Transportation Systems Management and Operations Performance Report

7TH EDITION

JANUARY 2024

TSMO

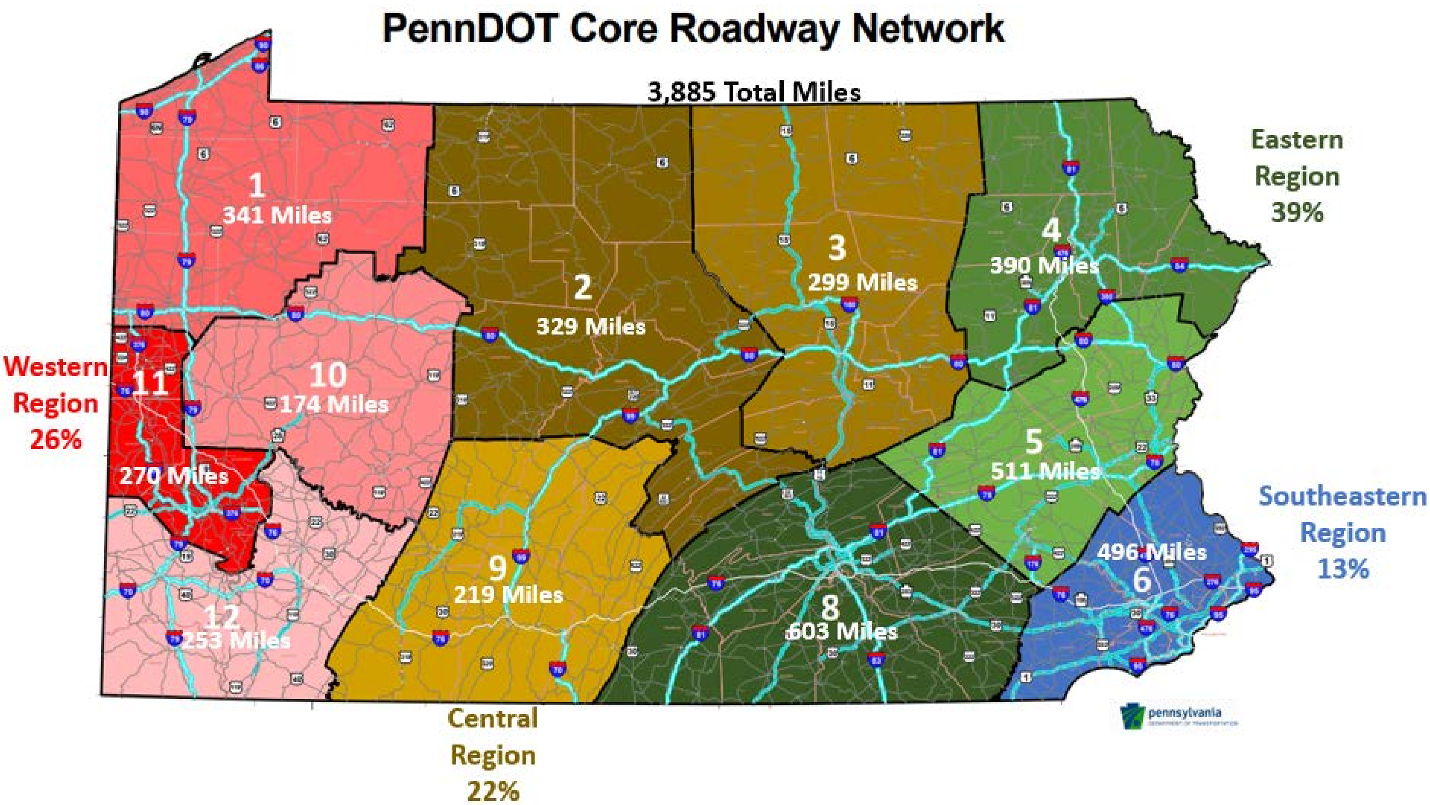




pennsylvania
DEPARTMENT OF TRANSPORTATION

Executive Summary

The TSMO Performance Report was developed to provide information to PennDOT traffic operations staff, partner agencies, and other key stakeholders to assist in implementing appropriate strategies and to make key decisions to improve the safety and reliability of the PennDOT Core Roadway Network[1].



Under each group of evaluations conducted, a brief introduction is provided along with a conclusions area which helps to explain the results as well as identify opportunities where this information could be beneficial. Based on the information provided within this report, each District or region will review and develop how they are going to adjust their District or regional approaches with the Traffic Operations Plans (TOPs) that are required as part of Publication 855 – TSMO Guidebook Part V – Operations.

The TSMO Performance Report (7th Edition) provides a new Reliability analysis. Reliability evaluates the consistency of travel times along a roadway segment during a specific day and time. Periods with the worst consistency are considered Unreliable periods and operationally deficient. This analysis includes an evaluation of the PennDOT Core Roadway network, which has determined the most Unreliable segments and periods throughout the State and each District. This evaluation can be found under **Reliability :**

In addition to this new analysis, this TSMO Performance Report also provides annual updates to 6 previously provided categories which include:

[1] Pennsylvania's "Core Roadway Network" was established in 2011 for 511PA, and includes state owned interstates, limited access roads, and other major routes throughout the Commonwealth.

- **Congestion Pie Chart Updates (Figures 7 through 8)** – Incorporates the methodology provided within **Appendix 1** to provide updates to the congestion pie chart on the PennDOT Core Roadway Network and compares with changes from 2019 and 2020.
- **Congestion Realated Crashes (Figures 9 through 11)** – Displays crashes by congestion type and type of crash, and provides a breakdown of injuries by severity.
- **Secondary Crashes (Figure 12)** – Displays a breakdown of secondary crashes by time and distance from the primary crash.
- **Work Zone Congestion Crashes (Figures 16 through 18)** – Displays a breakdown of work zone crashes by distance from the work zone and identifies the short-term and long-term work zones with the highest crash rates.
- **Traffic Management Center (TMC) Situational Awareness (Figures 16 through 18)** – Provides several metrics for the TMCs to evaluate and improve their performance.
- **Average Incident Clearance Times (Figures 19 through 21)** – Provides several breakdowns and comparisons of incident clearance times.

NEW ANALYSIS

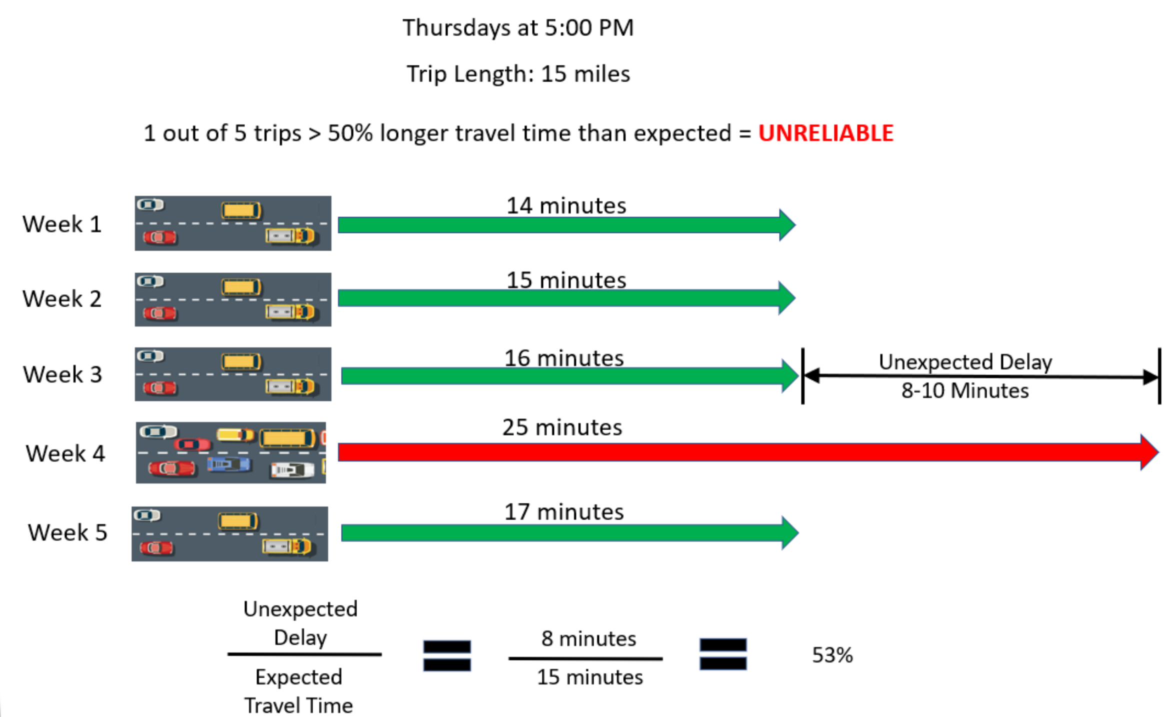
Reliability

Background

Historically, traffic management performance measures have focused on delay and travel speeds along a roadway facility. However, the amount of congestion along a particular facility at a particular day and time often varies greatly. For example, a motorist may experience daily congestion during a commute, but if this congestion is uniform from one day to the next, this commuter can properly plan for these delays. Although congestion, long delays, and travel speeds are undesirable, motorists can plan for delays on reliable roadway segments, when the delays recur at the same time to a similar magnitude. Alternatively, a motorist may experience varying levels of congestion from day to day, which might cause a typical 15-minute commute, to become a 25-minute commute. This commuter is unable to plan for the additional 10-minute delay on this unreliable roadway segment, which causes more frustration than if the route was predictably congested. Routes that are unreliable also may be better candidates for operational solutions, as the unreliability demonstrates that congestion is not a result of capacity being able to keep up with normal demand. Reliability is a new performance metric developed by PennDOT to measure this phenomenon and determine the most unreliable segments in terms of location and timeframe.

Methodology

The Reliability analyses include the core network and other critical transportation corridors throughout Pennsylvania. A Reliability score is calculated for each Traffic Message Channel (TMC) segment (or grouping of TMC segments) for each 15-minute period for each day of the week. Reliability scores are calculated by taking the 80th percentile travel time divided by the 50th percentile travel time. A segment is considered unreliable, or operationally deficient, during a 15-minute period if traveling the segment will take 50% longer than expected on 20% of the trips (Reliability score 1.5 or greater). The below figure illustrates an example of an unreliable segment. In this example, 1 out of 5 trips (20%) are 50% longer than the expected travel time.



