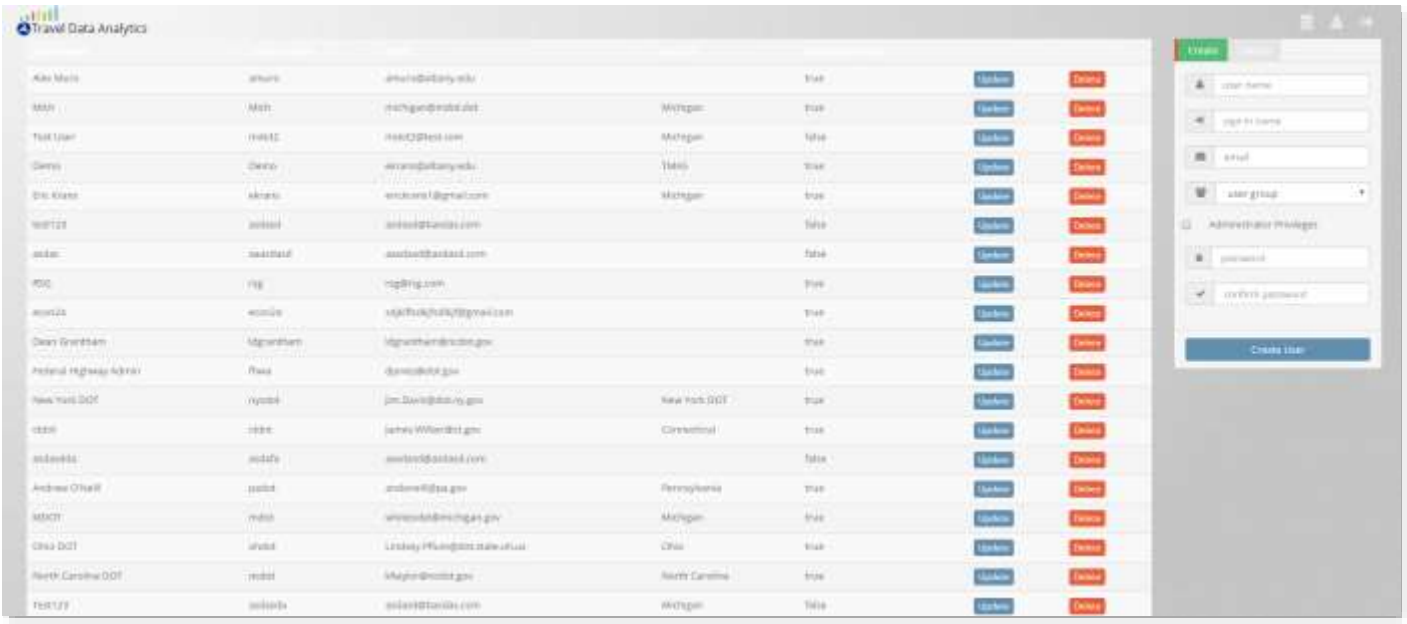


Figure 36

6.2.6.1 User Management

User management tools allow for the creation of users at various levels of access. Administrative Users can create accounts and assign access levels. The simple process of creating usernames and passwords allows State DOTs and FHWA to share this tool without worrying about corruption or removal of data.

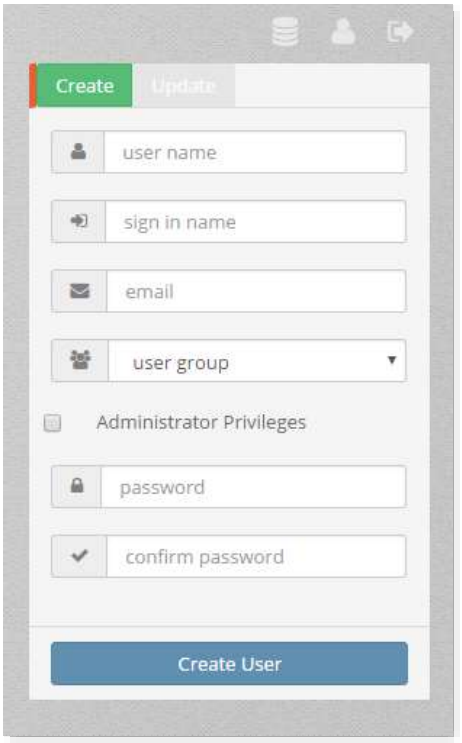


Figure 37

6.2.6.2 Data Upload

Administrative users can upload new data, simply by clicking on the upload box located on the right side of the data management page, labeled “Upload New Data.” A file explorer window will automatically open to allow users to search for WIM or Class data files.

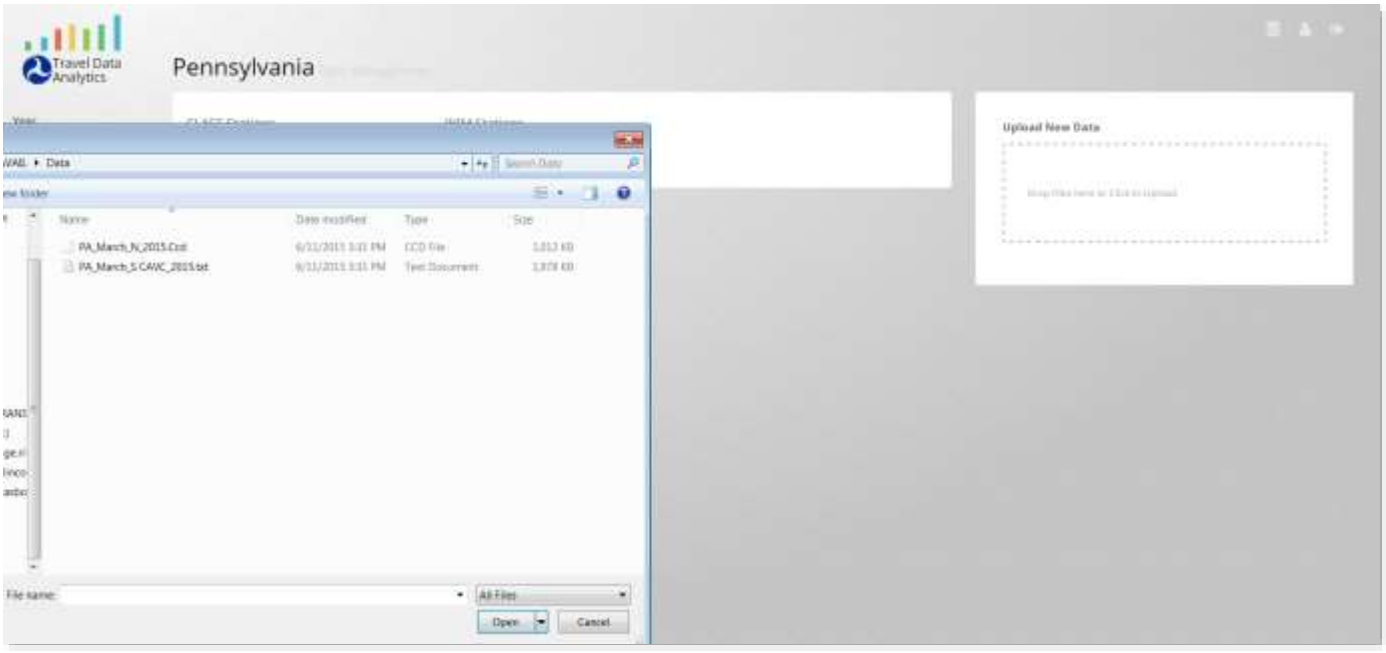


Figure 38

After clicking to upload the file, users can track the status of the file upload on the right side of the page.

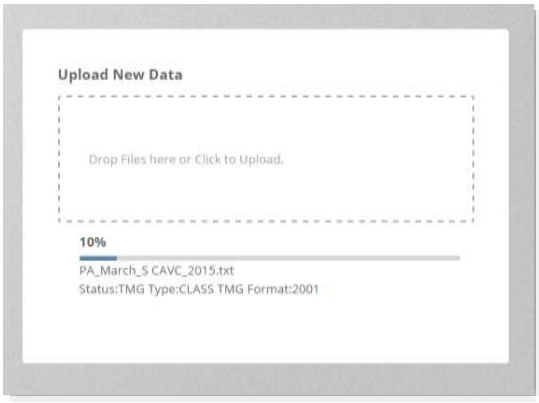


Figure 39

6.2.6.3 Calendar Graph of Uploaded Data

The available data for your state appears in calendar form. This is a general overview of available data for your state. Class data is listed on the left and WIM data is listed on the right. Dates with more data appear red. Dates with less data appear blue.

6.2.6.4 Removing Files from Analysis

Uploaded files are permanently included in the database. They can be removed from use in the analysis visualization by simply clicking on the box associated with the file.

Figure 40

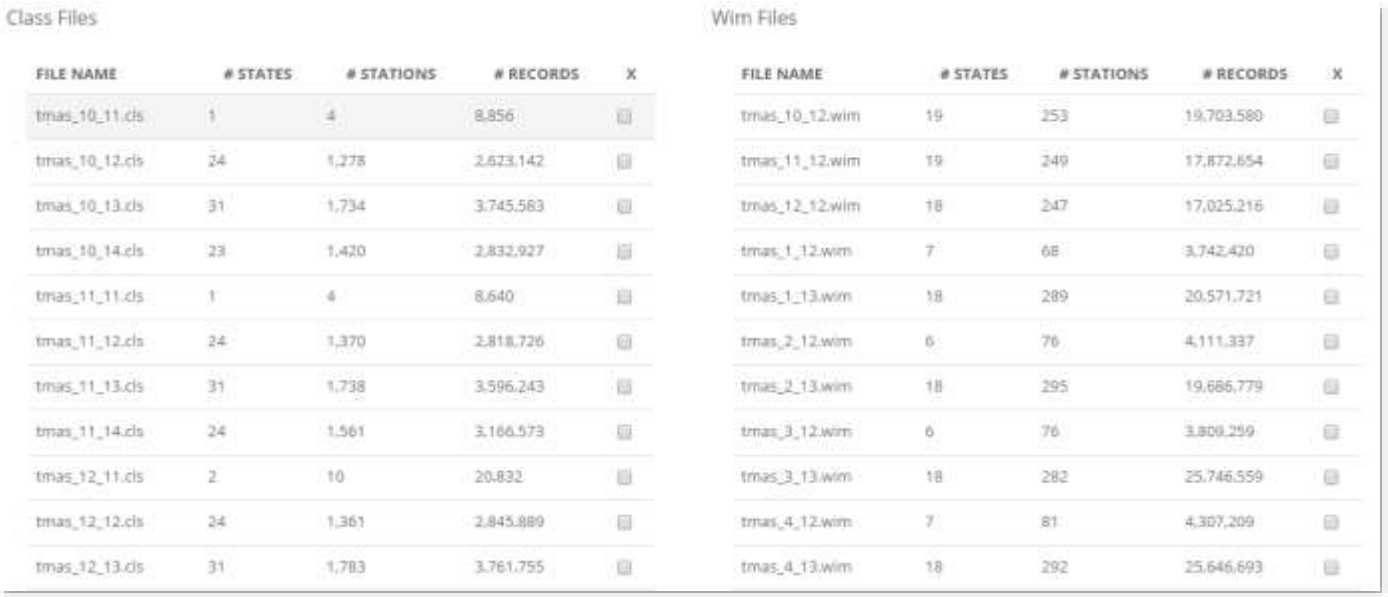


Figure 41

7 CONCLUSION

The goal of providing FHWA and state DOTs with an easy to use web-based traffic data visualization and analysis tool was achieved primarily for WIM and Class continuous counts data based on the particular needs of the technical panel members who participated in the initial phase of this project. The Tool features developed are designed to use both TMAS data and state level continuous counts data. This data flexibility allows for national analysis of TMAS data and for state-specific analysis where additional continuous counts data is available.

The tool suite accomplished the explicit goals recommended by the technical panel for this initial phase. The tool was tested over the period of one year, as per the scope of work, and was determined to be stable. The tool has been used in the New York State Freight Transportation Plan as well as by membership states to meet their continuous counts and weigh-in-motion program planning objectives.

The resulting technological approach to transportation data visualization and analysis tools is extensible to any standardized transportation dataset. Near the end of the project development phase, new standardized national data sources became available from FHWA, e.g. NPRMDS, which offer expanded opportunities to provide visualizations and data analytics for traffic and freight planning. Additionally, new performance measures have been proposed that can be applied agnostically to any geography in the country. These performance measures are, therefore, capable of being included in a web-based traffic visualization and analytics tool. Future phases of this project could explore tool development for various transportation datasets, as well as the national and regional performance measures such as those proposed under both MAP-21 and the FAST Act legislation.

