



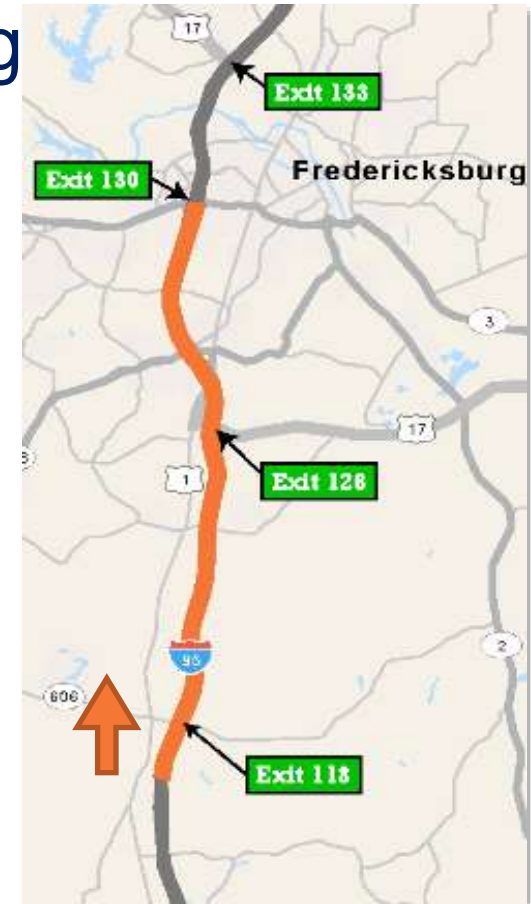
PERFORMANCE EVALUATION APPLICATION FOR THE I-95 VARIABLE SPEED LIMIT SYSTEM

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Background

- I-95 NB between MP 115-130, south of Fredericksburg experiences significant recurring and non-recurring congestion, especially in the summer.
- Speed variations are present, along with higher crash rates
- In June 2022, VDOT activated a VSL system on the corridor