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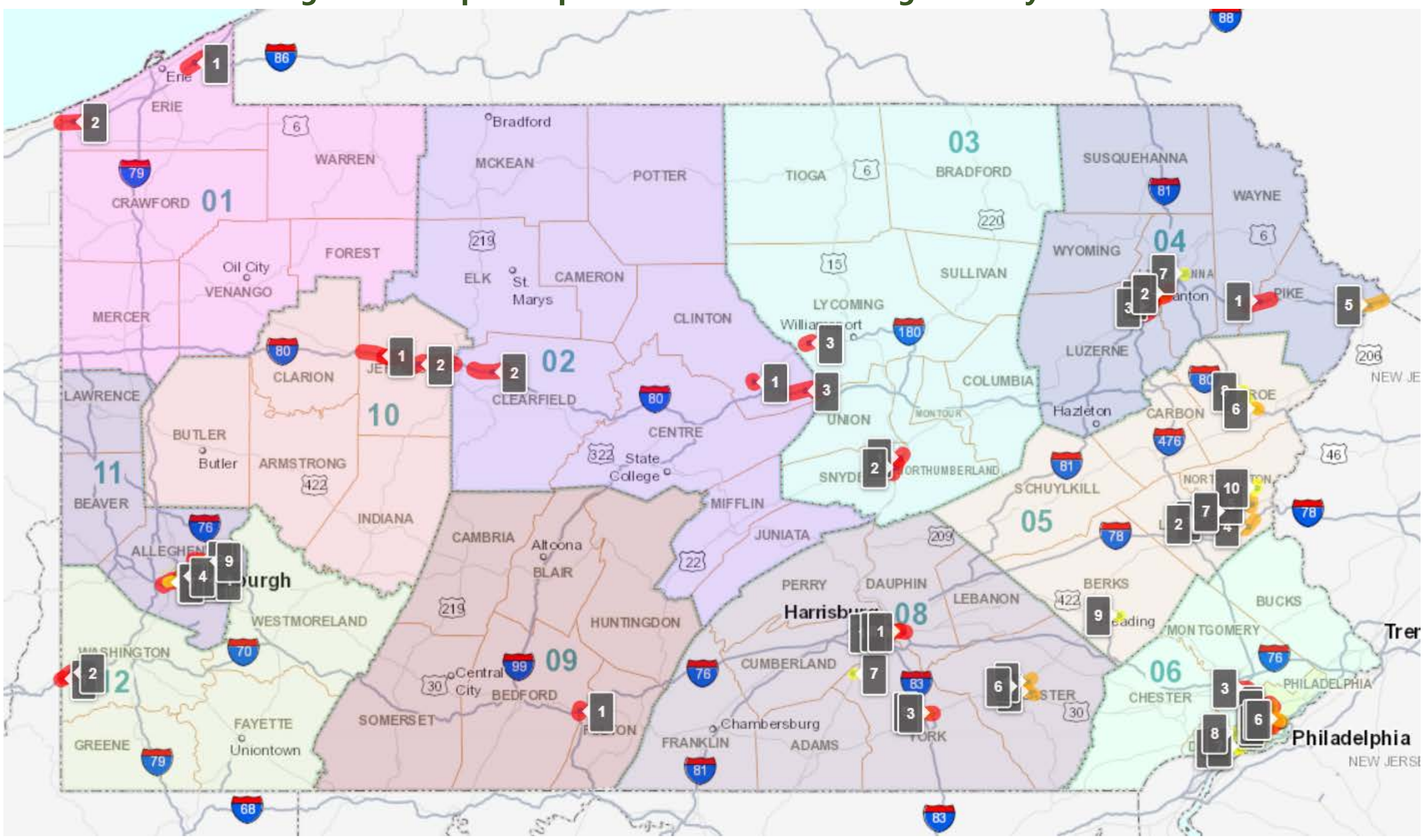
2022 Most Unreliable Segments

Within each PennDOT District, the top 10 most unreliable segments for each year are determined. These Segments are shown on the map below. An interactive map of these segments is available here. Note that clicking on one of the Most Unreliable Segments will generate a pop-out with additional information. This includes the following information for each segment:

- Basic segment information
- A link to an Excel file that contains a heatmap (Reliability scores for each 15-minute period of each weekday) and a congestion pie chart
- The number of unreliable hours in a week
- The weekday and weekend 15-minute periods
- The free flow travel time
- Up to 5 of the most unreliable periods - unreliable Periods are defined as periods of time when a segment is unreliable for at least 45 minutes, with no more than one Reliable 15-minute period. For each unreliable period, the typical travel time (50th percentile) and unreliable travel time (80th percentile) are indicated.

Figure 1 – Map of Top Ten Most Unreliable Segments by District



The most unreliable segments are the longest uninterrupted periods of operational deficiency during the week, ranked by total duration. The top 10 most unreliable Segments in Pennsylvania during 2022 are shown in the table and map on the following page.

Figure 2 – Listing and Map of Top 10 Most Unreliable Segments – Statewide

Statewide Rank	District	Route	Direction	Location	Leading Cause of Congestion
1	2	US-220	SB	PA-477/LONG RUN RD	Weather
2	6	I-76	WB	34TH ST/EXIT 346 to WALNUT ST	Other Incidents
3	6	I-76	WB	US-1/CITY AVE/EXIT 340/EXIT 339	Other Incidents
4	6	I-76	EB	I-476/EXIT 331B & 28B to MATSONFORD RD/EXIT 332	Other Incidents
5	6	I-76	EB	US-1/EXIT 340/EXIT 339 to US-30/US-13/GIRARD AVE/EXIT 342	Other Incidents
6	4	I-84	WB	PA-507/EXIT 20	Weather
7	6	I-676	EB	I-76/EXIT 344 to 23RD ST	Other Incidents
8	11	I-376	WB	GREENSBURG PIKE/EXIT 9 to BRADDOCK AVE/EXIT 7	Weather
9	6	I-676	WB	8TH ST to I-76/EXIT 344	Other Incidents
10	9	I-70	WB	I-70/LINCOLN HWY	Weather

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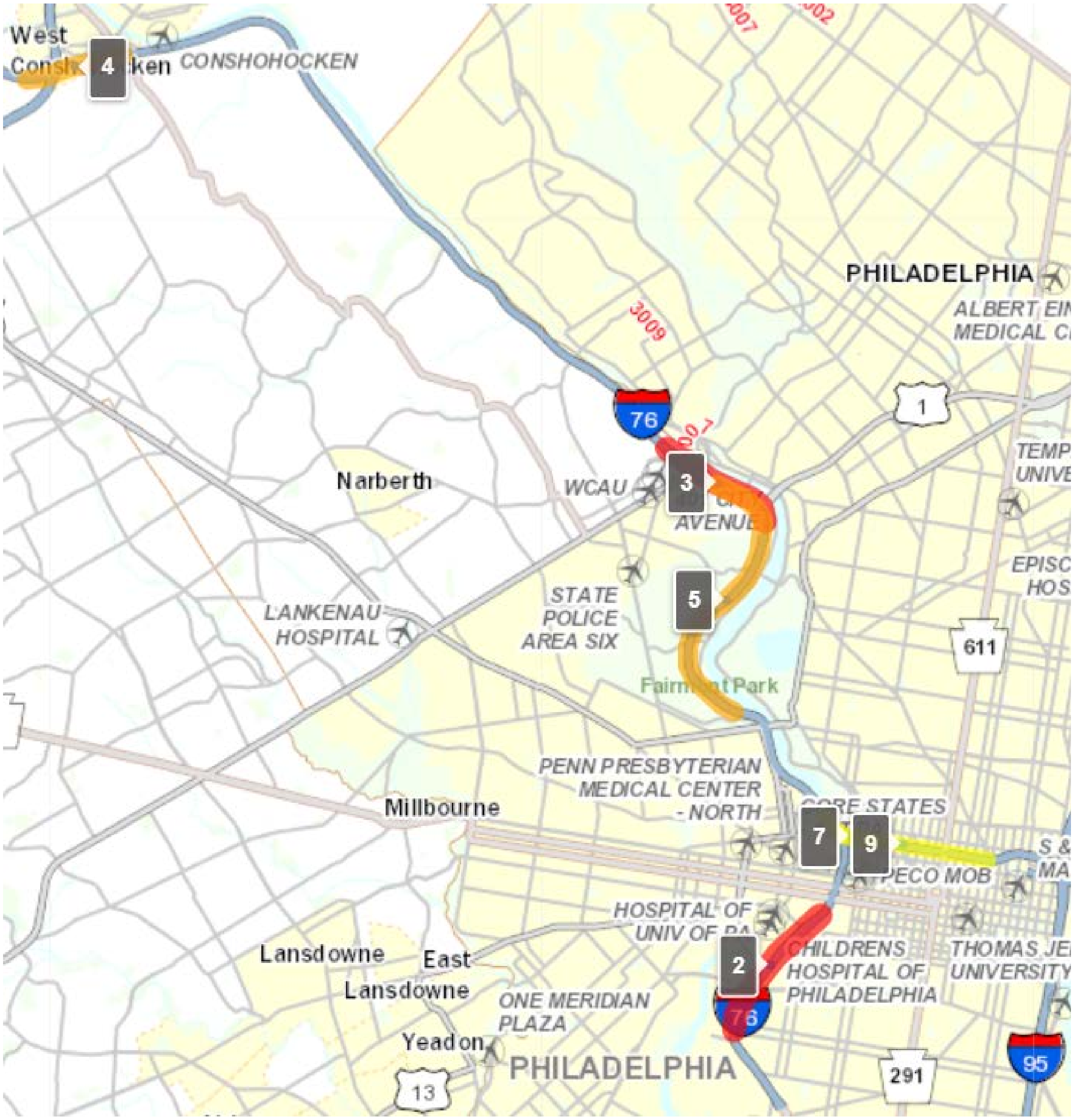
NEW ANALYSIS

As shown in the previous figure, 7 of the top 10 unreliable segments are in the Philadelphia area. Close ups of the segments in the Philadelphia area are shown below

Figure 3 – Closeups of Philadelphia Segments on the Top 10 Statewide LIst



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Reliability Trends

The number of Unreliable segments by District over the past 5 years is shown in the below table. Predictably, there was a substantial reduction in unreliable segments in 2020 and 2021 due to Covid. The number of unreliable segments increased in 2022, but did not return to 2018 / 2019 levels. Districts 1, 2, 3, 4, and 12 have experienced substantial reductions in unreliable segments from 2019 to 2022.

Figure 4 – Unreliable Segments by District 2018 to 2022

District	Year				
	2018	2019	2020	2021	2022
1	10	9	1	6	2
2	7	6	0	0	3
3	10	10	4	4	3
4	14	14	2	7	7
5	13	19	12	19	17
6	25	25	25	23	27
8	21	29	12	25	26
9	14	1	1	0	1
10	2	2	0	0	2
11	19	17	7	9	15
12	11	6	2	2	2
Total	146	138	66	95	105

The following 2 figures show the 10 segments statewide with the most improved reliability from 2019 to 2022, as well as the 10 segments with the most reduced reliability over the same period. 2019 was selected for comparison purposes due to Covid impacting 2020 and 2021, as noted above.