8 Appendix A: User Guide By Feature

8.1 Statewide Average Traffic and HPMS Graphs and HPMS View:

Sign in to the site: http://wim.availabs.org *(To request access the tool email AVAIL at availabs@gmail.com)*

***NOTE: whenever the page seems to be stuck**, you should refresh your browser and start over again.*

1. If you are a user at a state agency you will start by landing on a map of your state and the data will default to your state agency data.
2. If you are a national user your landing map is of the U.S. and your dataset defaults to TMAS. When you scroll over a state it should animate blue. To select a state control+click (ctrl+click) on a state.

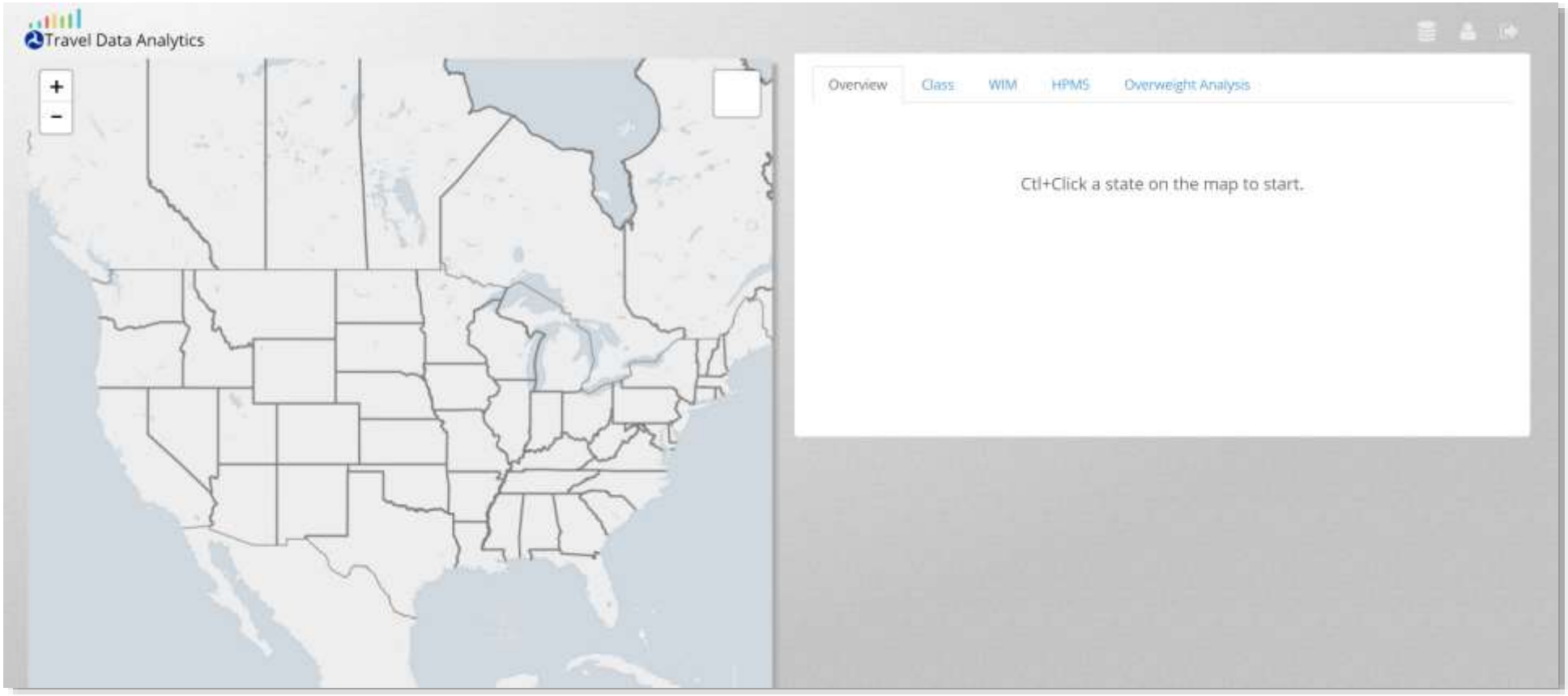


Figure 42

3. The data dropdown at the top right of the page contains the different datasets. For the purposes of this test we will use the TMAS dataset.

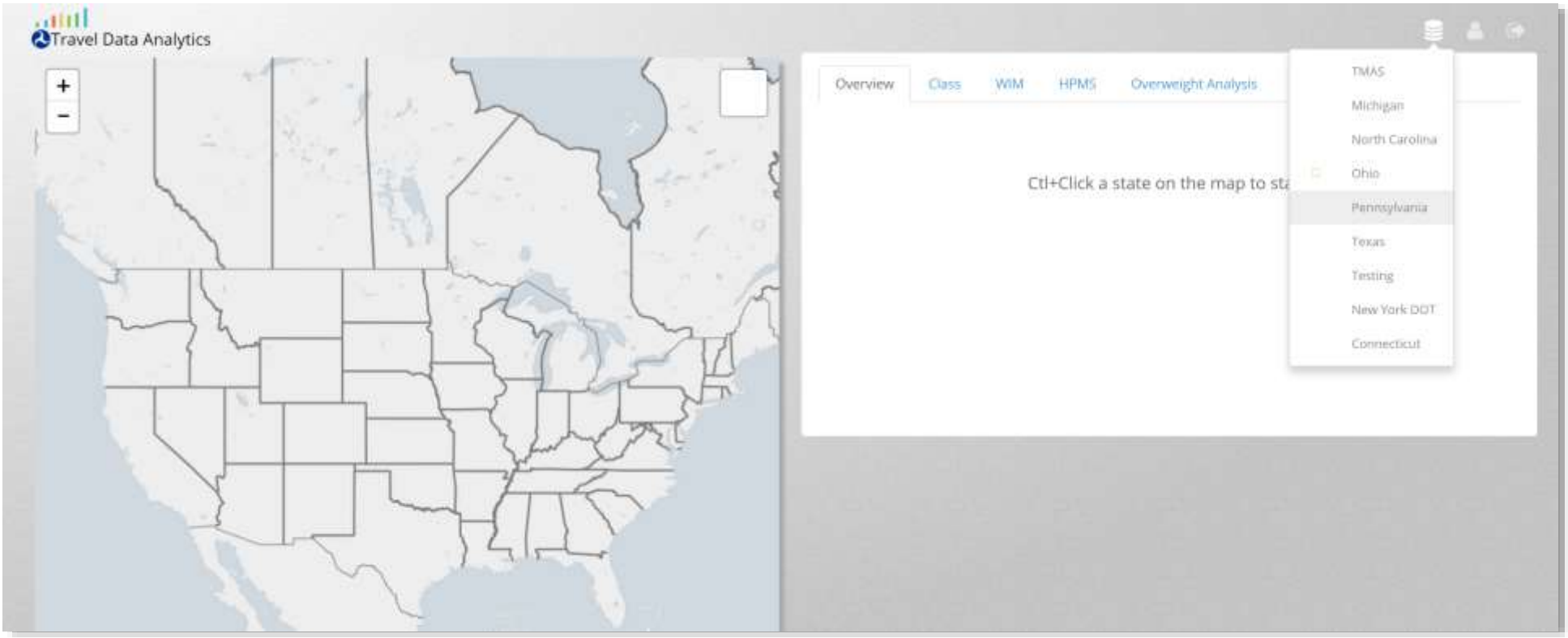


Figure 43

Note: TMAS dataset. Michigan, North Carolina, Ohio and Pennsylvania should all have excellent statewide data. If you'd like to explore the graphs and map features discussed in this document using those statewide datasets, you can access them using the dropdown menu pictured in figure 43 above.

4. Your statewide dashboard should appear like this:

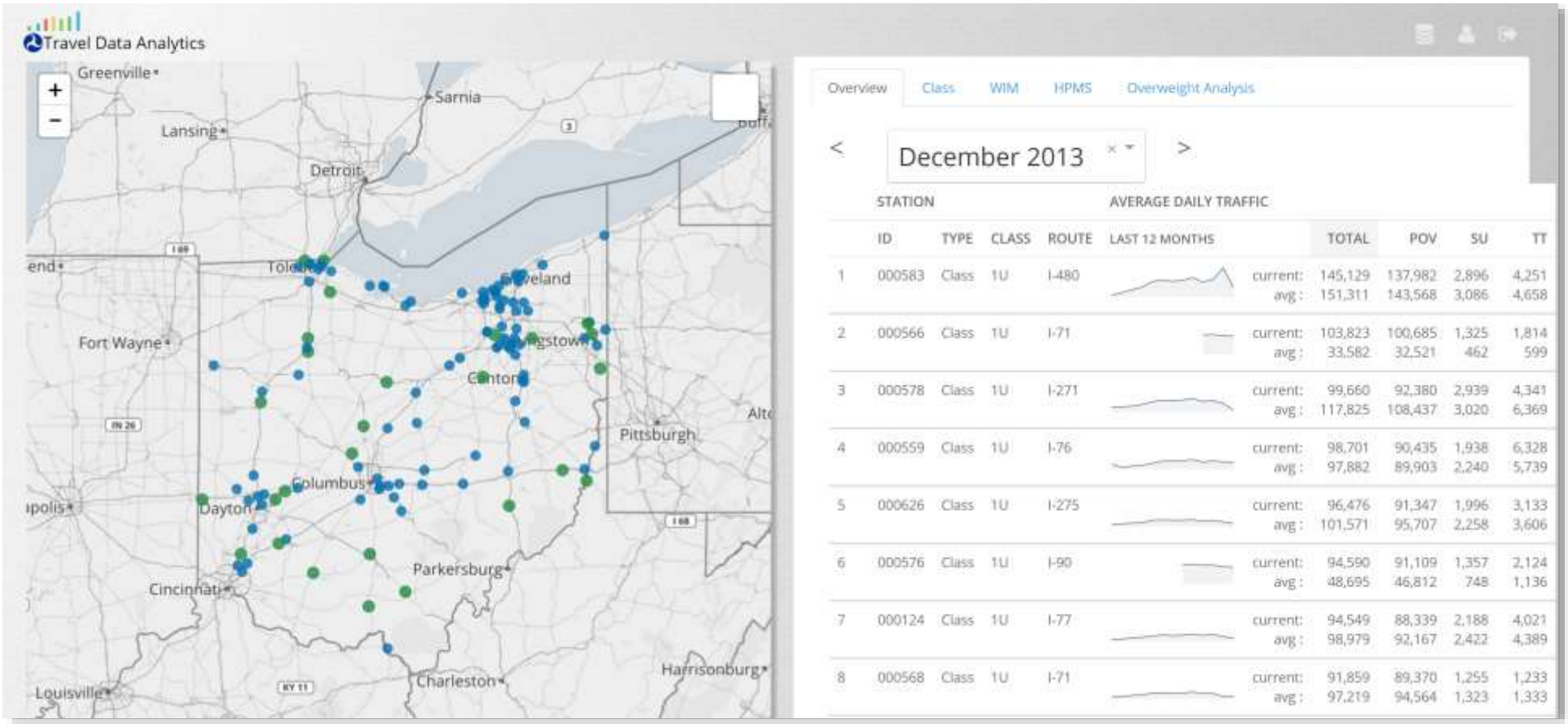


Figure 44

8.2 Overview Dashboard

5. First we'll take a look at the dashboard at right.
   We see a table of data. Each row in the data indicates one continuous class count station. The columns include:

- Station ID and Type (WIM/Class)
- Class of the road the station is located on
- Route name
- A spark graph showing the counts recorded at this station over the last 12 months
- And a table of Avg. Daily Traffic showing the current month (top sub-row) over the avg of all months (bottom sub-row) for Total AADT, Personal Occupancy Vehicle, Single Unit and Tractor Trailer.