I-95 VSL Field Elements



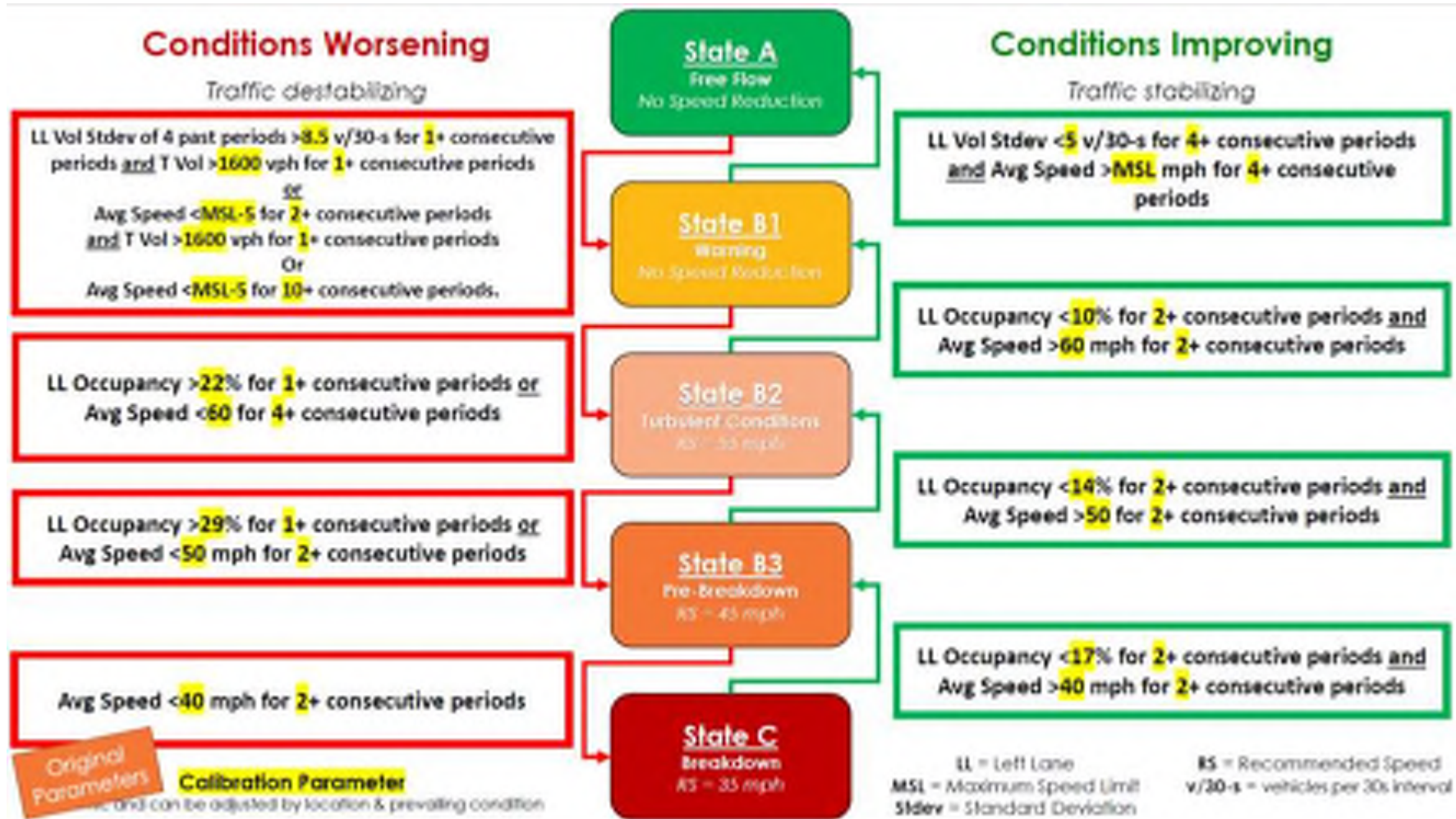
Background

- The system includes 24 detector stations that are all generating per-vehicle record (PVR) data.