Figure 5 – Segments with Most Improved Reliability from 2019 to 2022

2022 Statewide Rank	2019 Statewide Rank	District	Route	Direction	Location	Cause of Improvement
Reliable	2	8	US-222	SB	US-322	Completion of Roadwork
Reliable	7	8	US-222	SB	US-322	Completion of Roadwork
Reliable	9	6	I-76	EB	I-676/US-30/EXIT 345	Completion of Roadwork
Reliable	10	6	I-476	SB	US-1/EXIT 5	Completion of Roadwork
Reliable	11	8	US-222	NB	US-322	Completion of Roadwork
Reliable	12	6	I-476	NB	I-95 to MACDADE BLVD/EXIT 1	Completion of Roadwork
Reliable	14	8	US-222	NB	US-322	Completion of Roadwork
Reliable	15	11	I-279	NB	PA-65/EXIT 7 to PA-28/7TH ST/EXIT 7	Completion of Roadwork
Reliable	16	5	PA-33	SB	PA-191	Completion of Roadwork
Reliable	24	11	I-376	WB	FORT PITT BRIDGE to I-279/US-22/US-30/FORT PITT BLVD/EXIT 6	Congestion from smaller incidents was down significantly

Figure 6 – Segments with Most Reduced Reliability from 2019 to 2022

2022 Statewide Rank	2019 Statewide Rank	District	Route	Direction	Location	Cause of Reduction
1	Reliable	2	US-220	SB	PA-477/LONG RUN RD	Roadwork
5	Reliable	6	I-76	EB	US-1/EXIT 340/EXIT 339 to US-30/US-13/GIRARD AVE/EXIT 342	Significant increase in non-crash incident congestion
6	Reliable	4	I-84	WB	PA-507/EXIT 20	More Inclement Weather
10	Reliable	9	I-70	WB	I-70/LINCOLN HWY	Roadwork
11	Reliable	6	I-95	SB	STEWART AVE/EXIT 8 to CHESTNUT ST/EXIT 6	Significant increase in non-crash incident congestion
13	Reliable	11	PA-28	NB	HIGHLAND PARK BRIDGE/EXIT 6 to DELAFIELD RD/EXIT 7	Roadwork
19	Reliable	1	I-90	EB	PA-430/EXIT 32 to I-86/EXIT 37	Roadwork
23	Reliable	6	I-95	NB	I-476/EXIT 7	Roadwork
25	Reliable	11	I-376	WB	US-19/BANKSVILLE RD/EXIT 5 to POPLAR ST	More Inclement Weather
26	Reliable	11	PA-28	SB	DELAFIELD RD/EXIT 7	Roadwork

Conclusions

It is not surprising that the number of unreliable segments dipped significantly in 2020 as the COVID-19 pandemic led to significantly reduced traffic volumes throughout the state, resulting in notably less congestion statewide. The total number of unreliable segments statewide increased in 2021 and again in 2022 but is still lower overall than in 2018 and 2019. This is consistent with the fact that traffic volumes and congestion overall have risen significantly from pandemic lows, but still remain below pre-pandemic norms.

As a general rule, the segments that experienced significant changes in their level of reliability from 2019 to 2022 had active roadwork ongoing in one of the two years, but not both. Weather variability was also a common cause of variations in reliability. Some segments with significant changes showed a notable change in non-crash incident-related congestions, and these segments merit further investigation to determine what might be at the root cause of those changes.

Focus on Improvement

- Reliability as a metric identifies areas that may be candidates for operational solutions, because the unreliability is not strictly a result of a lack of capacity
- Data on unreliable segments should be incorporated into Regional Operations Plans (ROPs) and these locations can be targeted for further analysis and potential solutions.

Pennsylvania's Congestion Pie Chart - 2022

Background

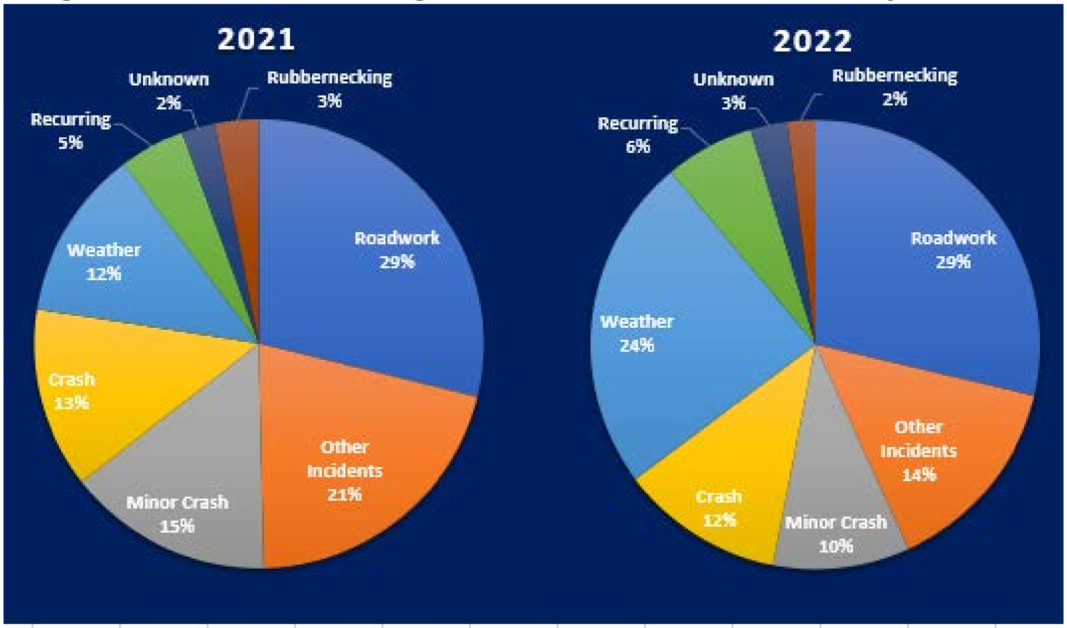
In early 2020, the TSMO Performance Program released a Pennsylvania-specific congestion pie chart using real data for 2018. This effort turned out to be one of the first in the nation to place comprehensive data behind the measure allowing for the congestion profile to be dynamically scaled to different geographies of interest.

In 2020, the tool was updated to allow for pie charts at the municipality level. The 2022 congestion pie chart is available via the Traffic Operations Analytics (TOA) portal for anyone with a Commonwealth of Pennsylvania account, via this link.

For further information about the methodology used to develop the congestion pie chart, see Appendix 1 – Congestion Pie Chart Methodology.

2022 Congestion Pie Chart – Statewide (Core Roadway Network)

Figure 7 – 2022 vs 2021Congestion Pie Chart for Core Roadway Network



Cause	Change from 2021 to 2022	Source/Definition
Roadwork	-0%	RCRS Roadwork, Maintenance Database, or Waze Roadwork event
Other Incident	-7%	Non-crash traffic hazard from Waze (i.e. disabled/car stopped on shoulder, hazard on roadway)
Minor Crash	-5%	Non-reportable crash from RCRS or Waze
Crash	-1%	Reportable crash from the Crash Record System (CRS)
Weather	+12%	Inclement weather[2] conditions from RWIS or Waze weather event
Recurring	+1%	Congestion where speed drop is no more than 10% greater than the historical average speed

[2] Heavy rain, any kind of snow, and/or snow covered, icy, or wet (with temperature below freezing) roads

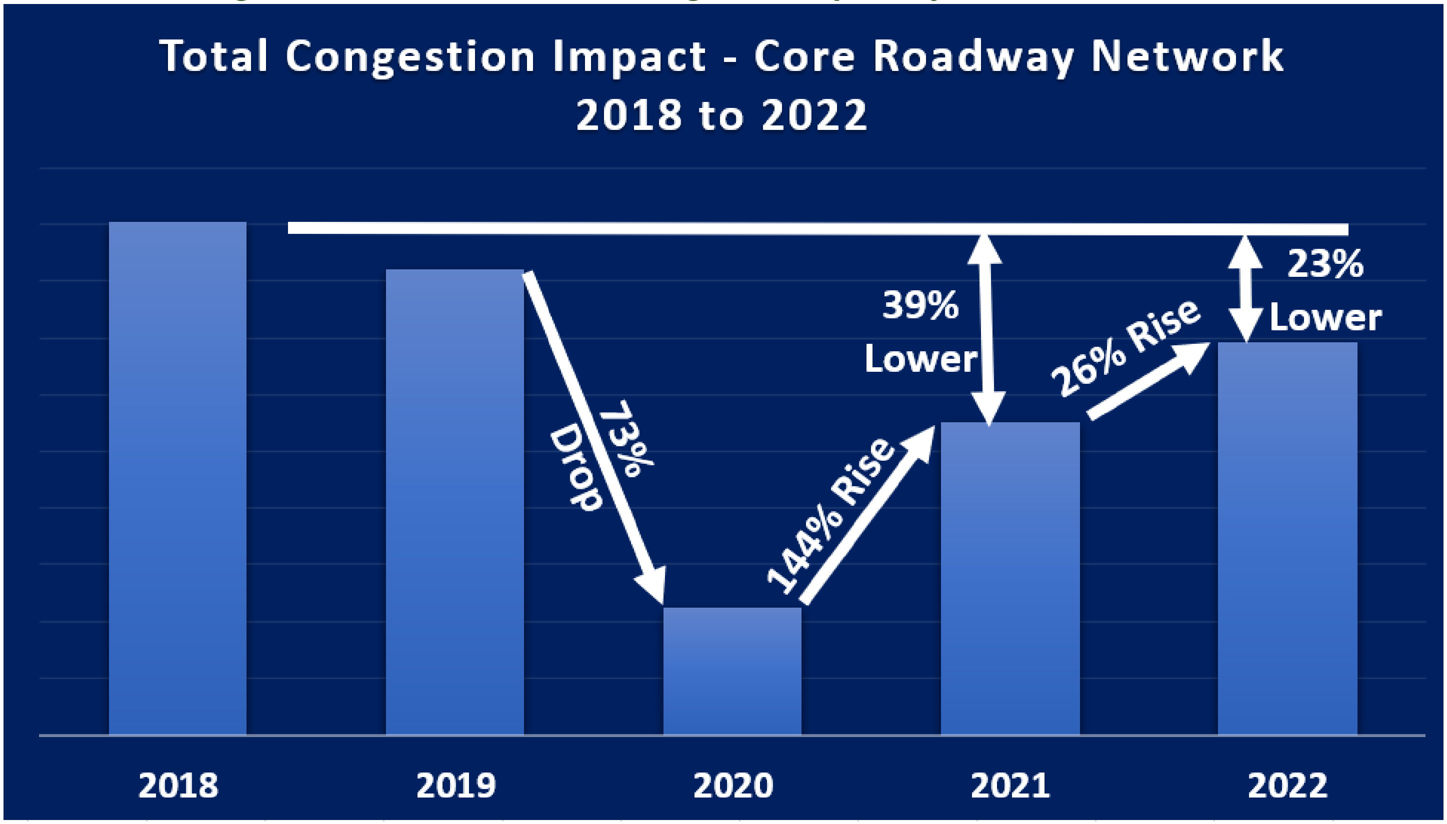
Unknown	-+1%	Cause could not be identified with current data sources
Rubbernecking	-1%	Any previously identified congestion pie chart incident cause is linked to one side of the road, and no incident is correlated to the other side of the road in the same area, but still experiences a speed drop above historical norm

Conclusions

The most notable change in the pie chart from 2021 to 2022 was the significant increase in weather, from 12% of congestion in 2021 to 24% in 2022. This is indicative of much more winter storm activity in 2021 when compared to 2022. Minor crashes and other incidents fell 5% and 7% respectively from 2021 to 2022, both return to levels that were more consistent with prior years. Recurring congestion increased slightly, which is consistent with the marginal increase in traffic volumes that was seen overall in 2022 relative to 2021.

Impact of COVID-19 Pandemic on Core Network Congestion

Figure 8 – Total Core Network Congestion Impact[3] by Year - 2018 to 2022[4]



Conclusions

The impact of the COVID-19 pandemic on the total amount of congestion on the core roadway network was dramatic, and while congestion did make a comeback in 2021 and 2022, congestion remains well below pre-pandemic levels. This is likely due to the ongoing increase in people working from home and suggests a "new normal," with congestion levels remaining below 2018-2019 levels.