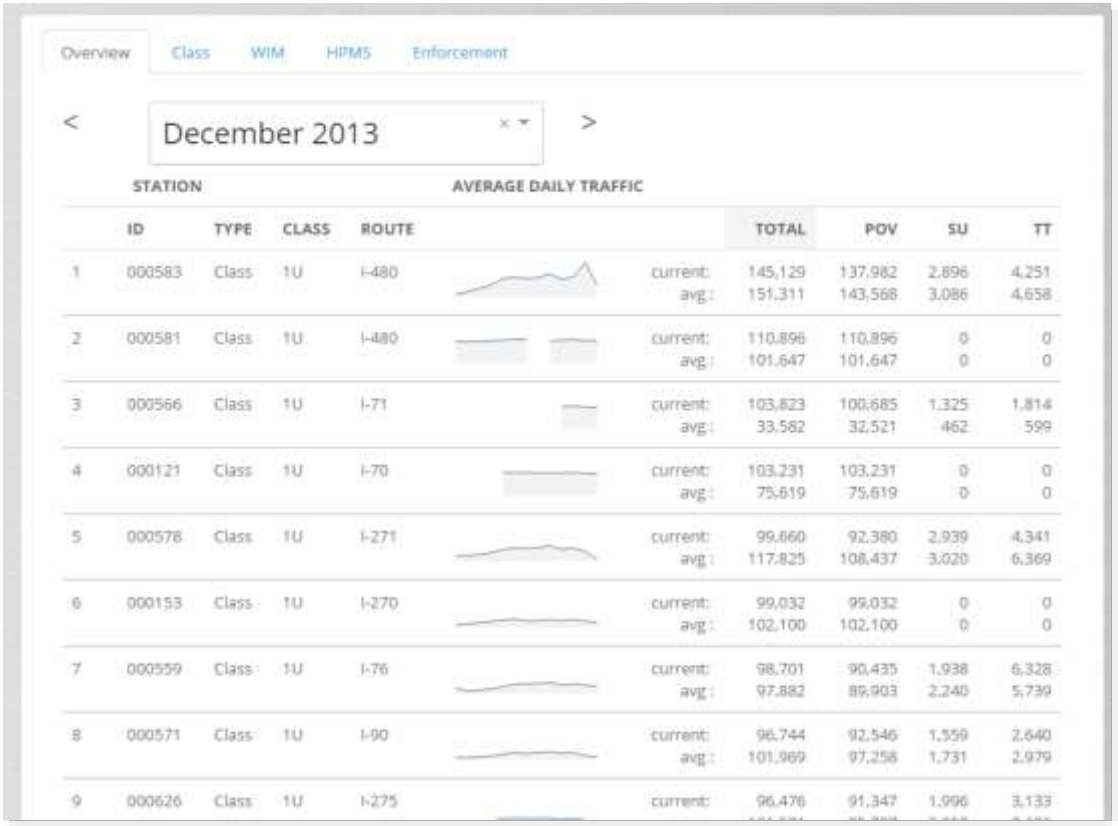


Figure 45

8.2.1 Single Station - Class Counts

6. You can select any single station to view the raw continuous counts data for that station either by clicking on the station row or by clicking on a station on the map:

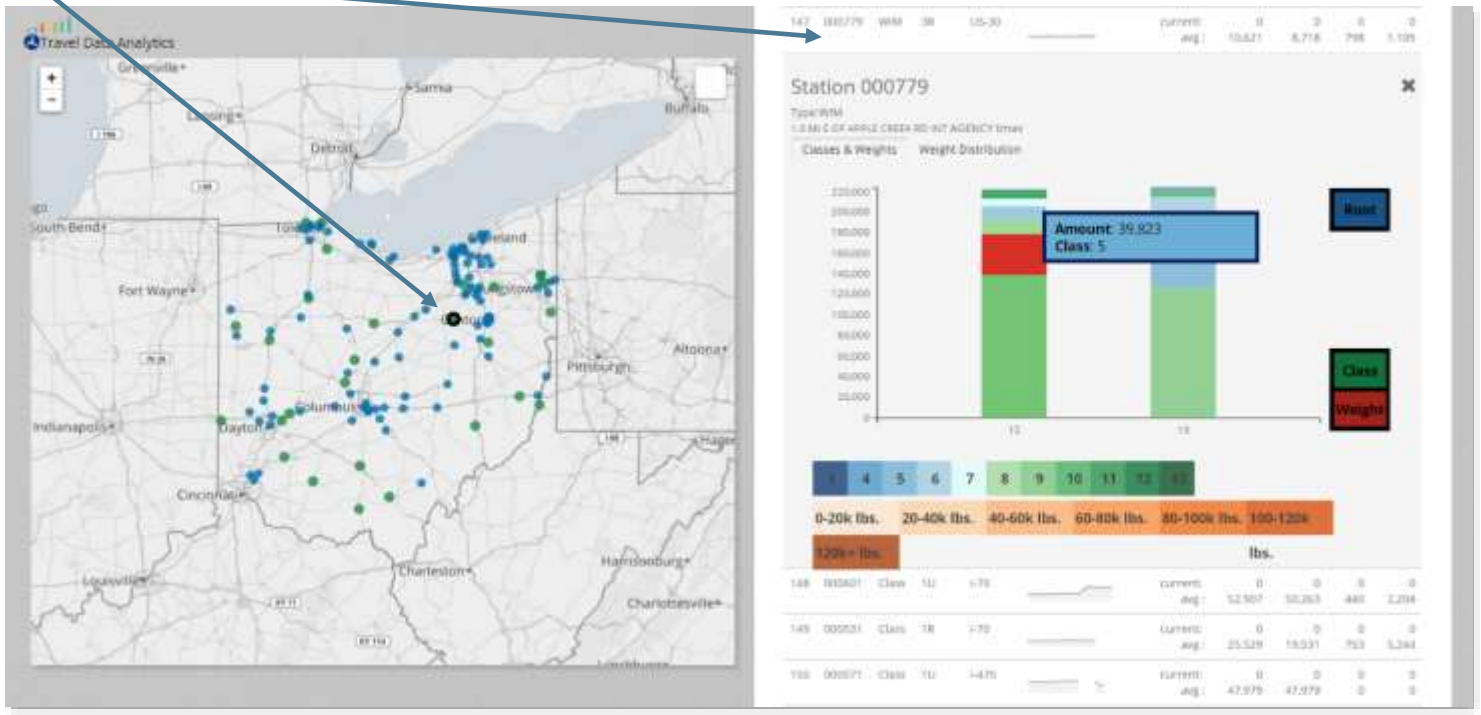


Figure 46

7. Click around on the class filters by clicking on the filters labeled 1-13.

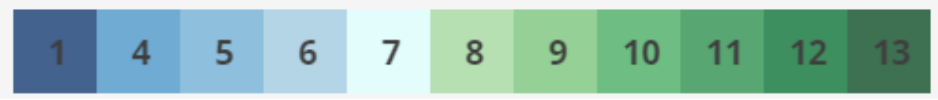


Figure 47

8.2.2 Single Station - Weight Counts

8. WIM Stations allow you to also look at raw WIM data for that station by clicking on the “Weight” button.

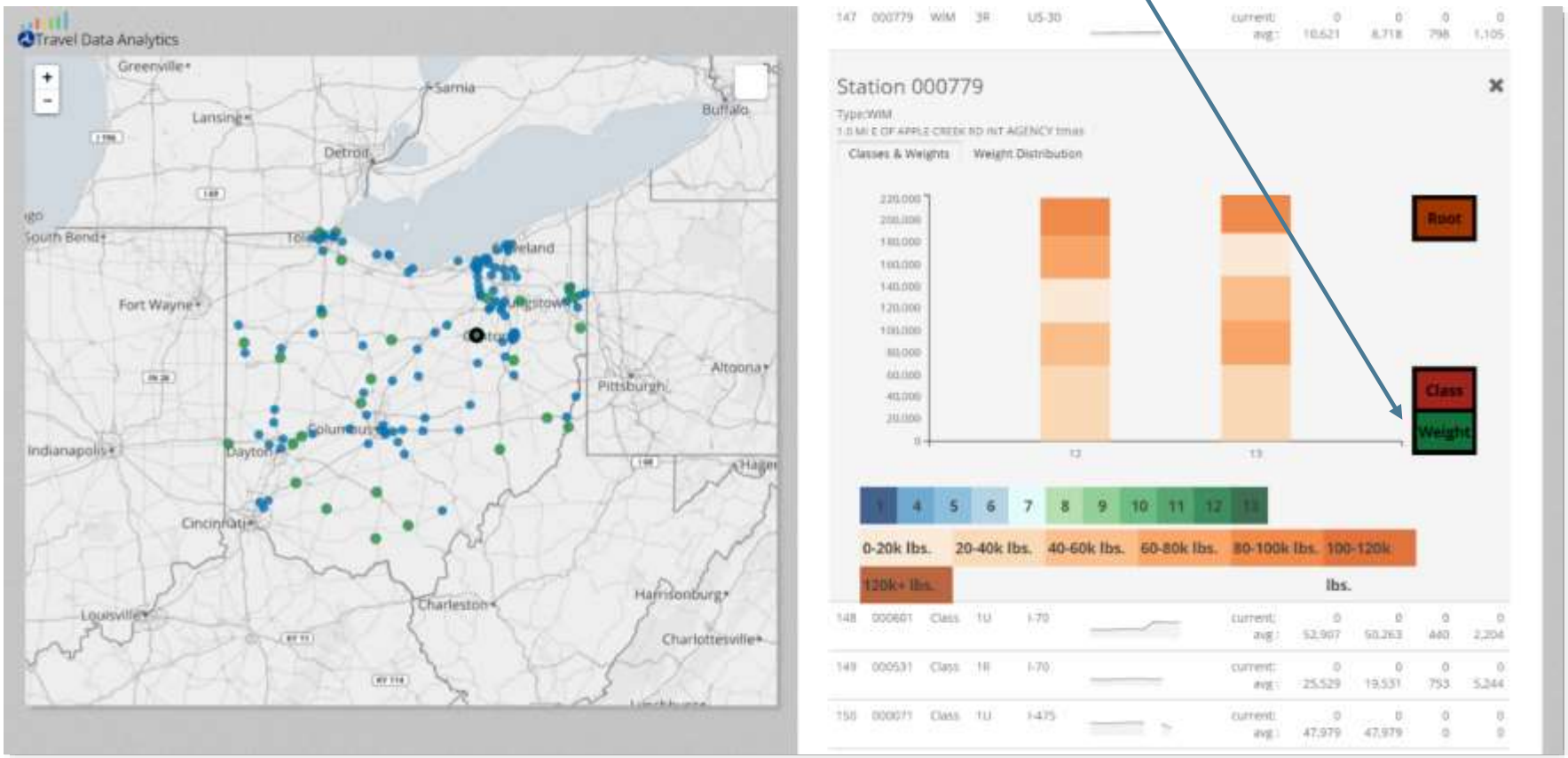


Figure 48

9. You can dig deeper into the raw data by clicking on any bar to view data for the year:

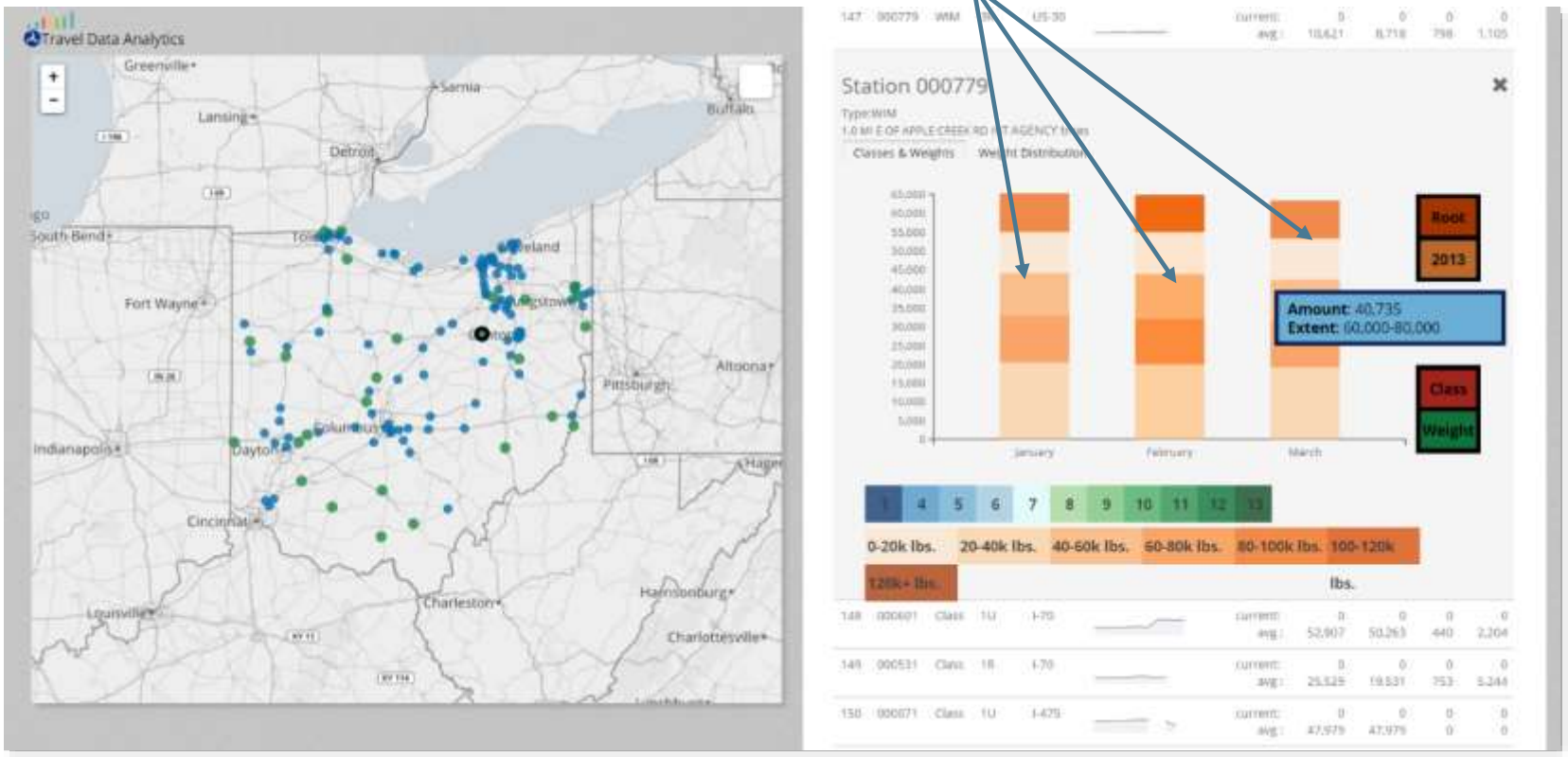


Figure 49

10. The site should now show a number of bars as seen in Figure 49. These bars represent months of a year of available data for this station. The bars in the graph show the months of January through August.
11. Click around on the weight filters to filter the graph.