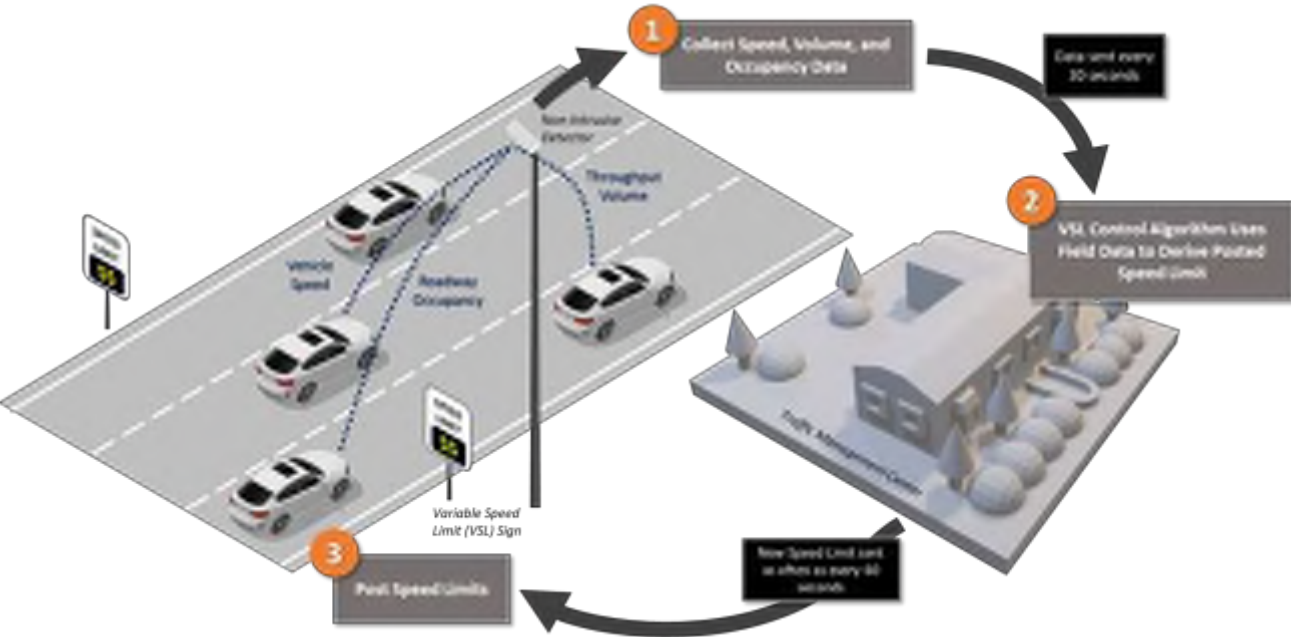


- The VSL system aims to improve both safety and operations in this congested section

VSL Algorithm



VSL Data Flows



- Sensors produced raw PVR data that consists of a unique vehicle ID, time, location (detector station ID, lane), speed, etc.
- The VSL system produced posted speed limit (PSL) data that had time stamp, location, and VSL recommended speed.
- The system produced an average of 1 million rows of data every day.

Project Objective

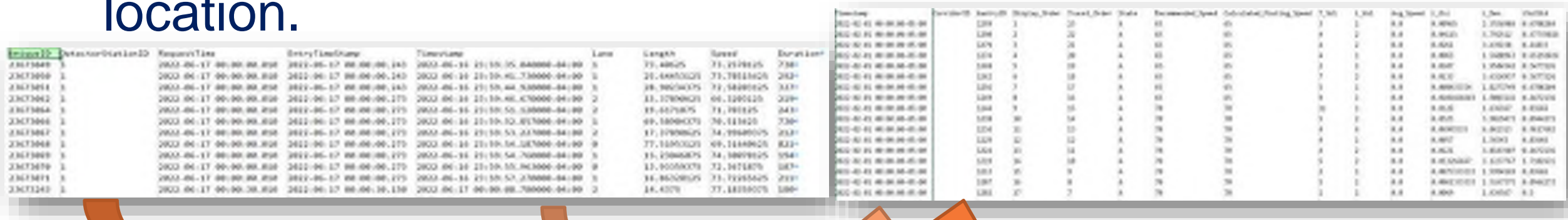
- This project developed a performance evaluation application to assess operations and safety
- With the application, the system performance could be easily analyzed despite the large volume of data.
- Focus of this presentation is on how the system data was analyzed and some representative key findings, not on system construction and operation.

Evaluation Performance Measures

Speed compliance	Operations	Crashes
<ul style="list-style-type: none">• Change in mean speed• Change in speed distribution• Change in speed compliance• Change in speed standard deviation	<ul style="list-style-type: none">• Change in delay• Change in travel time reliability (expressed in using multiple measures including travel time index and different percentiles of speed)• Change in speed-flow fundamental diagrams• Change in capacity and throughput	<ul style="list-style-type: none">• Change in crash frequency by crash severity• Change in collision type by severity• Change in secondary crashes• Change in crash rates

VSL Data flows

- PVR and PSL data were merged based on time and location.