[3] Congestion impact = Duration x length of queue x speed drop

[4] 2021 data is preliminary and may change slightly when all data sources have been processed

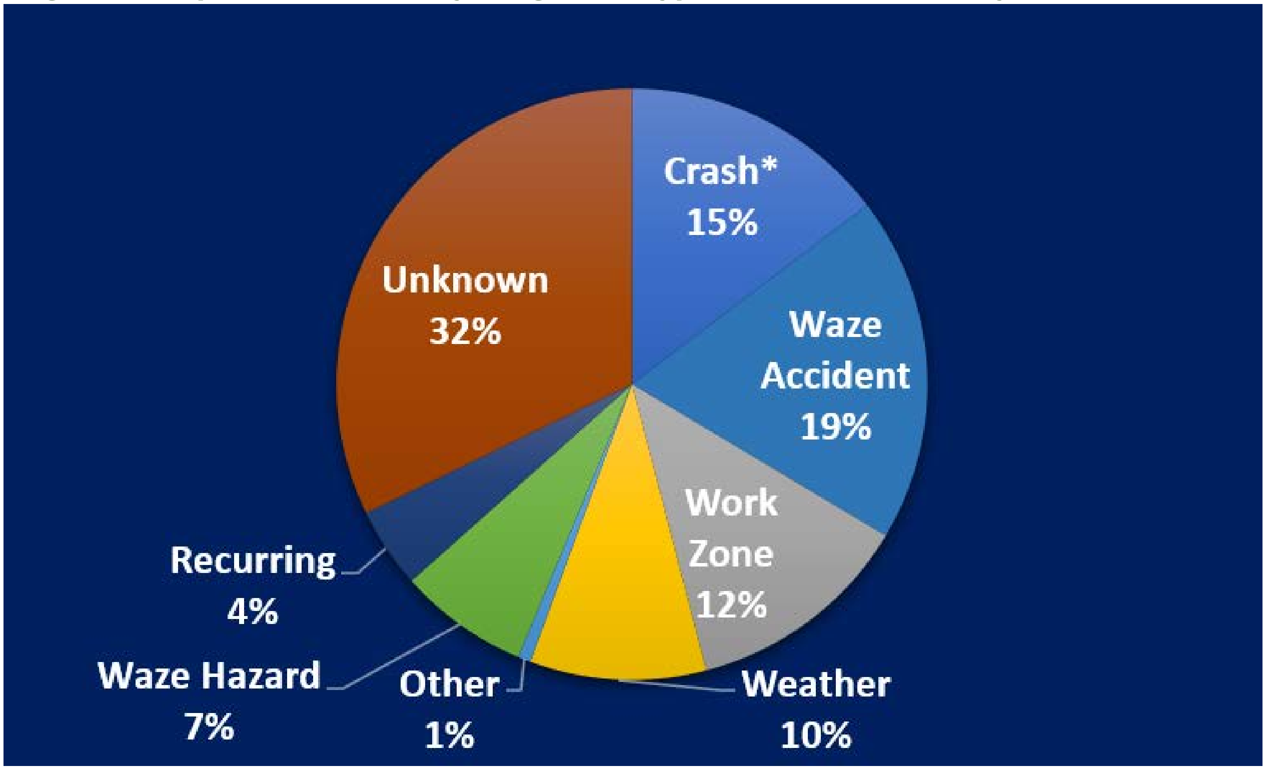
Congestion-Related Crashes on the Core Network

The TSMO Performance Report began presenting data on crashes that occurred in existing congestion on the core network with the 3rd report in 2017. The following information presents that data for 2022. For reference, the numbers under the "Work zone" column represent all crashes that occurred in the congestion behind a verified roadwork event (contractor or PennDOT).

Note: As in previous analysis, Special Events and Waze Weather were also analyzed as potential causes of congestion. However, there were no congestion-related crashes found in 2022 where either of these were determined to be the primary cause of the congestion.

The chart below shows the breakdown of 2022 congestion-related crashes by congestion type.

Figure 9 - Reportable Crashes by Congestion Type on the Core Roadway Network – 2022

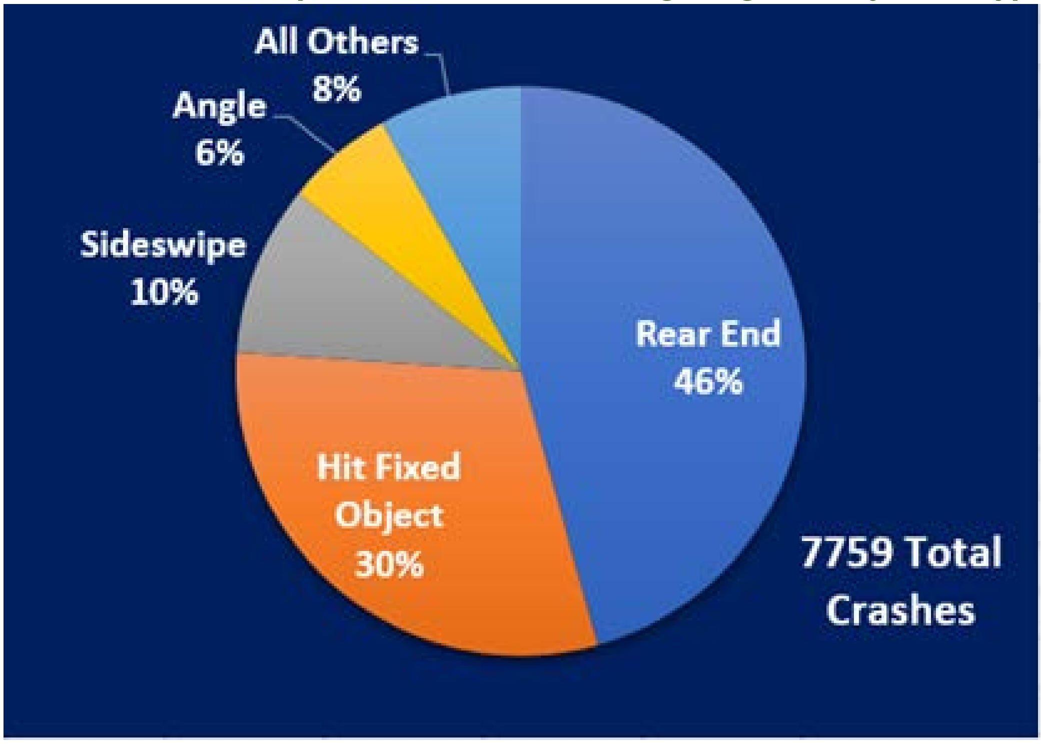


*** - Reportable crash or non-reportable crash that was verified in RCRS**

**** - Crash that was reported by Waze but not verified by a Department source**

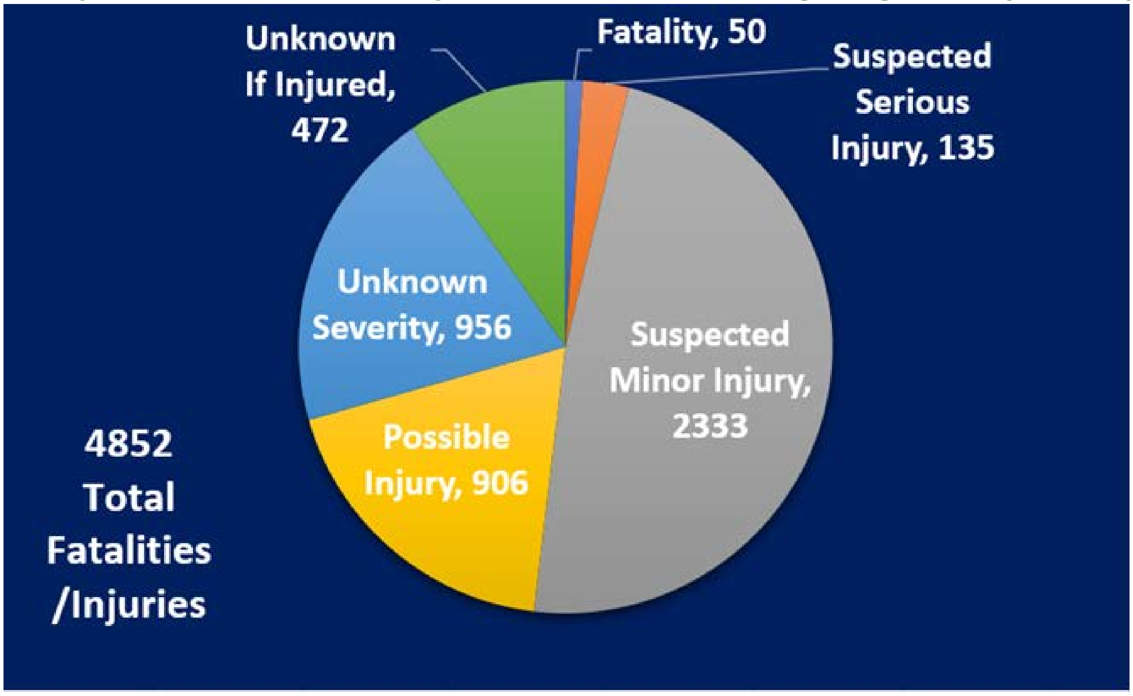
As seen in the chart below, 46% of these congestion-related crashes were rear end crashes, and an additional 30% were hit fixed object, which is consistent with drivers either running into the back of a queue or swerving off the road to avoid running into the back of a queue.

Figure 10 - Core Network Reportable Crashes in Existing Congestion By Crash Type – 2022



Below is a breakdown of the injuries that occurred in core network crashes in existing congestion, by severity.

Figure 11 – Injuries in Core Network Reportable Crashes in Existing Congestion by Severity – 2022

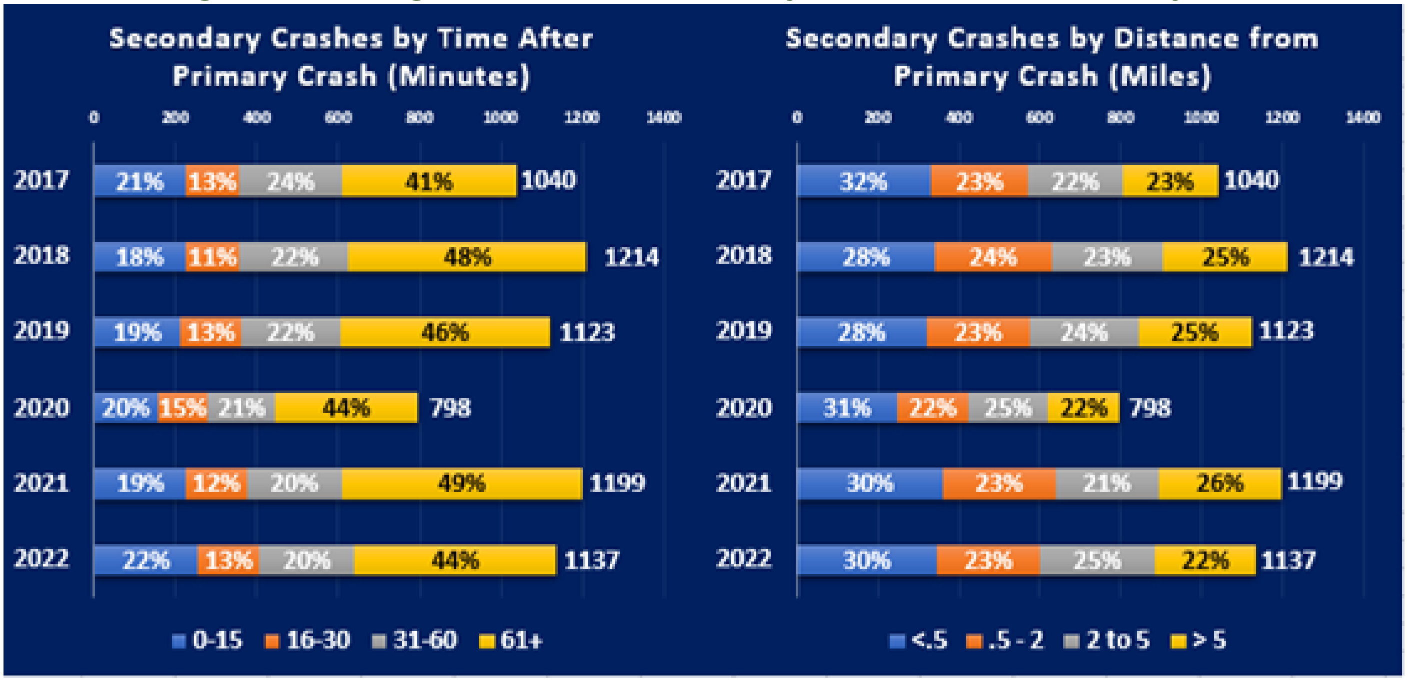


Secondary Crashes

For the purposes of this report, a secondary crash is when a subsequent crash occurs in the backlog or queue of a prior crash.