Figure 50

12. Click on one of the bars to zoom into the data for one of the months.

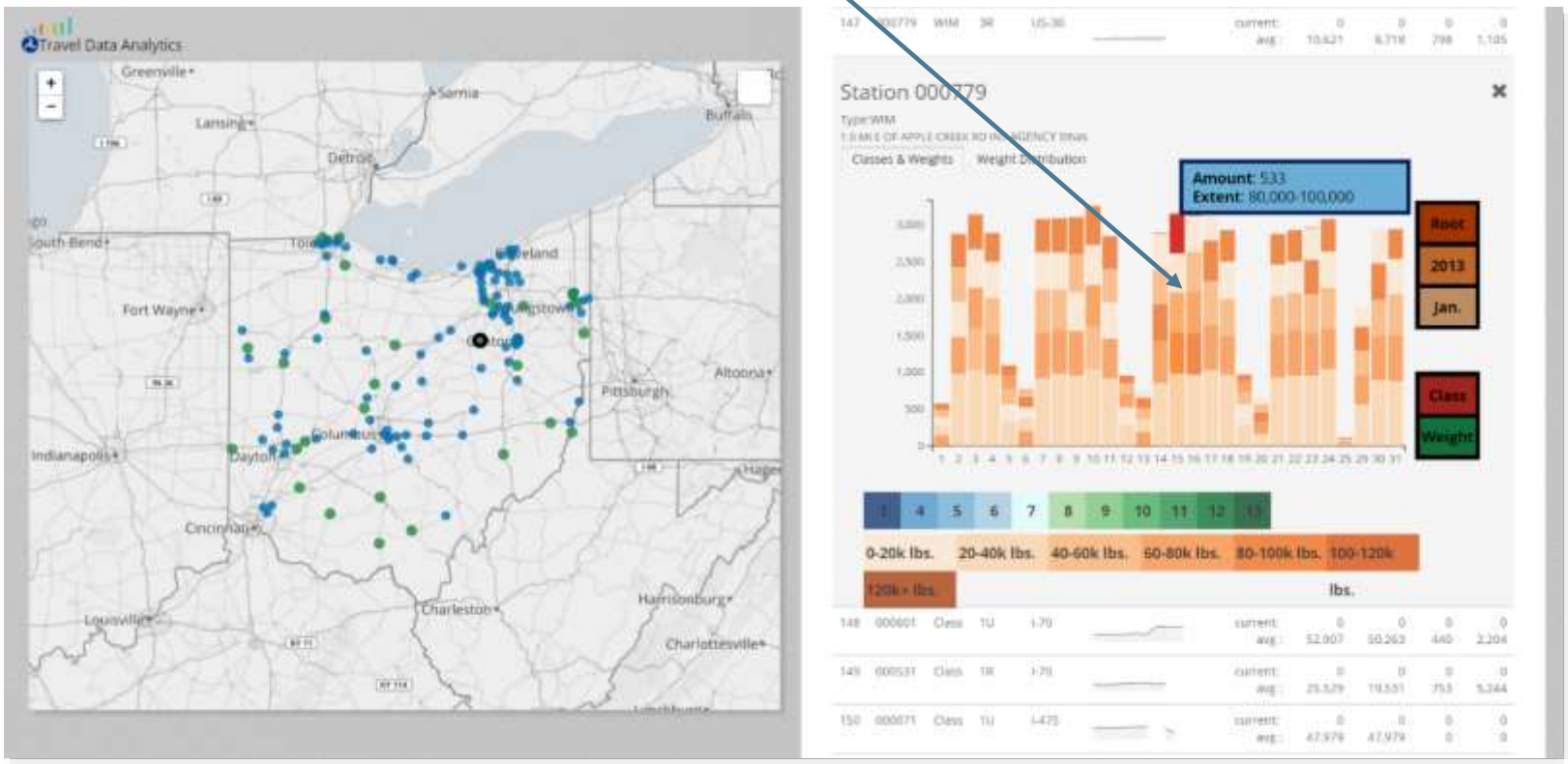


Figure 51

13. Notice on the right side of the screen that the year and month are listed for context. In this case it is July, 2013 as seen in Figure 52. To reset the filters, click on the "Root" button in the top right corner of the graph.

Figure 52

8.2.3 Single Station - Weight Distribution (Load Spectra)

14. Next, let's look at the Load Spectra Graph. In the web-tools Load Spectra is labeled Weight Distribution.
15. Click on the Weight Distribution tab.
16. Similar to the stacked graph for Weight Counts (Section 7.2.2 Nos. 9-14), The Weight Distribution graph is filterable by weight bin. Click on the weight bin bars to remove them from the spectra graph.

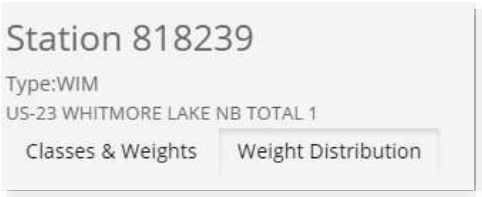


Figure 53

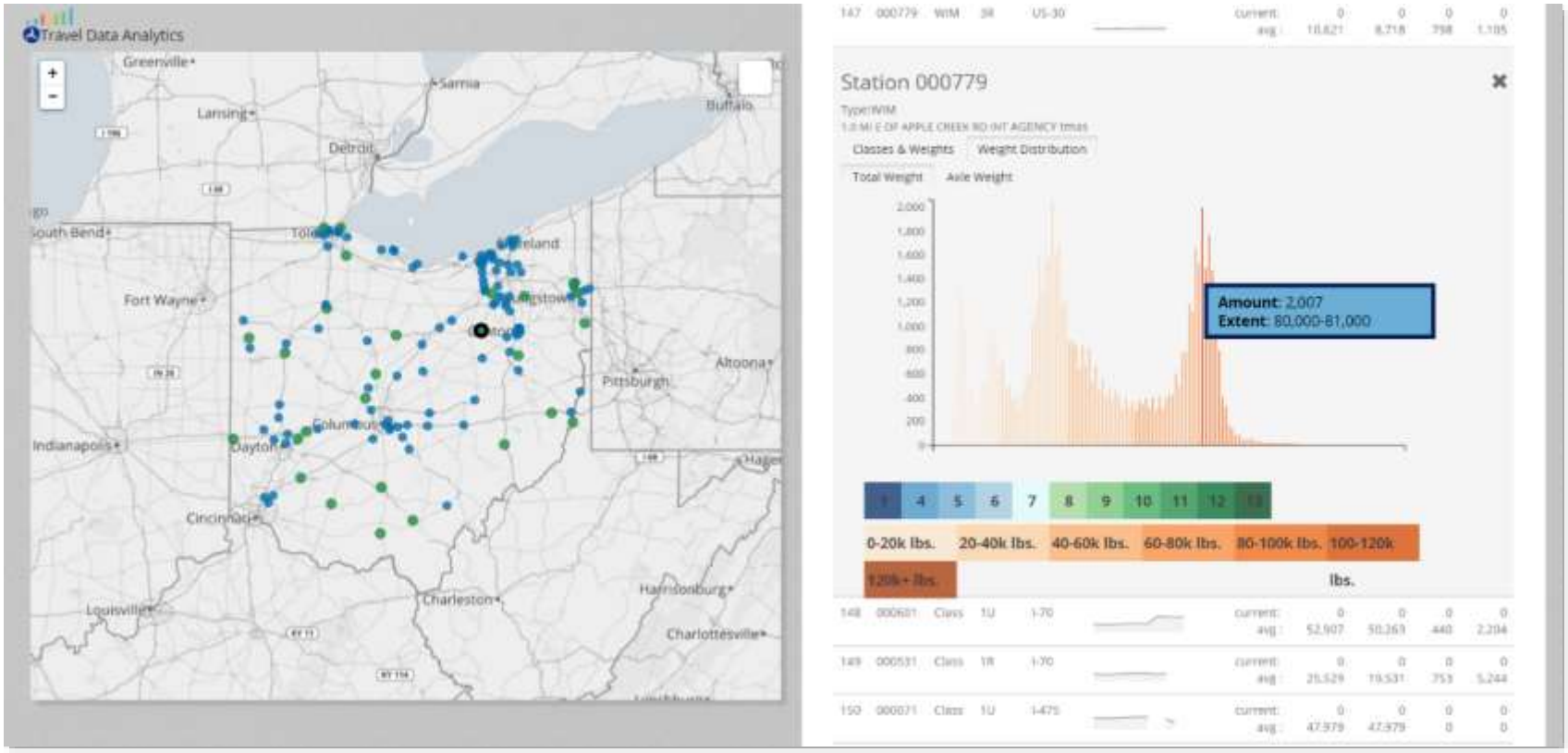


Figure 54

17. The time settings for the Load Spectra Graph are set by the Class & Weights tab. Click on the Classes and Weights tab to view the time settings. When years are listed, as seen in Figure 55, the Load Spectra Graph is showing data for all-time. Click on a year to drill in to that year, a month to drill in to that month.

Figure 55

Figure 56

18. Then, once you've set your time parameters (Figure 56 shows June 2013), click on the Weight Distribution tab to view Load Spectra for the month you selected.

Figure 56

8.3 CLASS TAB

19. Scroll back up to the top of the page and click on the “Class” tab.

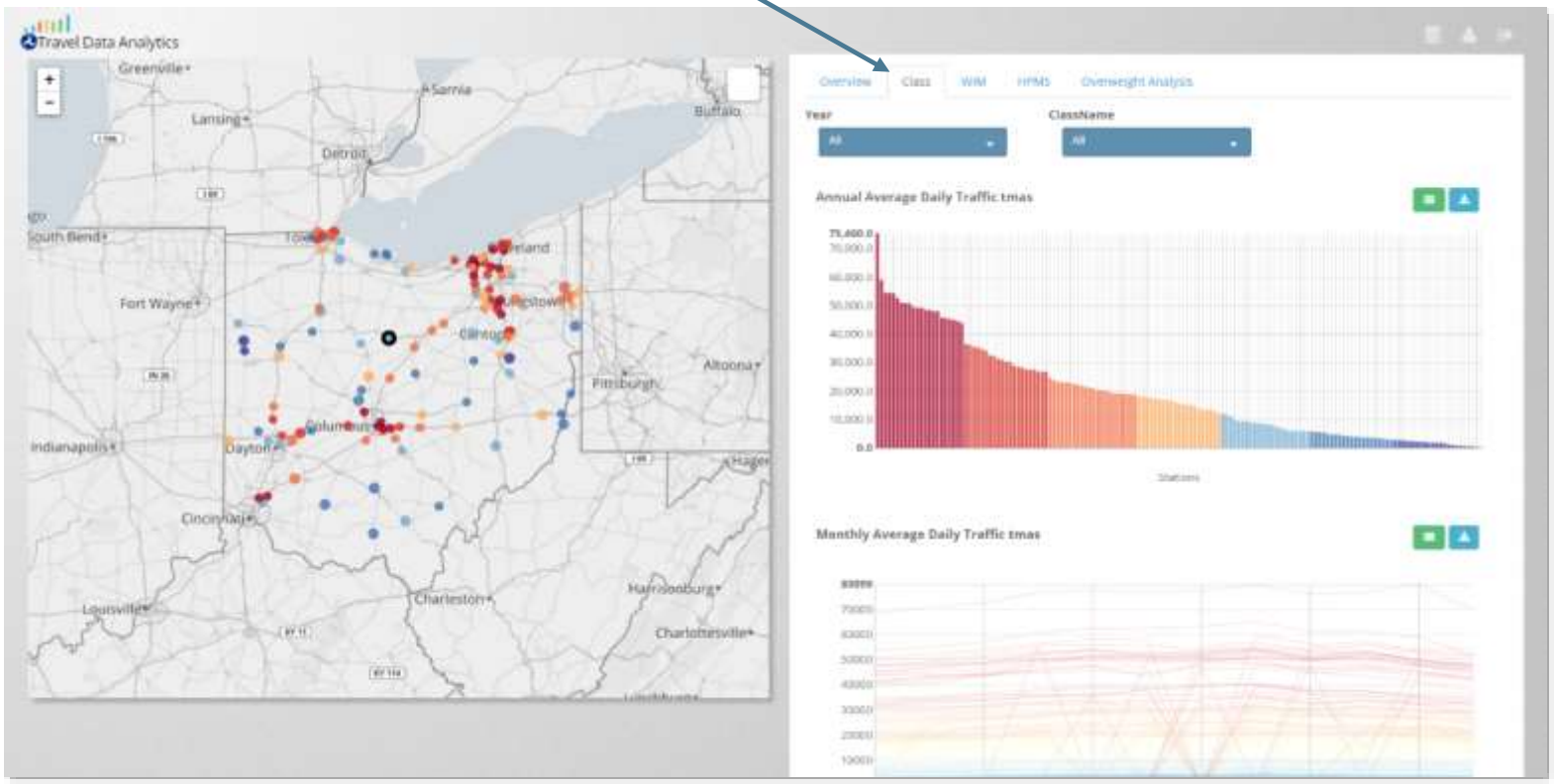


Figure 57

20. Now let’s take a look at the map on the left side. The map shows all of the stations in the state for which there is data. They are represented by circles. The size and color of the circle correspond with the Annual Average Daily Traffic for that station.