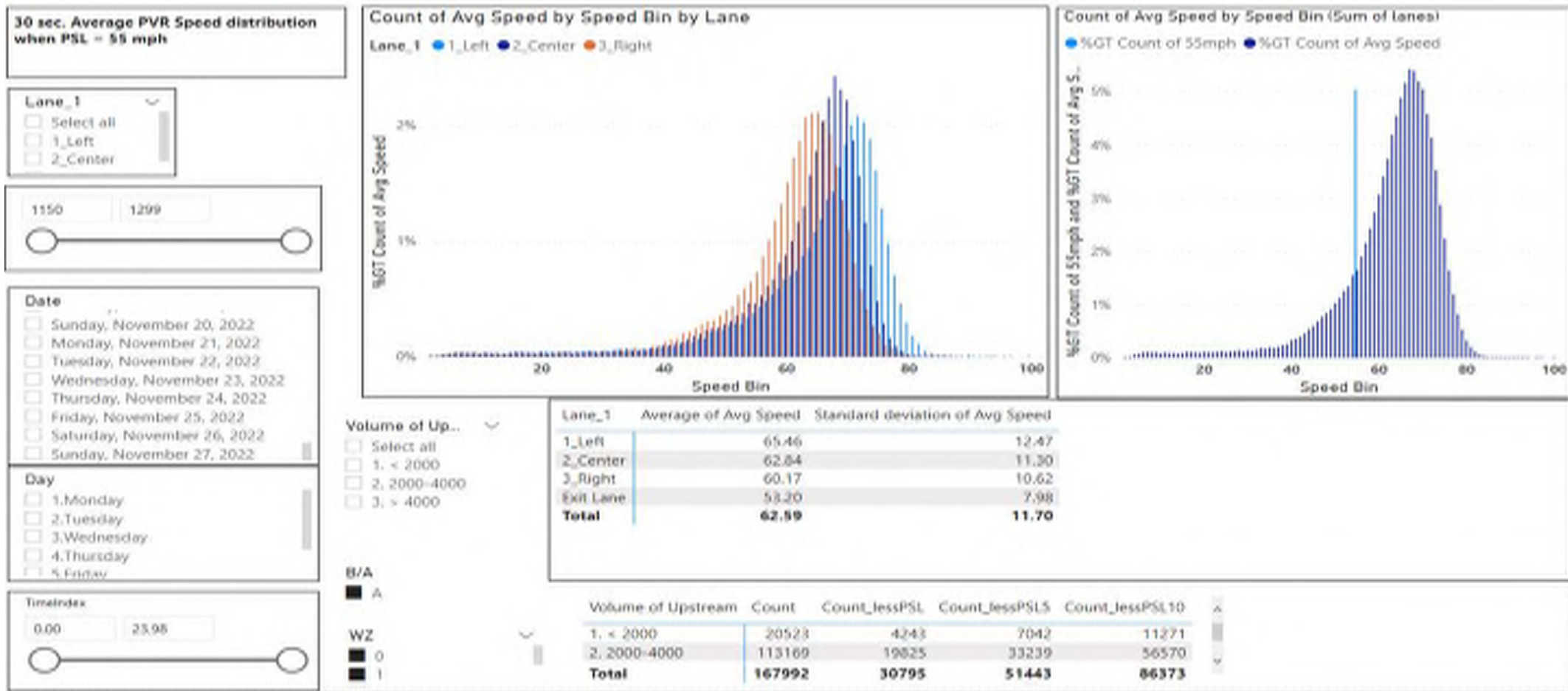


The image shows two screenshots of data tables. The left table has columns: DetectorOrLocationID, RequestTime, EntryTimeGroup, TimeStamp, Lane, Length, Speed, and Duration. The right table has columns: TimeStamp, DetectorID, RequestID, Stoppage_Status, Check_Status, Status, Recommended_Speed, Calculated_Headway_Speed, T_Sat, L_Sat, Avg_Speed, L_Sat, L_Sat, and Duration. Two large orange arrows point from the left table to the right table, indicating the merging of data.

- Over 250 million rows of data were ingested into a PowerBI application for analysis.