The charts below provide a breakdown of secondary crashes by their distance from the work zone, from 2017 to 2022.

Figure 12 - Timing and Distance of Secondary Crashes Relative to Primary Crash



Conclusions

The drop in secondary crashes from 2019 to 2020 was not surprising due to the drop in traffic volumes and overall congestion in 2020 due to the COVID-19 pandemic. 2021 and 2022 secondary crashes are comparable to 2018 and 2019 secondary crashes. Accordingly, the reductions in 2020 were not indicative of operational improvements.

The high percentage of crashes that continue to occur more than 15 minutes, and even over an hour, from the primary crash demonstrate that these timeframes are where focus should be placed by TMCs to target better operational response times and highlight the importance of promoting the efforts in FHWA's "Best Practice in TIM" DMS guidance for continuing effective messaging throughout the duration of incident's timeline, congestion, and queue adjustments.

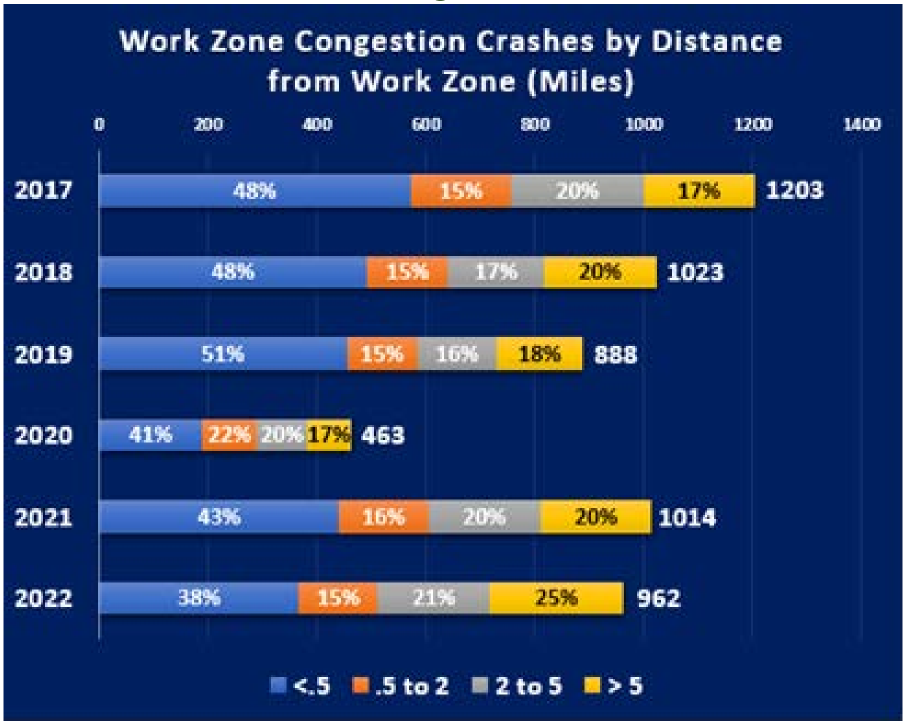
The more motorists that can be deterred from driving towards a queue may in-turn positively impact the safety of our congestion-related crashes. The distance information above provides better supporting information for the use of upstream congestion messaging, and can be shared with TIM teams to help mitigate congestion points more effectively. Regardless of time and distance from the primary crash, analysis has shown a CMS is close enough to alert approaching motorists of the congestion in over 85% of secondary crashes. Future analysis will focus on the effectiveness of CMS messaging in preventing secondary crashes.

Work Zone Congestion-Related Crashes

Congestion from work zones is another significant factor of crashes. In 2022, there were 962 reportable crashes on the Core Roadway Network in congestion originating from a work zone[5].

The charts below provide a breakdown of work zone congestion-related crashes by their distance from the work zone, from 2017 to 2022.

Figure 13 - Distance of All Work Zone Congestion-Related Crashes from the Work Zone



Conclusions

The significant drop in work zone congestion-related crashes from 2019 to 2020 was not surprising given the overall drop in traffic volumes and congestion during 2020 due to the COVID-19, and the fact that there was a statewide pause on roadwork early in the pandemic. 2021 and 2022 work zone crashes are comparable to 2018 work zone crashes and and higher than 2019 work zone crashes. Accordingly, the reductions in 2020 were not indicative of operational improvements.

The continued drop in the percentage of crashes that occur within a half mile of a work zone does continue a trend of decline in this area. This suggests that improvements are being made in managing safety in the immediate proximity of the work zone. However, the fact that 38% of crashes still occurred here highlights that areas approaching a work zone are at higher risk for crashes, as well as the importance of having situational awareness on work zones, and having an operational response in place for when congestion begins to build in the work zone.

[5] Due to data processing limitations, congestion was linked to a work zone up to a maximum of 8 miles behind the work zone. Crashes that occurred in congestion further from the work zone would not be flagged as being caused by the work zone.

2022 Work Zones with Highest Congestion-Related Crashes

The below tables highlight the 2022 work zones with the highest rates of reportable crashes that occurred in congestion related to the work zone. Tables are provided for both short-term work zones (up to one week in duration) and long-term work zones (longer than one week) with RCRS IDs. Work zones must have more than one related crash to be included. For purposes of this analysis, a crash is linked to a work zone only if it occurred in congestion that was being caused by the work zone[6] – crashes that occur in/near the work zone under non-congested conditions are not considered. Long-term work zones are ranked by crashes per day, short-term is ranked by crashes per hour. Where possible, these work zones should be investigated to determine any lessons learned/safety improvements that could be made in the future.

Figure 14 - 2022 Work Zones With Highest Congestion-Related Crash Rates (Less than 1 week)

District	RCRS ID	Route	Location	Crashes	Duration (Hours)	Crashes Per Hour
6	672305	I-95 S	MM 34 to MM 31	2	4.3	0.47
11	694346	I-376 E	Exit 64A to Exit 65	2	5.5	0.37
8	700296	I-83 N	Exit 46B	2	5.6	0.36
11	677875	I-376 W	Exit 73A	2	5.9	0.34
11	699665	I-376 E	Exit 69C to Exit 69B	2	6.4	0.31
6	677578	US 422	Exit to Sanatoga	2	7.8	0.25
6	686310	I-95 N	MM 6.5 to MM 10	2	8.8	0.23
6	687252	I-95 S	MM 11 to MM 7	2	10.3	0.20
4	704237	I-81 S	MM 199 to MM 197	2	11.9	0.17
11	685224	I-376 W	MM 73.5 to MM 72.5	3	56.3	0.05

Figure 15 - 2022 Work Zones With Highest Congestion-Related Crash Rates (Longer than 1 week)

District	RCRS ID	Route	Location	Crashes	Duration (Days)	Crashes Per Day
6	678701	PA 309	Exit to PA 563	3	7.3	0.41
6	637939	I-95 S	Exit 25	53	132.8	0.40
11	673161	I-376 W	Exit 74 to Exit 72.5	5	14.6	0.34
6	637938	I-95 N	Exit 22 to Exit 25	41	132.8	0.31
5	684715	US-22 W	Exit to 15th Street	4	15.2	0.26
5	664287	I-78 E	MM 63.5 to MM 65	12	49.4	0.24
8	665514	I-83 S	Exit 44B to Exit 43	4	17.7	0.23
11	698700	PA-28 S	Exit 13	3	13.4	0.22
5	643882	US-22 W	Exit to Cedar Crest Blvd	3	14.0	0.21
11	682023	I-79 S	Exit 66 to Exit 65	2	9.4	0.21

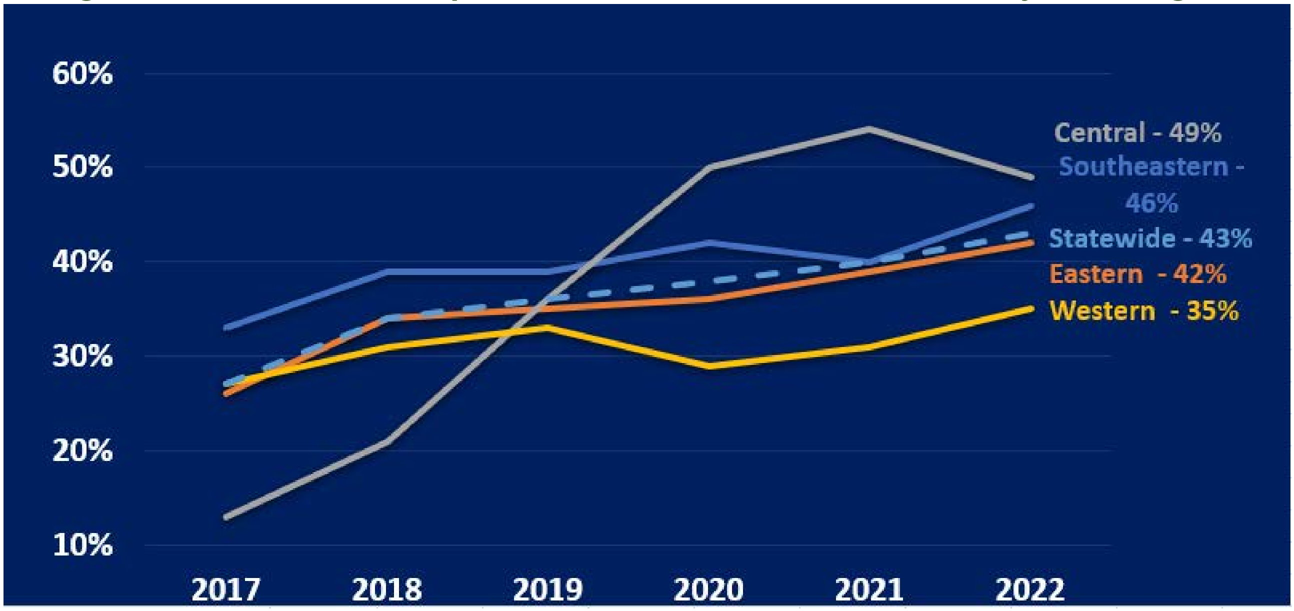
[6] Due to data processing limitations, congestion was linked to a work zone up to a maximum of 8 miles behind the work zone. Crashes that occurred in congestion further from the work zone would not be flagged as being caused by the work zone.