21. Also notice, in Figure 59, how when you scroll your cursor over a station the station card appears as a tool tip. The station also highlights yellow in the AADT graph on the right.

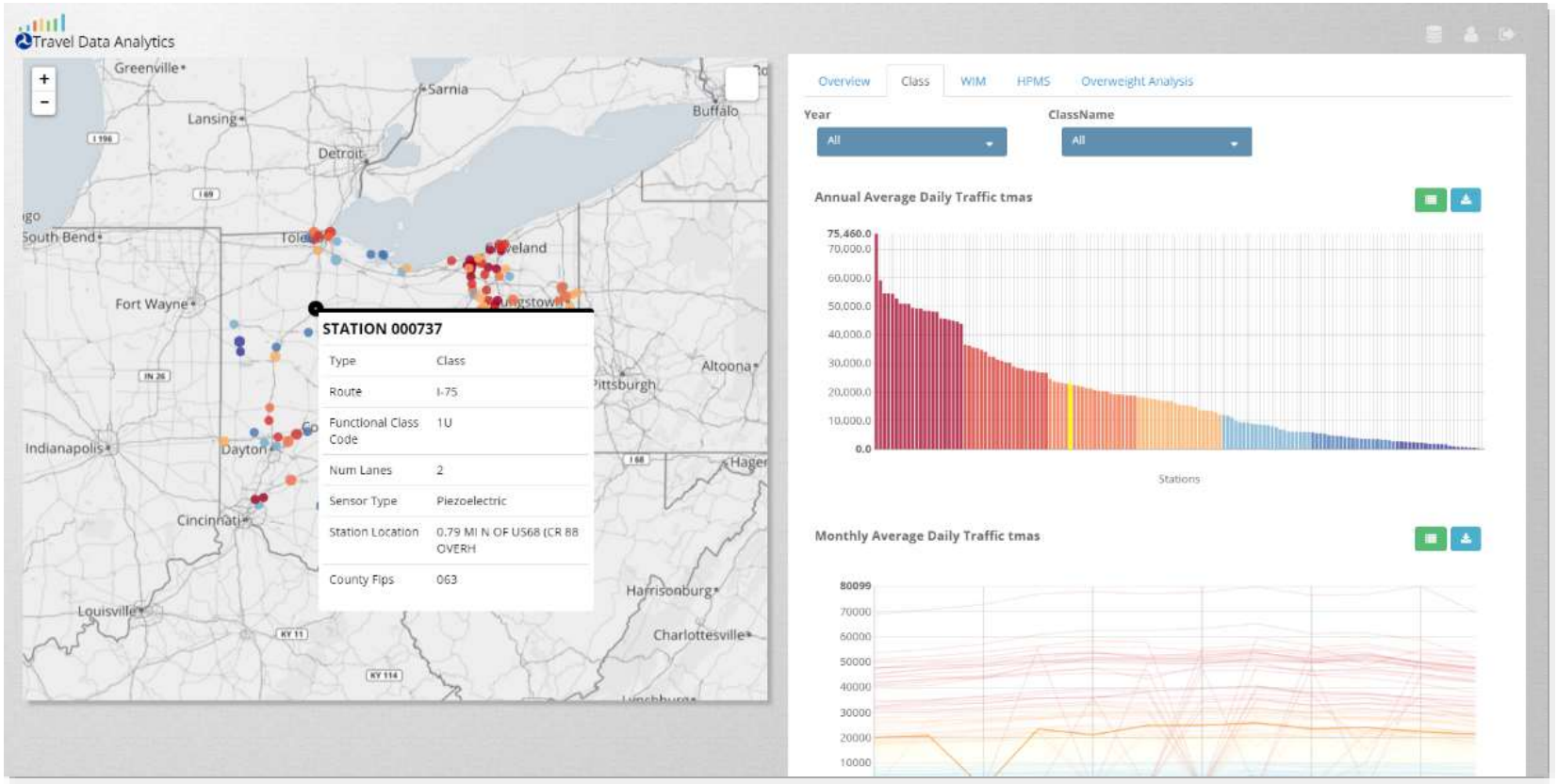


Figure 58

22. **Annual Average Daily Traffic**. To find data for this graph, AVAIL uses the class data and takes the simple average of all days (when data for a day is missing, the denominator is reduced by one) as per the Traffic Monitoring Guide:
    a. AADT – Annual Average Daily Traffic – The total volume of vehicle traffic of a highway or road for a year divided by 365 days. It is meant to represent traffic on a typical day of the year. The Traffic Monitoring Guide lists two basic procedures for calculating AADT. In the first of these techniques, AADT is computed as the simple average of all 365 days in a given year (unless a leap year). When days of data are missing, the denominator is simply reduced by the number of missing days:
        i. A simple average of all days; and
        ii. An average of averages (the American Association of State Highway Transportation Officials (AASHTO) method).
    b. ***NOTE:*** *AVAIL is capable of employing the AASHTO method of calculating AADT if the TA Panel deems it necessary.*

The AASHTO formulation for AADT is as follows:

$$AADT = \frac{1}{7}\sum_{i=1}^{7}\left[\frac{1}{12}\sum_{j=1}^{12}\left(\frac{1}{n}\sum_{k=1}^{n} VOL_{ijk}\right)\right]$$

Where:

VOL	=	daily traffic for day *k*, of DOW *i*, and month *j*
i	=	day of the week
j	=	month of the year
k	=	1 when the day is the first occurrence of that day of the week in a month, 4 when it is the fourth day of the week
n	=	the number of days of that day of the week during that month (usually between one and five, depending on the number of missing data)

Figure 59

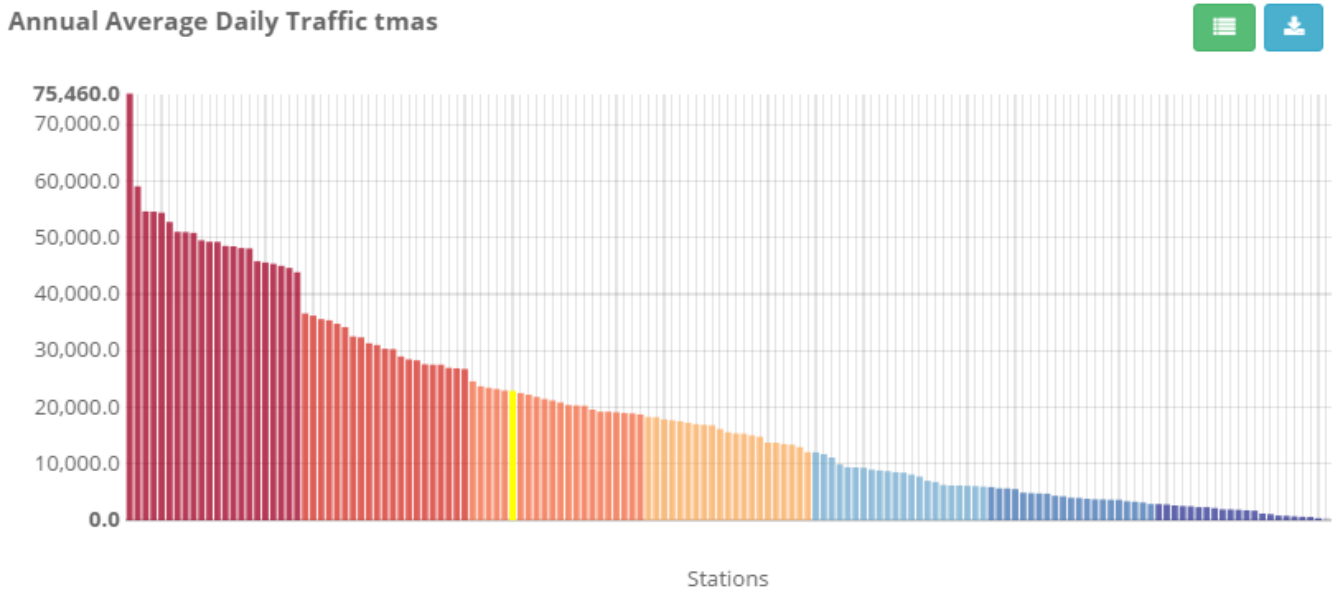


Figure 60

23. The second graph is **Monthly Average Daily Traffic.**
    a. Monthly Avg. Daily Traffic sums all traffic in a month and divides by the number of days in that month. For all of the days of data that are missing from a given month, the graphing algorithm reduces the denominator by one.
    b. MADT = Sum of Traffic in Month / Number of Day of Data in Month
24. The Bottom graph on this page is the **Seasonal Adjustment Factor** graph.
    a. To calculate the Seasonal Adjustment Factor, AVAIL takes the Monthly Average Daily Traffic and Divides it by the Annual Average Daily Traffic. **SAF=MADT/AADT**
    b. The Seasonal Adjustment factor shows how much more or less traffic than average, a station sees in any given month.

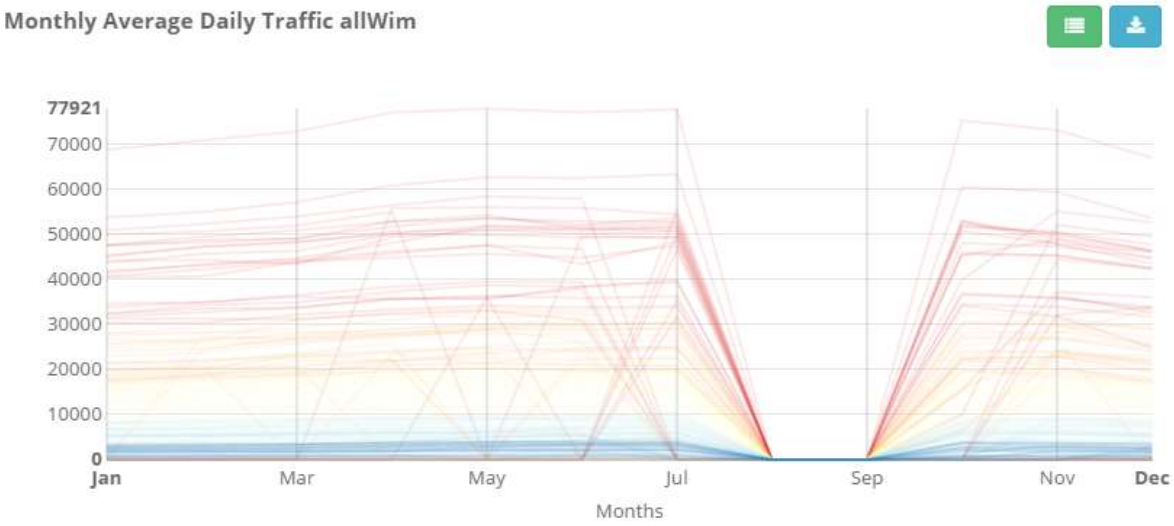


Figure 61

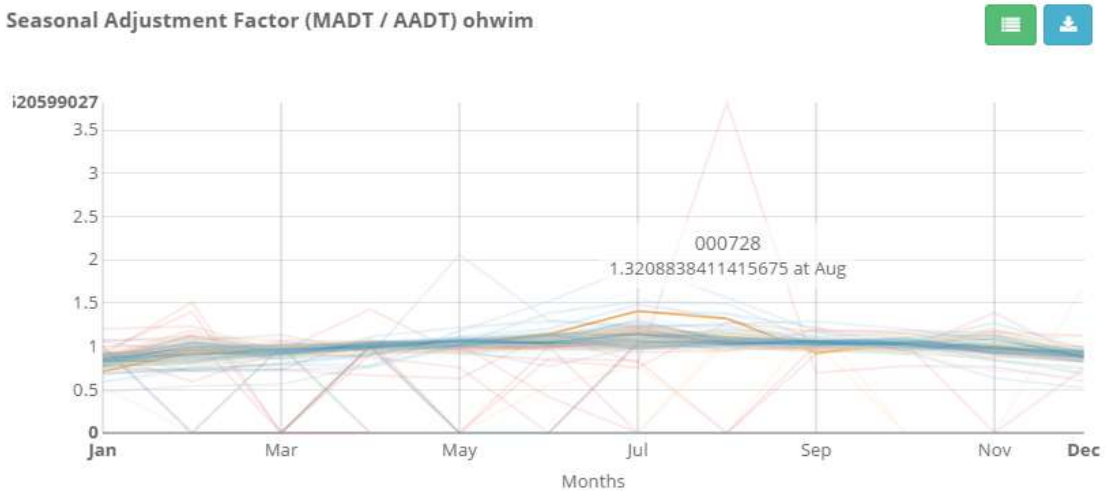


Figure 62

25. Also notice, some of the graphs have a set of icons in the top right.
    a. The green icon is a table icon. You can view tabular data for the graph by clicking on it.
    b. The blue icon is to download an image of the graph or a comma separated values file of the tabular data.
    c. Figure 64 is an example of the tabular data of the MADT Graph:

Station Id	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
16421	1.10	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.89	1.16	0.94
109511	1.49	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	1.44	0.64
16411	1.17	1.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	1.14	1.07
16811	1.10	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	1.10	0.99

Figure 63

8.4 WIM TAB

26. Scroll back up to the top of the page and click on the WIM tab.
27. Notice first in Figure 65 that the stations appearing on the map have been filtered. The only stations appearing now are the WIM stations.

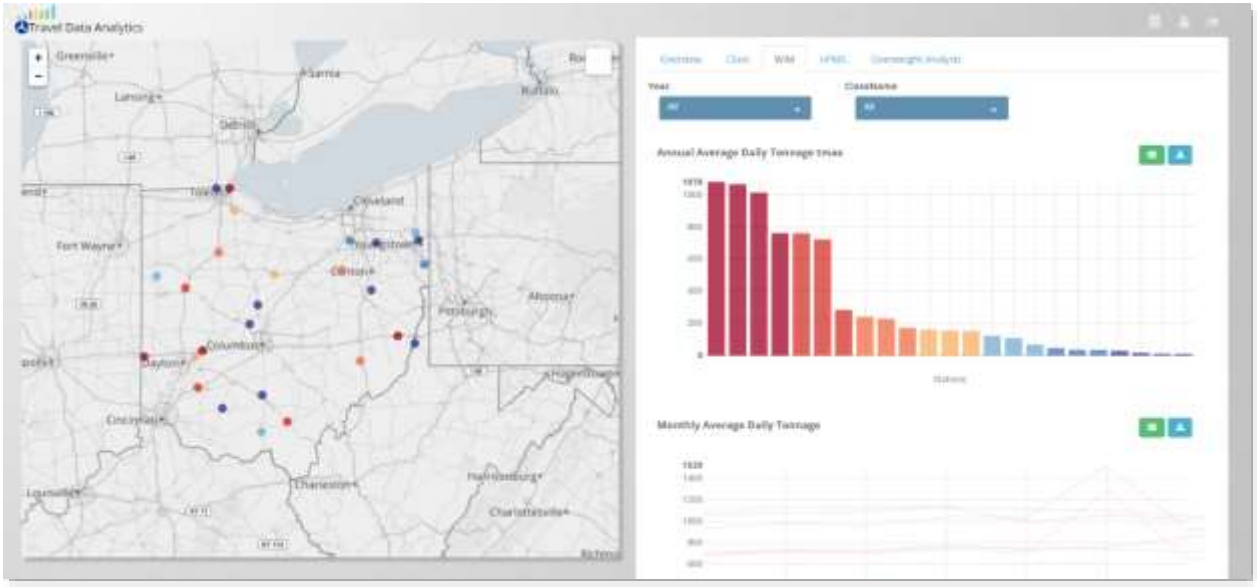


Figure 64

28. The WIM Graphs are exact replicas of the Class Graphs but are generated using weight data (in tons) instead of counts data.
29. The **Annual Average Daily Tonnage** graph is an exact replica of the Annual Average Daily Traffic graph listed above (Bullet Number 23). The algorithm for creating the AADTonnage graph is the same as the one used to make the AADTraffic graph except using Tons instead of Counts.
30. MADTonnage and Seasonality of Tonnage Graphs are replicas of the MADTraffic (Bullet Number 24) and Seasonality of Traffic (Bullet Number 25) graphs.

Figure 65

8.5 WIM and Class Tab Filters

31. Let's take a look at how the filters effect the graphs.

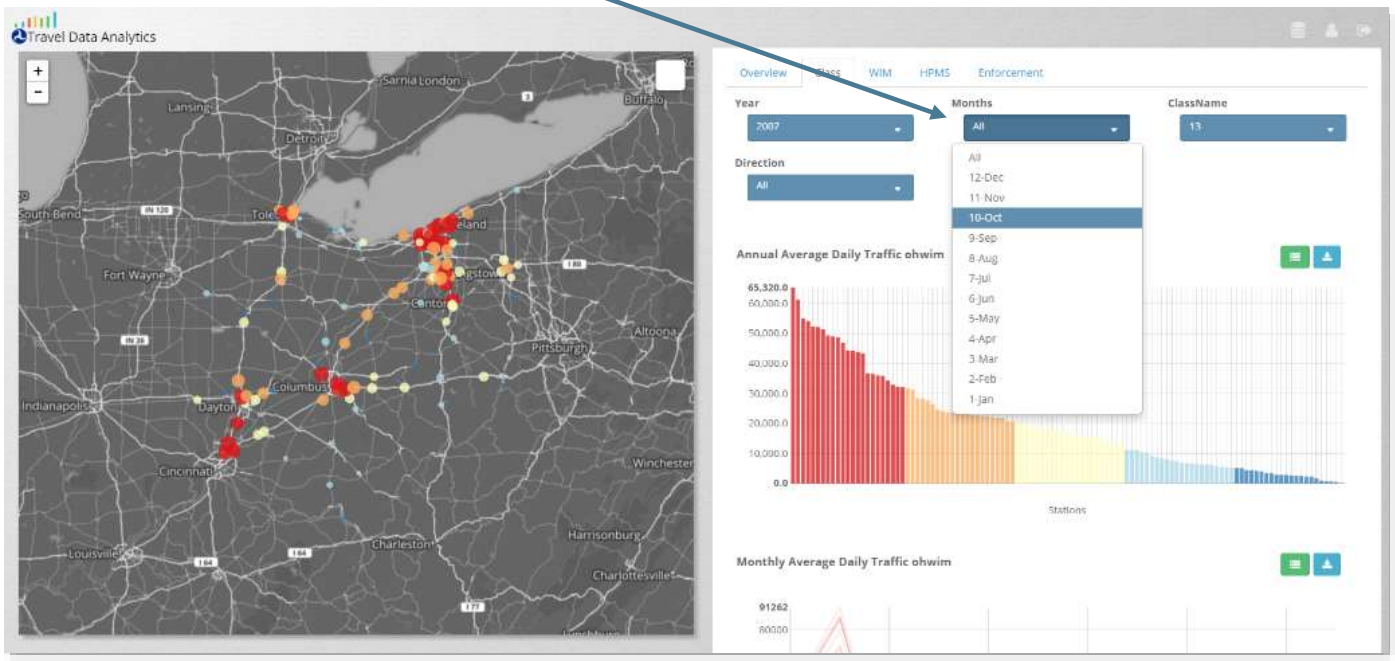


Figure 66

a. There are three filters to choose from for the Class and WIM tabs:
    i. Year
    ii. Classname
    iii. Direction

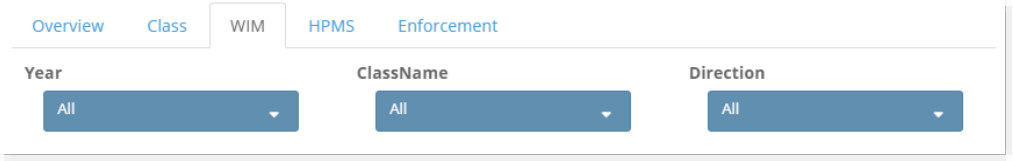


Figure 67

32. The Year filter is default to All. When All is selected the graphs show an average of all data in the system. By clicking on the Year filter you can select data for a given year for which there is data.
    a. After selecting a year, a new filter will appear. You can now select a given month.
33. The ClassName and Directrion filters also default to "All." When All is selected the graphs below show the AADTraffic or AADTonnage of all classes. Filter for Class 9 to see Class or WIM graphs of Class 9 vehicles. Filter by direction to see data from stations traveling in a given direction.

8.6 HPMS TAB

34. To view HPMS Data for road segments in a state, click the HPMS Tab.
35. When you scroll over an HPMS road segment, a box displays HPMS road segment and AADT information (Figure 69).
36. You can zoom in to the map by putting your cursor on the map and scrolling in or out.
37. Map tools include magnification (+/-) and layer switch (Terrain, Light and Dark Colored Maps and Satellite).