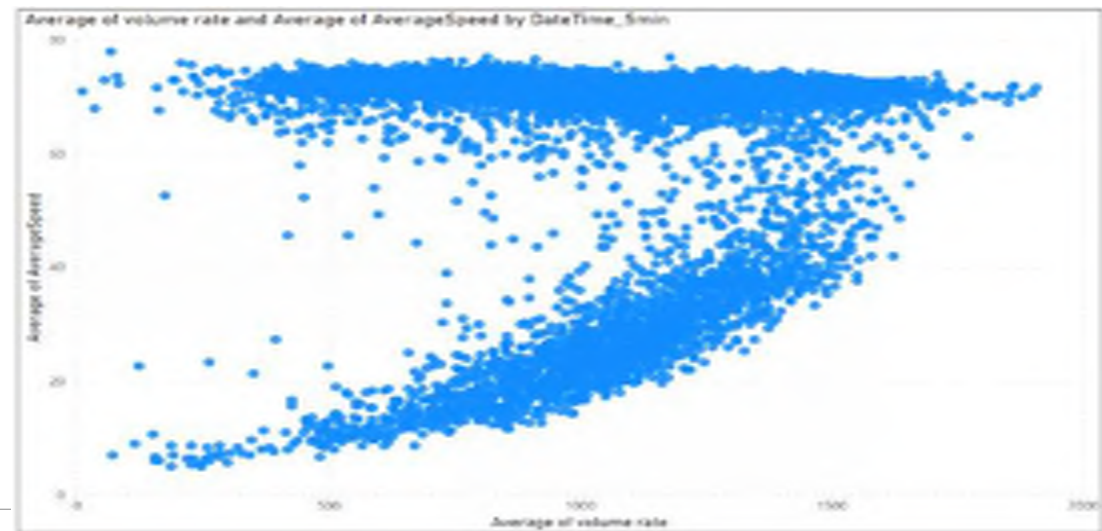
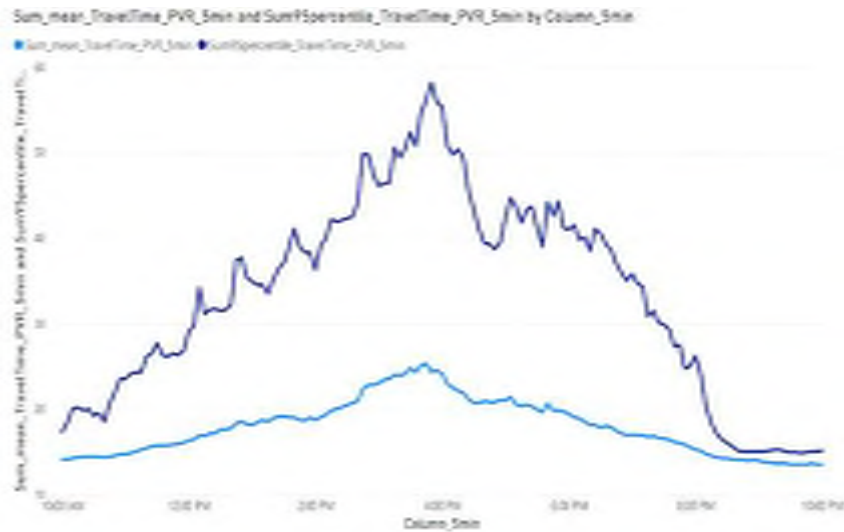
Application Example