Focus on Improvement

- Secondary and work zone crashes continue to be a safety and mobility concern within Pennsylvania.
- As a result, PennDOT has implemented automated queue protection corridors in nearly 30 locations throughout the state
- In these corridors, queue protection messaging is automatically posted to relevant message boards whenever slow or stopped traffic is detected within the corridor
- Preliminary analysis in several of these locations has shown a positive impact on crashes, but more extensive analysis is needed
- Continual adjustment is needed to daily operations procedures to better manage traffic conditions until traffic returns to normal, and not just when an incident or roadwork has been cleared.

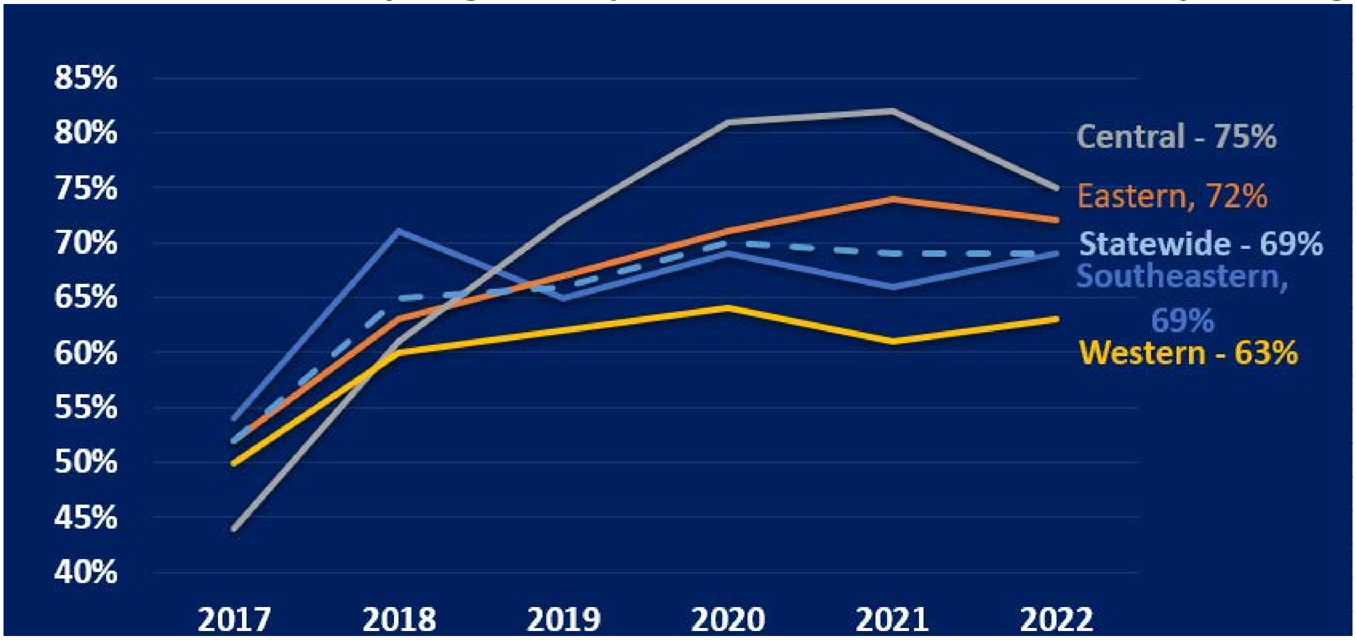
TMC Situational Awareness

Figure 16 – Core Network Reportable Crash RCRS Verification Rate – by RTMC Region



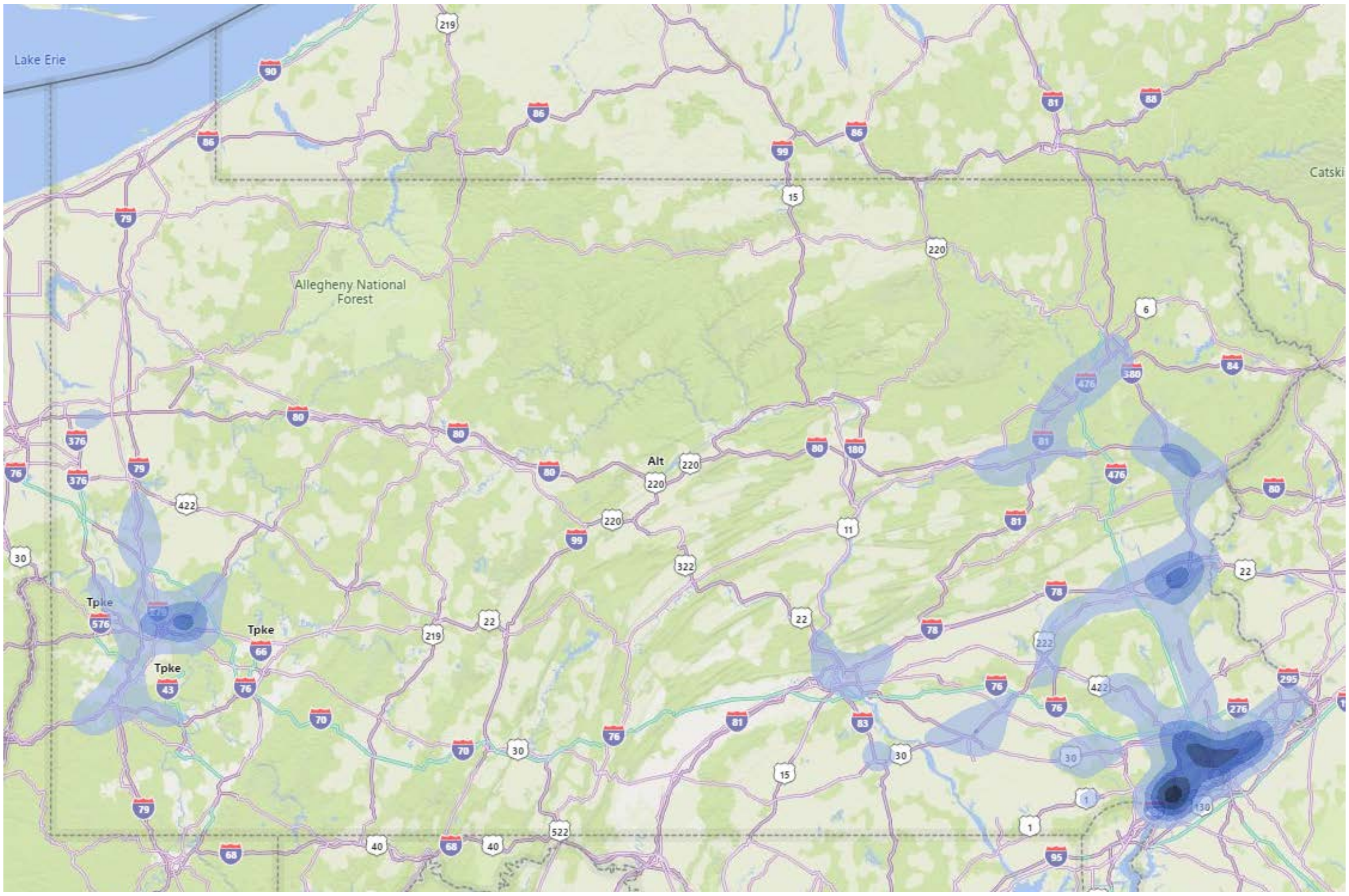
Major crashes on core network roads can gridlock entire metropolitan areas. These are the instances when effective traffic management strategies are paramount, and most importantly need to be clearly communicated to first responders, and the traveling public to allow for actionable decisions. PennDOT TMCs should aim to have 80% of heavy congestion crashes verified by an RCRS entry for all core roadway network roads. RCRS feeds incident information directly to social media and third-party mapping providers. The chart below show the trends in RCRS verification rates of heavy congestion reportable crashes from 2017 to 2022, by RTMC Region, and then by TMC/District.

Figure 17 – Core Network Heavy Congestion Reportable Crash RCRS Verification Rate – by RTMC Region



A statewide map of unverified heavy congestion crashes is provided below. For District specific maps, please see Appendix 2 – District Specific Heavy Congestion Crash Maps.

Figure 18 – Statewide Heat Map of Un-Verified Heavy Congestion Crashes – Core Network



Conclusions

The overall trend for RCRS reportable crash verification rates across the state is one of slight improvement, with an exception of a drop in the Central Region from 2021 to 2022 after a number of years of significant improvements. The overall trend for heavy congestion crash verification rates across the state is generally flat, with a similar drop in the Central from 2021 to 2022 as was noted for all crashes.