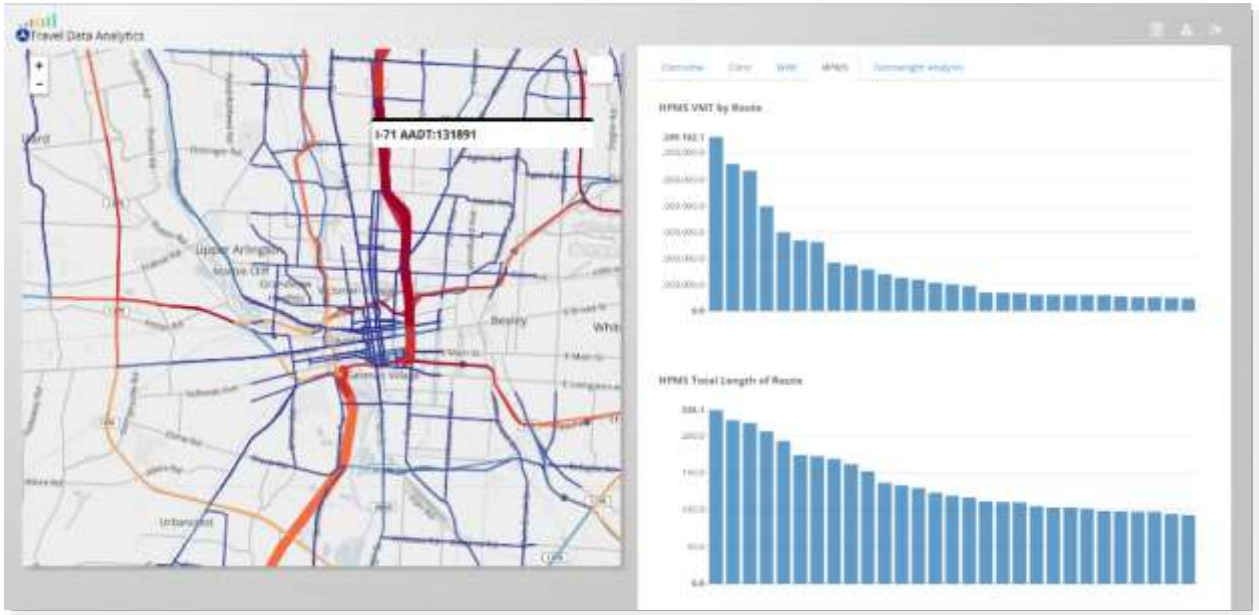


Figure 68

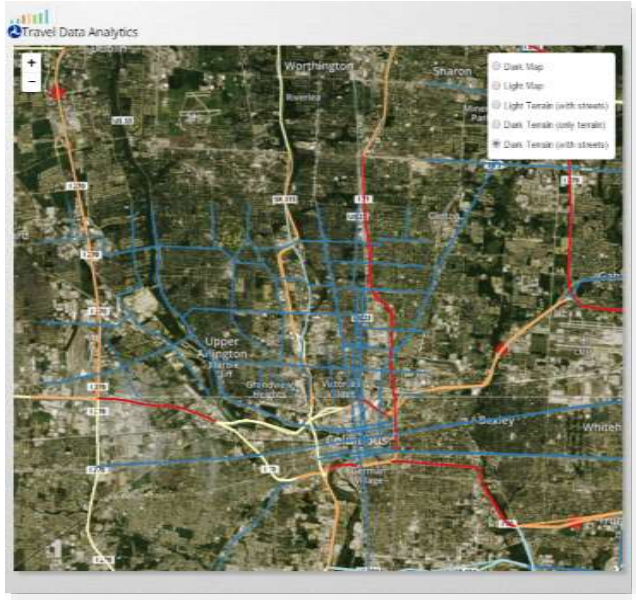


Figure 69

8.7 Overweight Analysis Tab

38. Click on the Overweight Analysis Tab

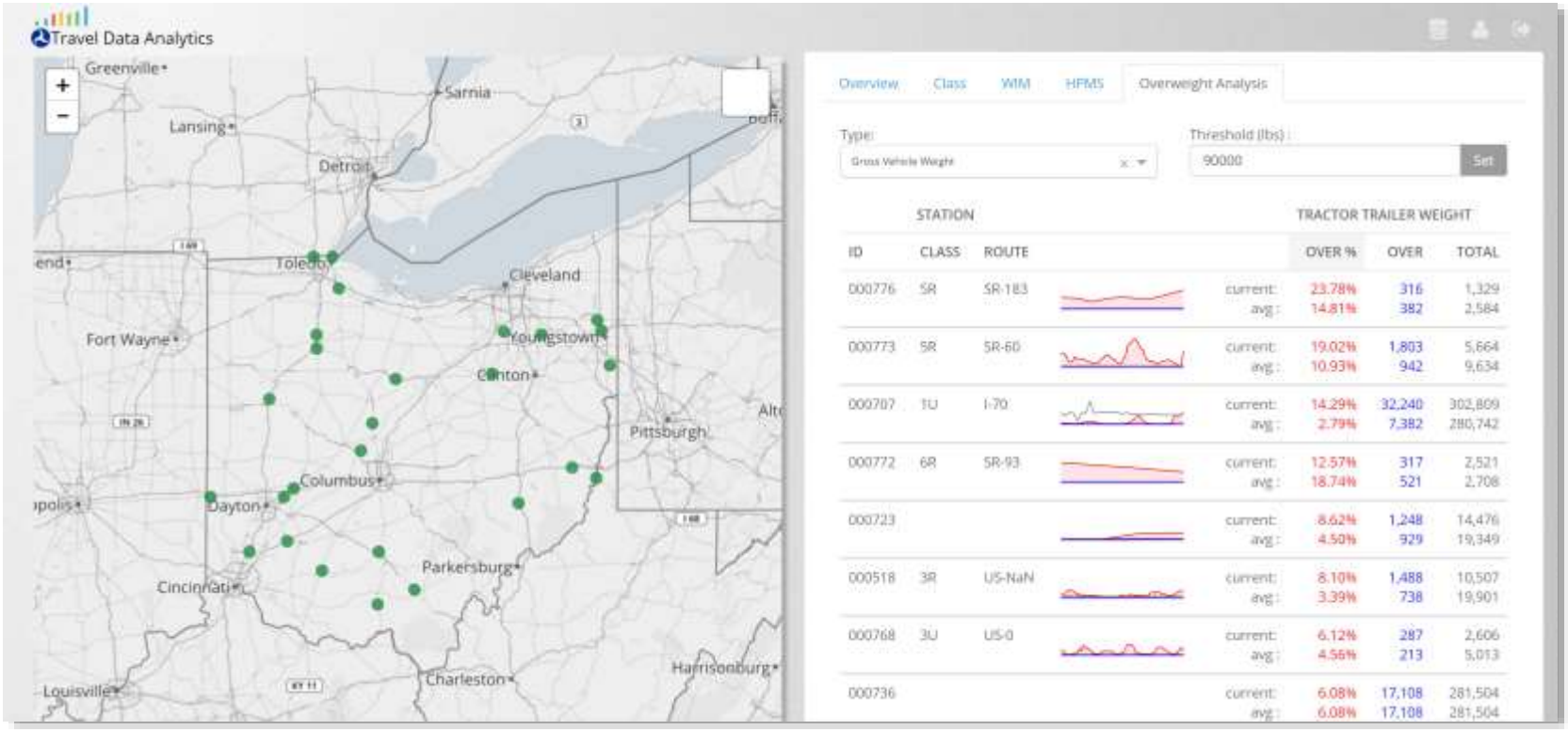


Figure 70

39. The Map once again filters stations, leaving only WIM stations. Scroll over the stations in the Overweight Analysis list to see their location on the map.
40. The Overweight Analysis Table shows all of the WIM stations in the state. Similar to the Overview Table. The Overweight Analysis Table defaults to the latest month of data in the system and shows a series of Columns (Station ID, Route Class, Route Name, Overweight %, Overweight Total, and Total Counts). The rows show each station. The sub-rows show the all-time average and the current month.

a. The spark line in the station row of the Overweight Analysis Table, shows the trend of overweight violations at this station over the last year ending at the selected month. The spark line shows overweight % (red line) and number of overweight (blue line).
b. At the top of the Overweight Analysis Table are settings for Overweight Type (Gross Vehicle Weight, Axle Weight and Bridge Formula) and an Overweight Threshold setting.

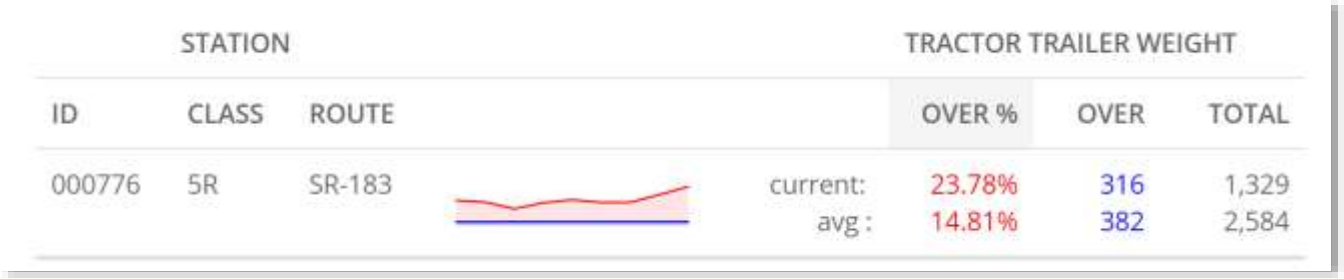


Figure 71

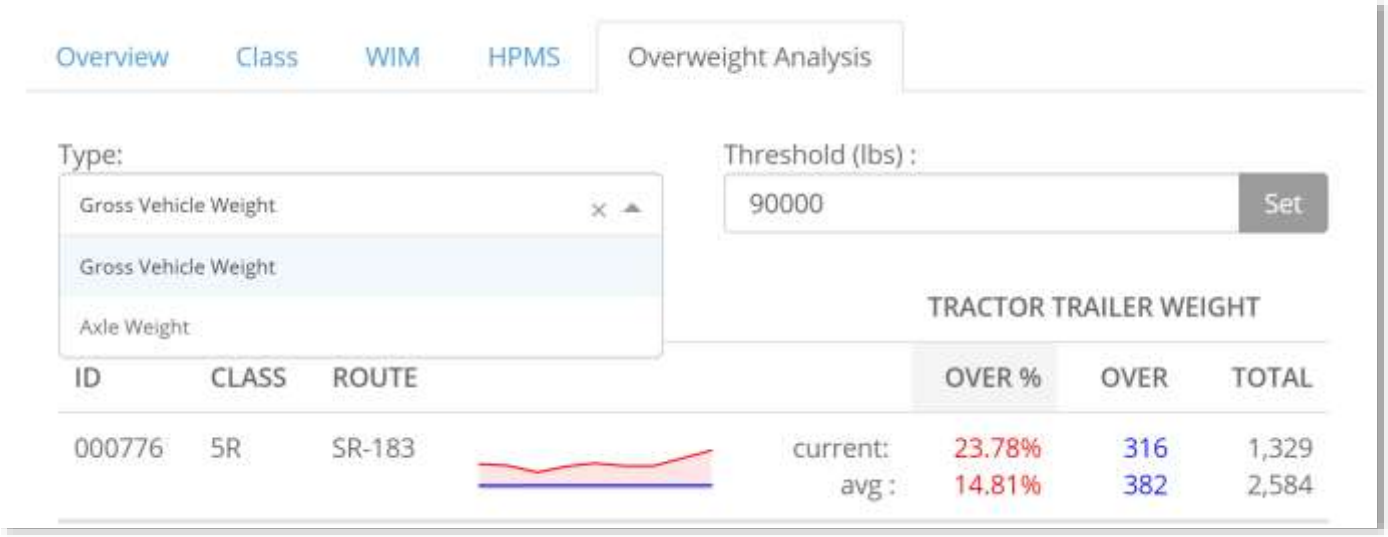


Figure 72

8.7.1 Single Station Overweight Analysis Graphs

41. Select a station by clicking on a row in the table. This will open the single station overweight graphs (Figure 74).

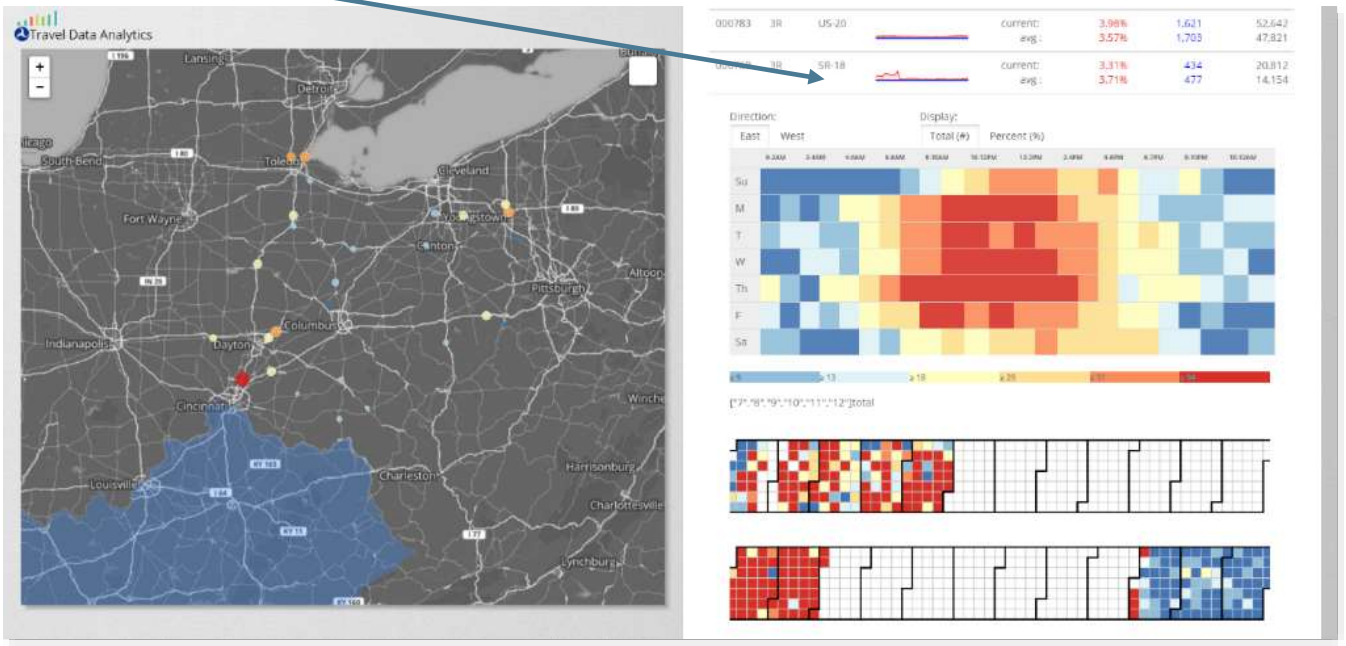


Figure 73

42. Two overweight graphs appear.
    a. Heat Graph: The first shows overweight truck information for an average day. This "heat graph" has day of week as a y-axis, Sunday (top) through Saturday (bottom), and the x-axis shows the hours in a day. The heat graph shows the hours of the day with the highest average of overweight violations.
    b. Calendar Graph. This graph shows all of the available data for the chosen station, by day, month and year where days with highest numbers of violations are red and lowest are blue.