Speed Compliance

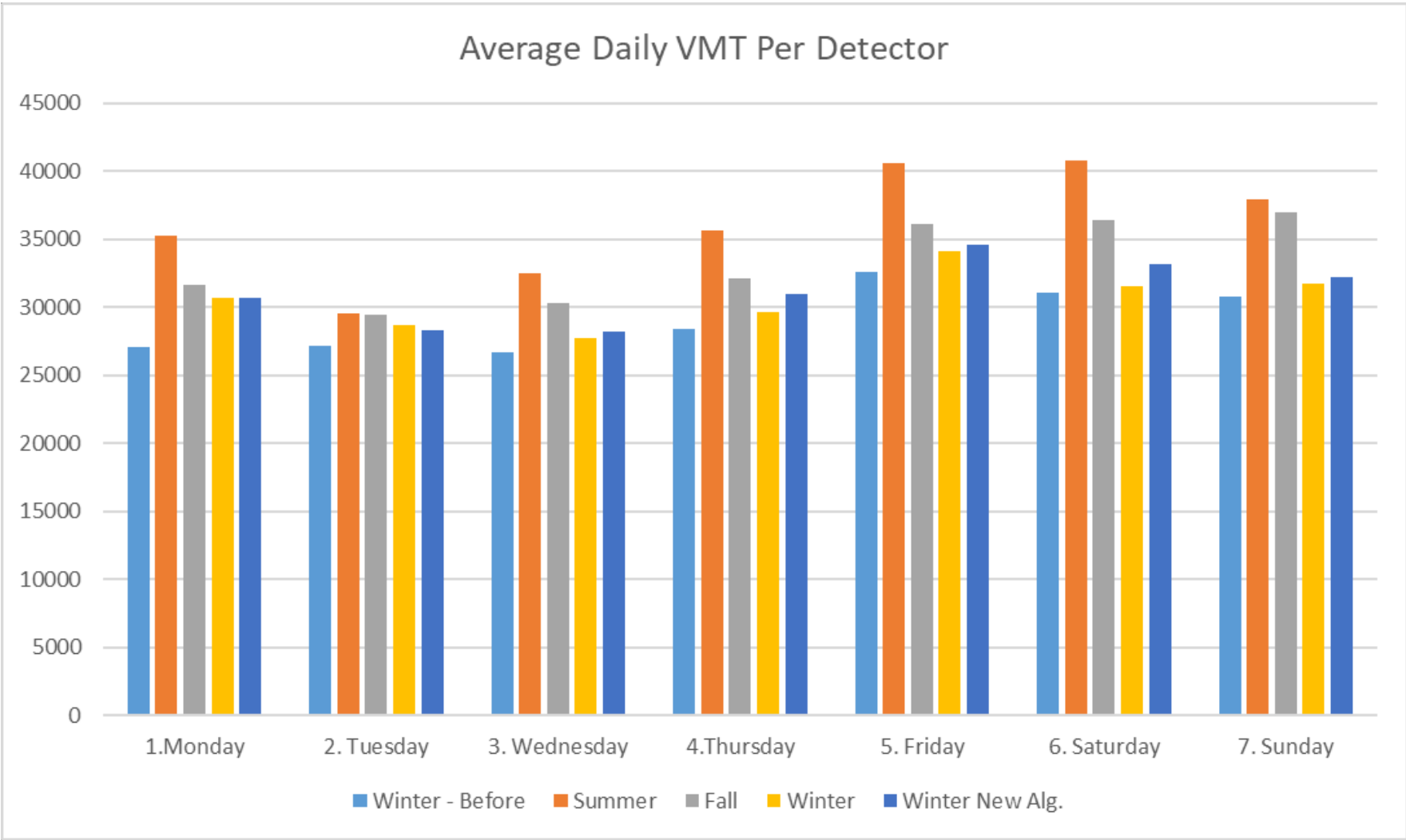


Operations

- Travel time for each 5-minute timestamp is calculated by adding average travel time of each section for the whole corridor
- Speed-flow curves represent only one detector station's data, and each point describe a feature of 5-minute interval's traffic.



VMT Comparison by Season



Traffic Impacting Events

- Mobility and safety are likely impacted by many factors:
 - Work zones
 - Weather
 - Traffic volume
 - System outages
 - Crashes
- Added filters to the tool so that “apples to apples” comparisons between before/after data could be performed.

Crash Data - Frequency

Crash Type	Crash Frequency	
	6/22/22 - 3/31/23	Change from 6/22/21 - 3/31/22
All	209	+1 (+0.5%)
Fatal+Injury	41	-6 (-13%)
Rear End	114	-7 (-6%)
SS-SD	27	-4 (-13%)
FO-OR	41	+12 (+41%)

High Speed Vehicles

- Speeds before and after VSL activation were compared, filtering for similar conditions.
- Speed behavior during free flow and congestion remained largely the same.
- The proportion of vehicles traveling more than 10 mph over the recommend speed limit **declined by up to 22%** during the conditions when 55 mph was posted.

Conclusions

- The developed tool was able to process large volumes of data quickly and efficiently.
- Early results also showed positive trends, especially during transitional speeds. Results continue to be monitored with the developed application.

Acknowledgements

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