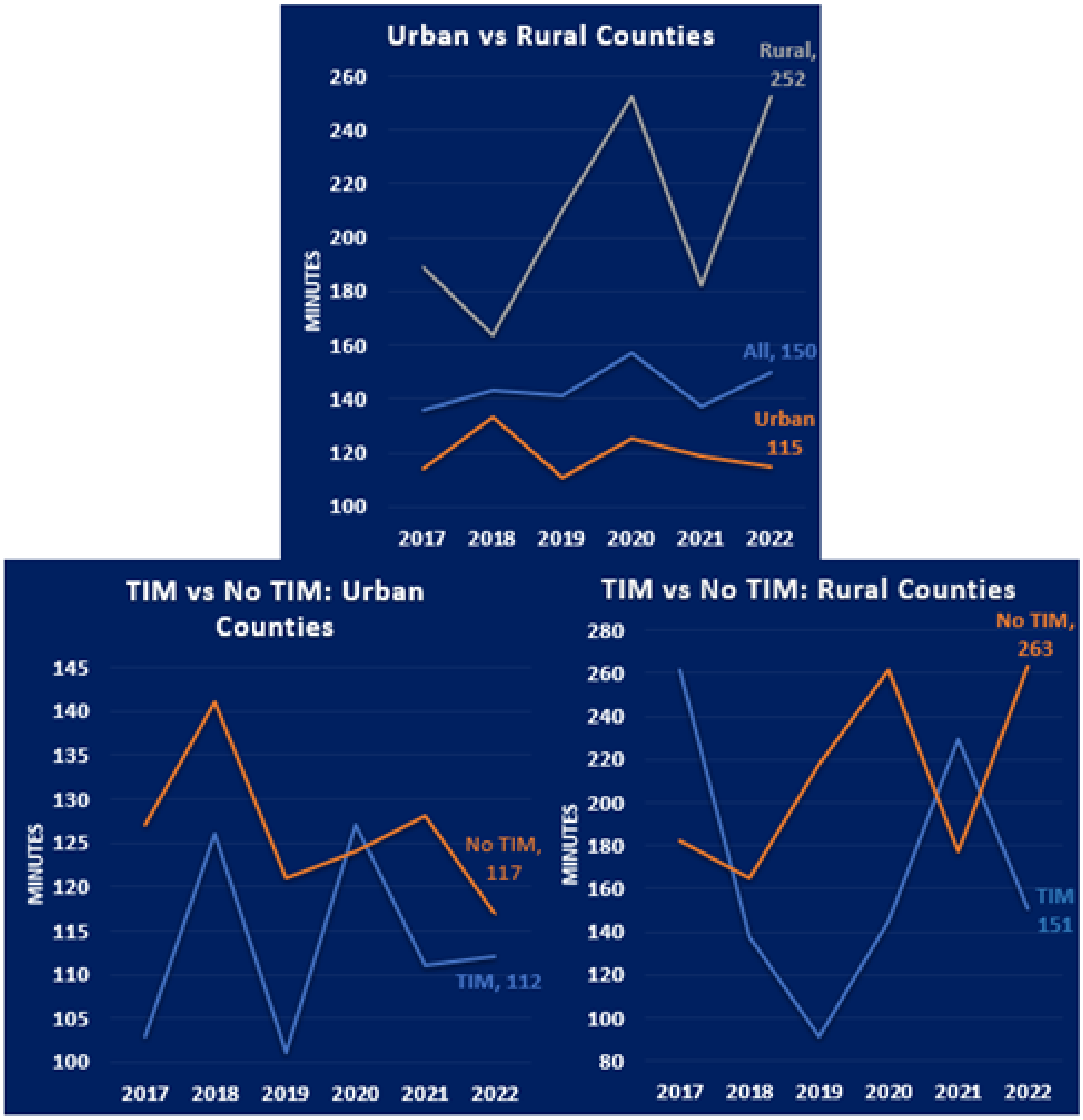
Focus on Improvement

- Improving the situational awareness of TMCs remains a core goal of PennDOT Traffic Operations
- TMCs should investigate the data and maps presented above in order to identify any gaps in their situational awareness and find potential solutions.
- The Traffic Alerts platform has been developed for use by TMCs
    - This platform provides operators with a view of crowd-sourced incident data from INRIX and Waze to allow them to become aware of incidents that traditional methods, such as CCTV cameras, might not catch
- PennDOT is working to expand the availability of Computer Aided Dispatch (CAD) data from 911 centers into the TMCs
    - The Central Region has seen significant success in this area, and the goal is to expand statewide

Average Incident Clearance Times – 2018 through 2022

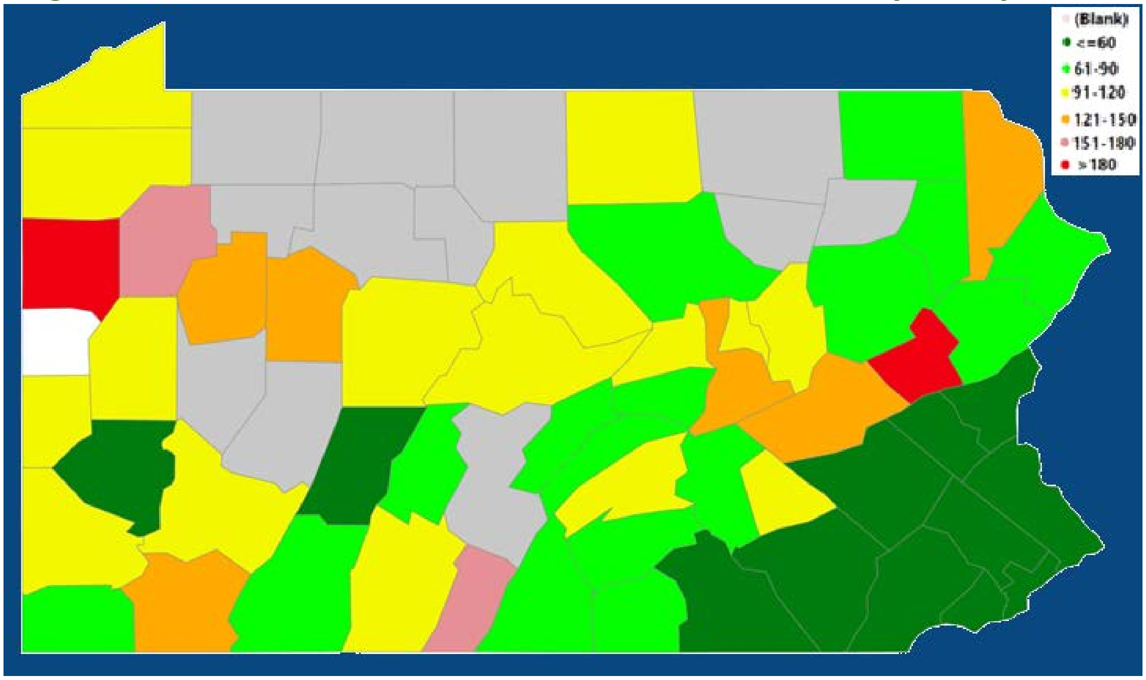
The chart below shows a breakdown of core network incident clearance times for full closures on the core network for rural vs urban counties for 2018 through 2021. It further breaks down the urban and rural counties into those which have a traffic incident management (TIM) team and those who don't.

Figure 19 - Core Network Incident Clearance Times for Full Closures – 2018 through 2022



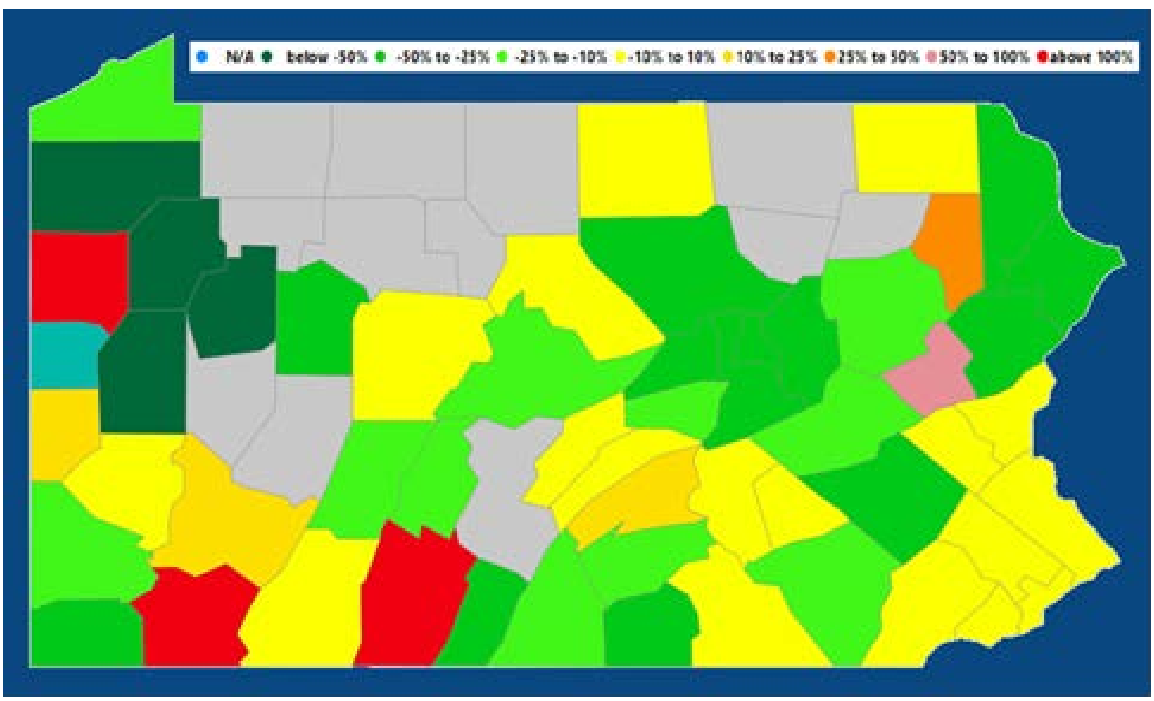
The map below illustrates core network clearance times and number of core network incidents by county for 2022.

Figure 20 - Core Network Incident Clearance Times (Minutes) by County – 2022



The map below shows the change in core network incident clearance times from 2017 to 2022, by county.

Figure 21 – Core Network Incident Clearance Time Percent Change from 2017 to 2022 by County



Detailed charts showing incident clearance times by District are available on the TSMO Dashboard.

Conclusions/Recommendations

The above charts and map are presented to provide insight into areas and locations where incident response and management can be improved. The initial chart comparing urban vs rural clearance times, as well as clearance times where TIM teams are in place compared to where they are not highlights the importance of these teams. Although there were outlier years in both the urban and rural areas, the general trend shows a reduction of incident clearance times in counties with TIM teams. According to FHWA, the chance of a secondary crash increases 2.8% for every minute that a primary crash remains a hazard. This emphasizes the importance of reducing incident timelines, even the 15-20 minute reductions seen in urban counties with TIM teams. TIM Team involvement needs to be consistently increased on a statewide level.

The Traffic Operations Analytics tool provides an Incident Timeline module which can be used to analyze and better understand incident clearance times at the region, district, route, county, and even municipality level. This is a tool that can be utilized to aid TIM teams in better understanding the timeliness and effectiveness of their incident responses. In addition to incident clearance times, the module calculates the incident influence time, which is defined as the time between when the incident occurs and when traffic returns to normal. This metric provides a better picture of the overall impact of an incident on a route.

Focus on Improvement

- Reducing incident clearance time is an important goal of traffic operations.
- Even small reductions in clearance time can lead to significant improvements in safety and mobility
- TIM Team Involvement needs to be consistently increased throughout the state, in order to realize improvements in clearance times
- Use of better data, such as what is available in the Incident Timeline tool is important in analyzing and being able to better understand incident clearance times at all level.
- PennDOT has partnered with Maryland to make its traffic cameras available at no cost to TIM partners via the web-based MVIEW platform. For information on how to gain access to the tool, email ra-pdmview@pa.gov.

Appendix 1 – Congestion Pie Chart Methodology

Methodology

PennDOT's congestion pie chart was developed by utilizing traffic speed data provided by INRIX's flow incident API. While INRIX's exact methodology for conditions that produce a flow incident is proprietary, the general guidelines they issue are traffic speeds that drop below 65% of reference (freeflow) speed for at least 2 minutes, and that a flow incident ends when speeds have returned to greater than 70% of reference speed.

PennDOT's congestion pie chart tool was developed starting with 2018 data and it is limited to routes on PennDOT's Core Roadway Network. All INRIX flow incidents on the Core Roadway Network were brought into the database and correlated to a variety of Department data sources to uncover DOT known "causes":

Data Source	Data Type
Road Condition Reporting System (RCRS)	Traffic Incidents, Roadwork
Maintenance Database	Roadwork
Crash Reporting System (CRS)	Reportable Crashes[7]
Roadway Weather Information System (RWIS)	Inclement Weather

The table below provides the distance and time buffers that were utilized to correlate the causes from various data sources to flow incidents.

Data Type	Distance	Time
Crashes (RCRS + CRS)	2 miles	30 minutes
Weather (RWIS)	15 miles	15 minutes
Work Zone (RCRS)	3 miles	Within start/end time of work zone
Work Zone (Maintenance Database)	3 miles	30 minutes
All Waze Alerts	1 mile	30 minutes

In some cases, multiple potential causes were identified for a single congestion incident. At this time, no special analysis was done to determine a primary cause, or to assign percentages of congestion across the multiple causes. For purposes of this analysis, congestion that correlated to multiple causes, DOT data or crowd-sourced, were classified using the following priority:

1. Crash
2. Roadwork
3. Weather

To generate the pie chart, all congestion events were assigned an impact score[8]. The congestion pie charts as presented represent a breakdown of the total impact score by cause.