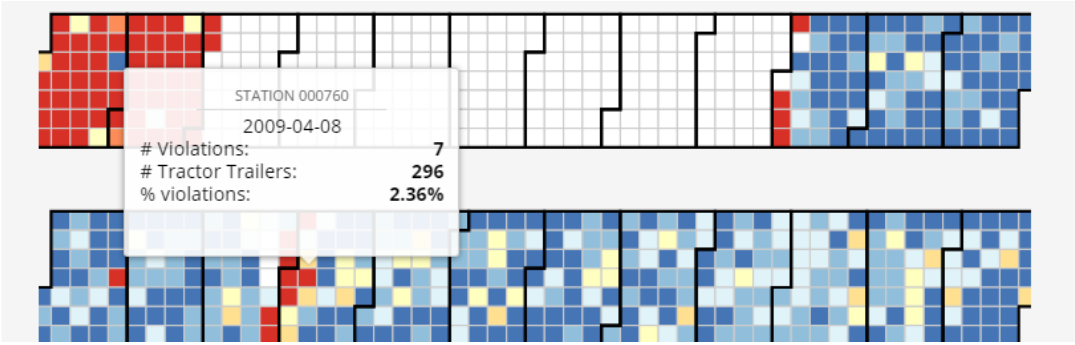


Figure 74

43. Filter in the single station Overweight Analysis graphs.
    a. Both graphs can be viewed by Total (number of violations) and percent (number of violations/number of tractor trailer trucks).
    b. Both graphs can also be filtered by direction of travel.

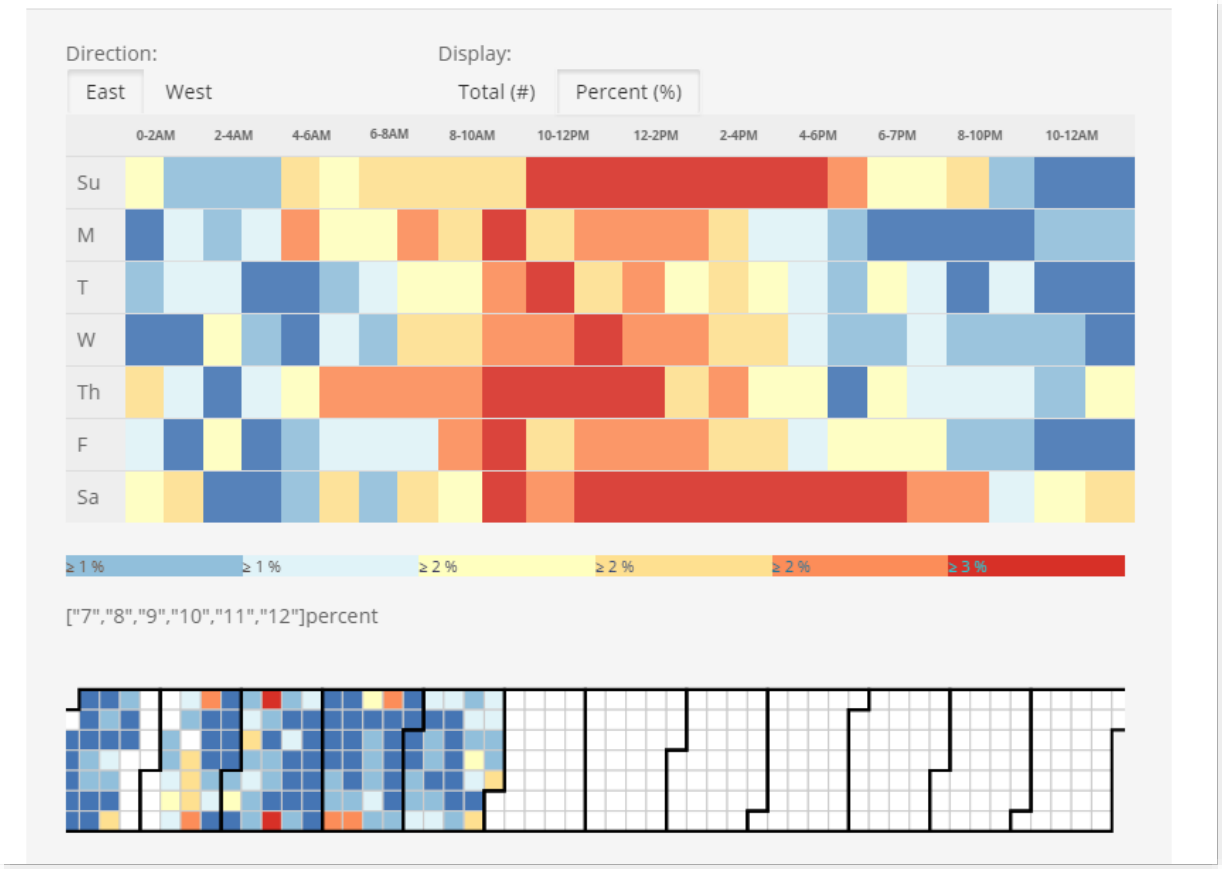


Figure 75

8.8 DATA MANAGEMENT

1. Log in to wim.availabs.org
2. In the top right corner of the page there are three icons .
3. Click on the icon of the person in the middle and a dropdown menu appears.

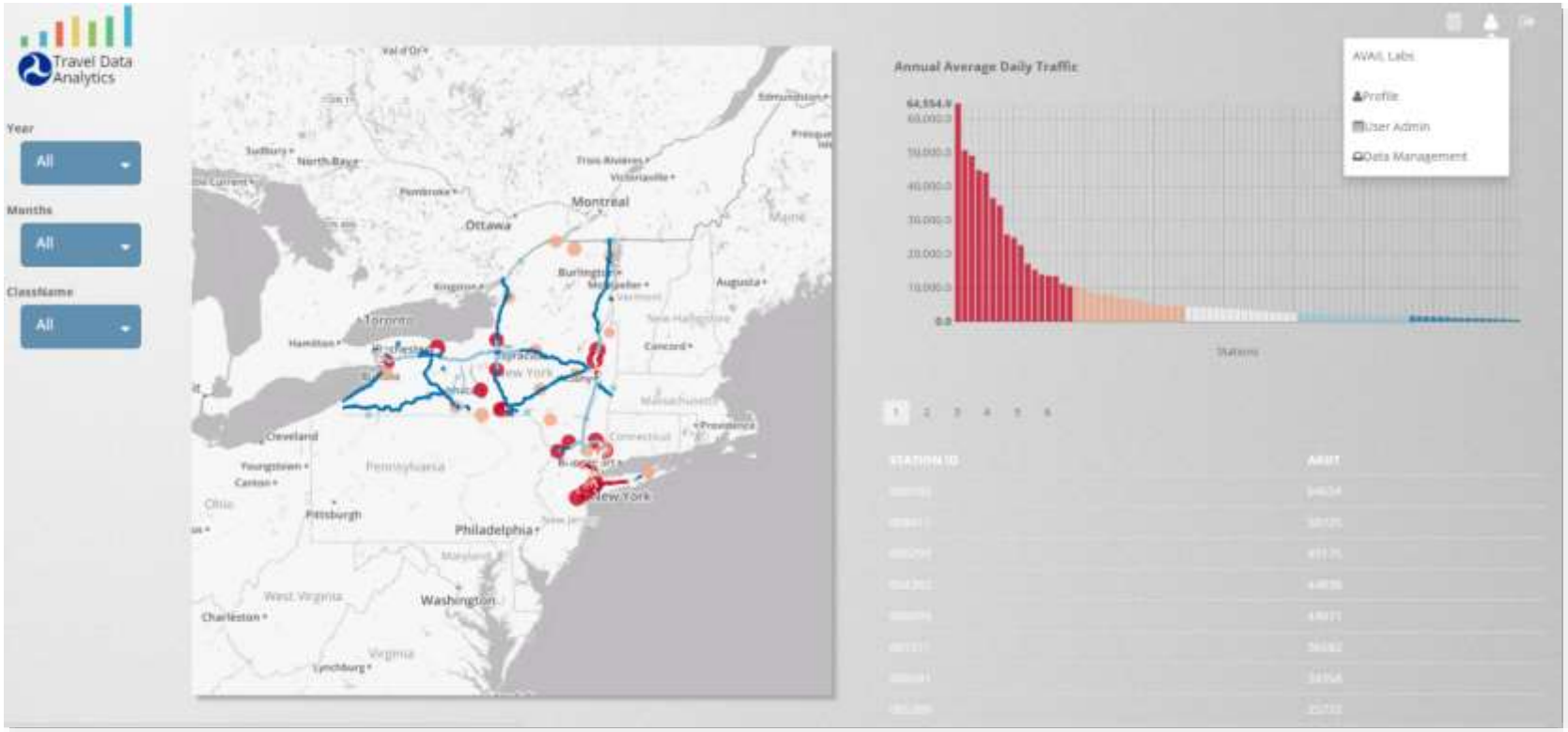


Figure 76

4. At the bottom of this menu, choose Data Management

5. You should now see the data management page shown in Figure 78.

Figure 77

8.8.1 Data Upload

6. To upload new data, simply click in the box located on the right side of the page, labeled “Upload New Data.”
7. As seen in Figure 79, you should now be able to search your files for a WIM or Class data file.

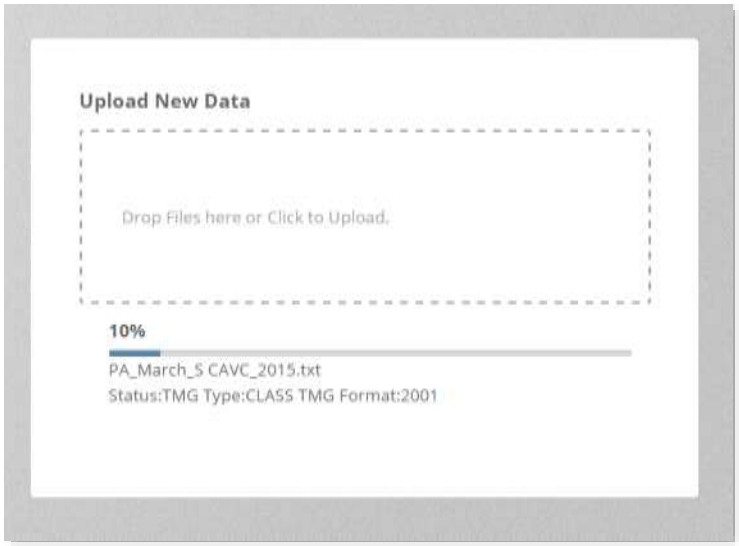


Figure 78

8. After clicking on the file, you should now see the status of the file upload on the right side of the page, as seen in Figure 80.

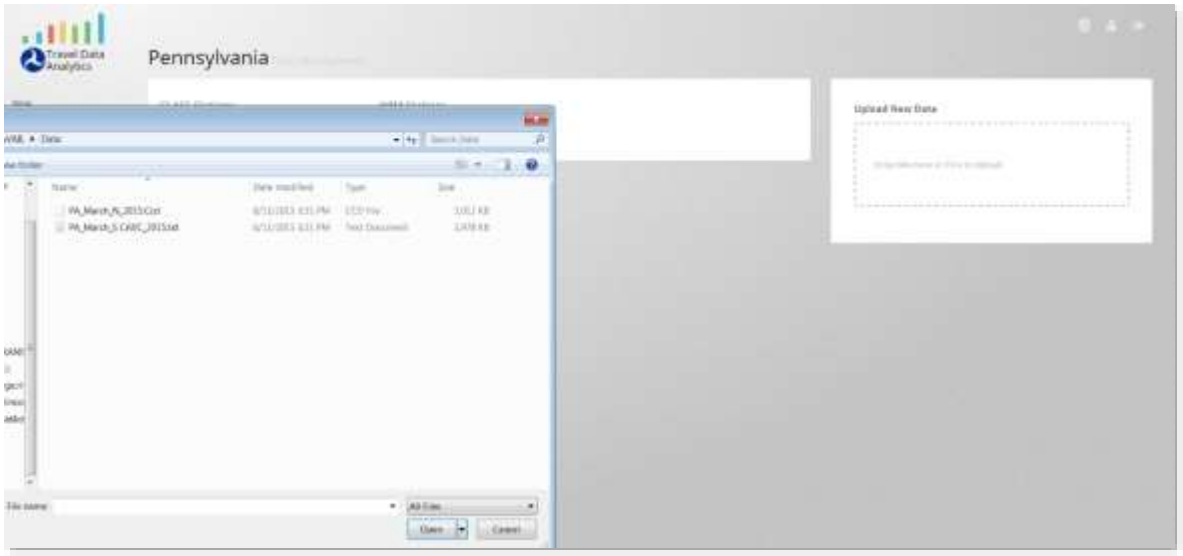


Figure 79

Calendar Graph of Uploaded Data

9. The available data for your state appears in calendar form. This is a general overview of available data for your state. Class data is listed on the left and WIM data is listed on the right. Dates with more data appear red. Dates with less data appear blue.

Figure 80