[7] A reportable crash is one in which an injury or a fatality occurs, or if at least one of the vehicles involved required towing from the scene.

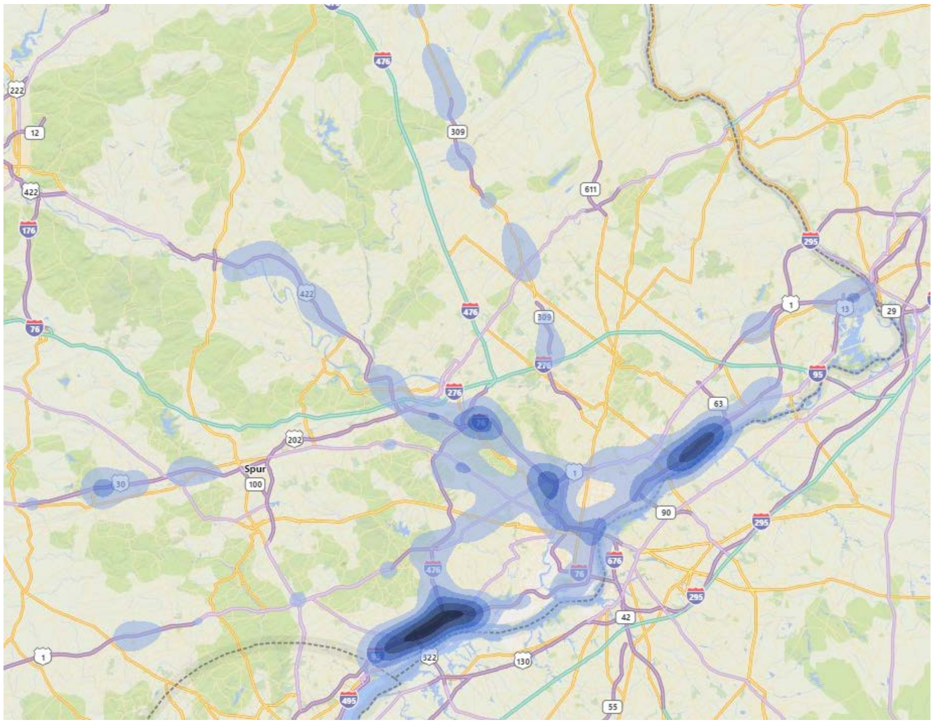
[8] The impact score of a congestion event = (event duration) x (length of queue) x (speed drop).

Appendix 2 – District Unverified Heavy Congestion Crash Maps

The heat maps provided below illustrate heavy congestion crashes that were not verified in RCRS in 2022

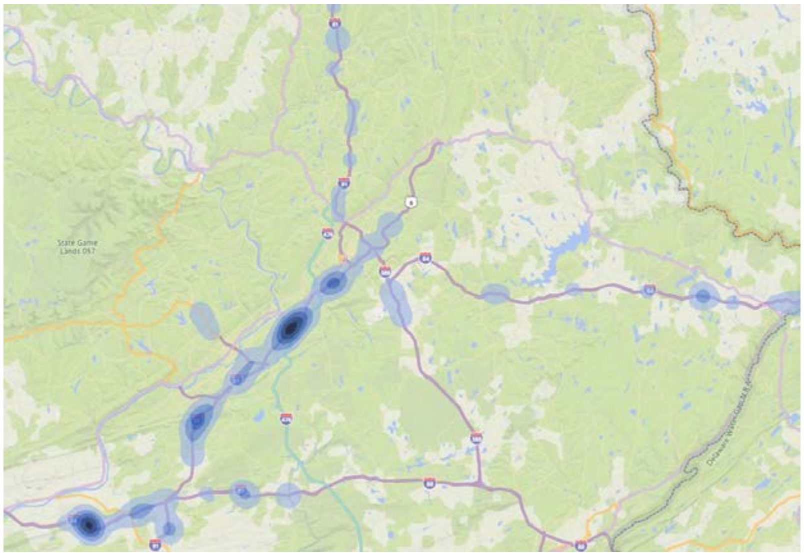
Southeastern Region

District 6

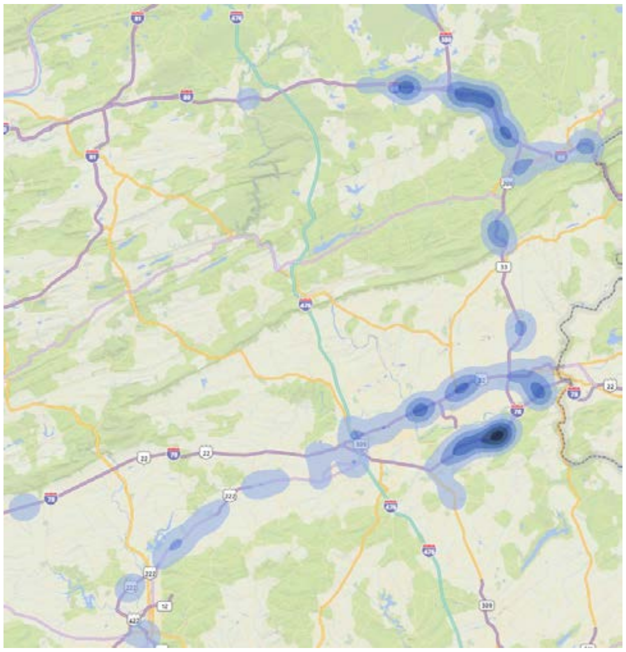


Eastern Region

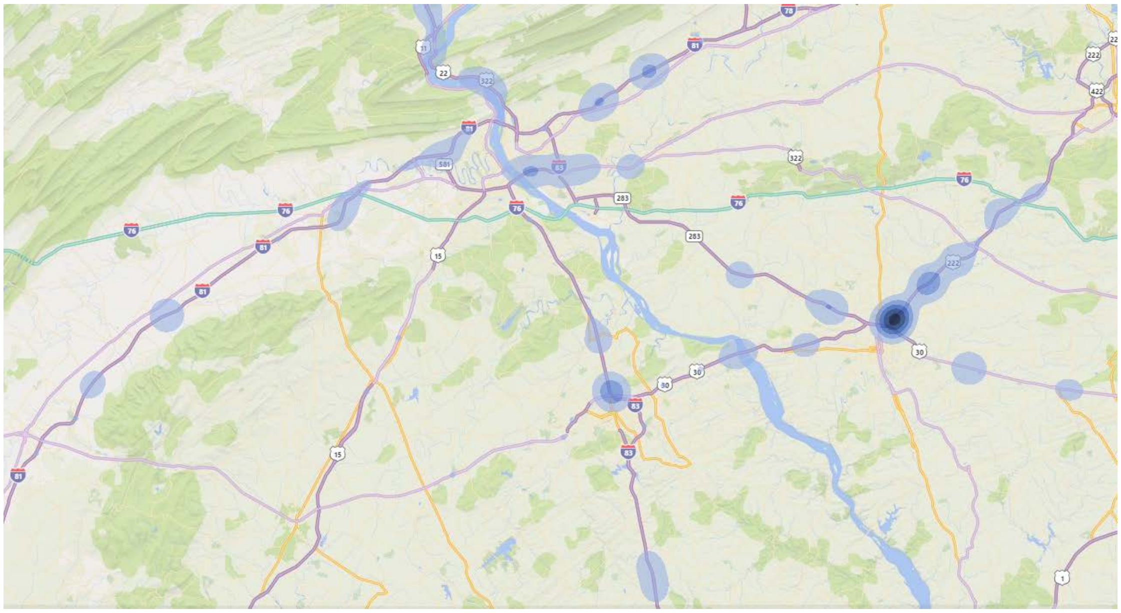
District 4



District 5



District 8

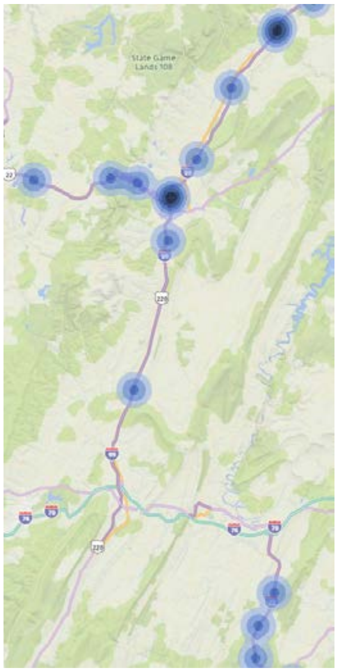


Central Region

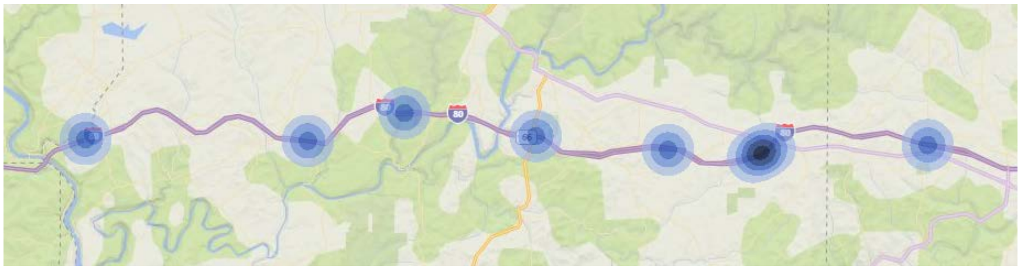
District 2

District 3

District 9

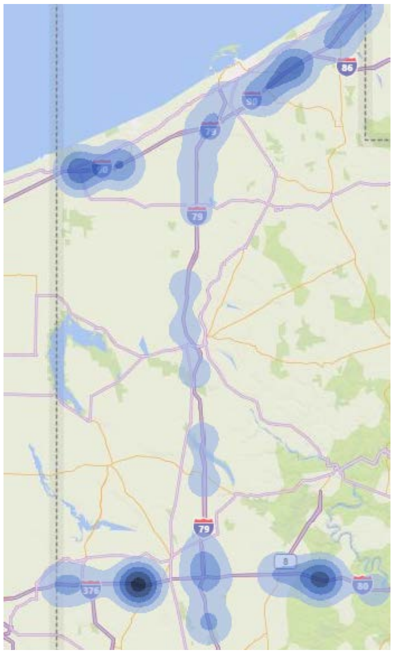


District 10 (Clarion and Jefferson)



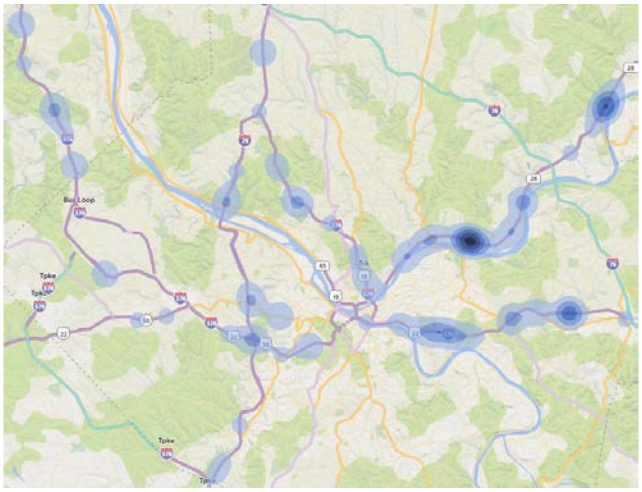
Western Region

District 1



District 10 (Butler)

District 11



District 12