REGIONAL TWELVE-YEAR BOTTLENECK ANALYSIS

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Agenda Item 4

National Capital Region
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Introduction

- On July 8, 2022, the TPB Technical Committee accepted as final the 2022 Congestion Management Process (CMP) Technical Report
- During discussion, the committee had questions about the top ten bottleneck analysis in the report (for calendar year 2021)
  - The bottleneck methodology had changed: the University of Maryland Probe Data Analytics [PDA] Suite bottleneck tool instead of TPB staff in-house methods used for previous reports
  - The methodology change influenced changes in the top ten rankings compared to the most recent previous report (2020)
- It was not feasible to redo analysis with the previous methodology, but staff offered to undertake a multi-year analysis with the current PDA Suite methodology to examine changes over time

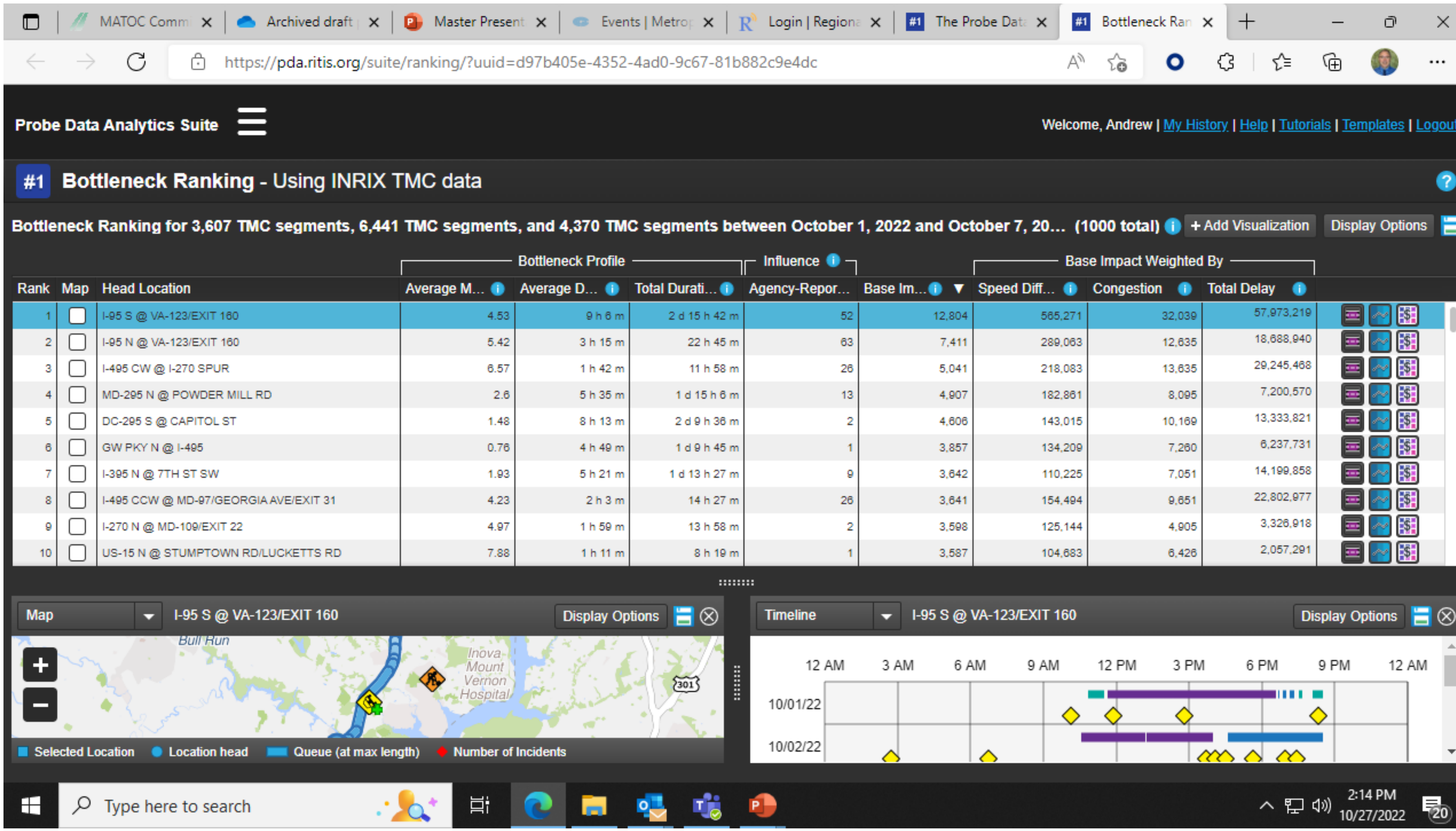
Today's Presentation

- Bottom Line Up Front: results of staff's analyses show a complex set of occurrences beyond one persistent top-ranked bottleneck
- Today's presentation will look at:
  - The PDA Suite bottleneck tool methodology, how options within the tool cause variations in results, and caveats
  - Results from analyzing the twelve years available in the PDA database (2010 through 2021) using the same (staff-recommended) tool options as used for the 2022 CMP Technical Report
  - Observations on how choosing alternative tool options would impact results
  - Observations on why bottleneck rankings change over time

How the PDA Bottleneck Tool Works

- Uses vehicle probe data (speeds) provided for a set of network links
  - TPB staff has access to data sourced from Inrix for a robust set of roadways in our states (DC, MD, VA)
- We choose links of interest (not trivial – staff uses a saved set of thousands of roadway links) and set of days of interest (but the maximum period of analysis is one year)
  - Day and time options are limited (cannot screen out holidays; cannot analyze sub-24-hour periods)
- The tool produces a ranking table and can produce maps of bottlenecks
- The rankings in the table can be sorted by several component factors
  - Note that staff has chosen not to use the default ranking factor

Example Screenshot from the PDA Tool



Rank	Map	Head Location	Average M...	Average D...	Total Durati...	Agency-Repor...	Base Im...	Speed Diff...	Congestion	Total Delay
1		I-95 S @ VA-123/EXIT 160	4.53	9 h 6 m	2 d 15 h 42 m	52	12,804	565,271	32,039	57,973,219
2		I-95 N @ VA-123/EXIT 160	5.42	3 h 15 m	22 h 45 m	63	7,411	289,063	12,635	18,688,940
3		I-495 CW @ I-270 SPUR	6.57	1 h 42 m	11 h 58 m	26	5,041	218,083	13,635	29,245,468
4		MD-295 N @ POWDER MILL RD	2.6	5 h 35 m	1 d 15 h 6 m	13	4,907	182,861	8,095	7,200,570
5		DC-295 S @ CAPITOL ST	1.48	8 h 13 m	2 d 9 h 36 m	2	4,606	143,015	10,169	13,333,821
6		GW PKY N @ I-495	0.76	4 h 49 m	1 d 9 h 45 m	1	3,857	134,209	7,260	6,237,731
7		I-395 N @ 7TH ST SW	1.93	5 h 21 m	1 d 13 h 27 m	9	3,642	110,225	7,051	14,199,858
8		I-495 CCW @ MD-97/GEORGIA AVE/EXIT 31	4.23	2 h 3 m	14 h 27 m	26	3,641	154,494	9,651	22,802,977
9		I-270 N @ MD-109/EXIT 22	4.97	1 h 59 m	13 h 58 m	2	3,598	125,144	4,905	3,326,918
10		US-15 N @ STUMPTOWN RD/LUCKETTS RD	7.88	1 h 11 m	8 h 19 m	1	3,587	104,683	6,426	2,057,291

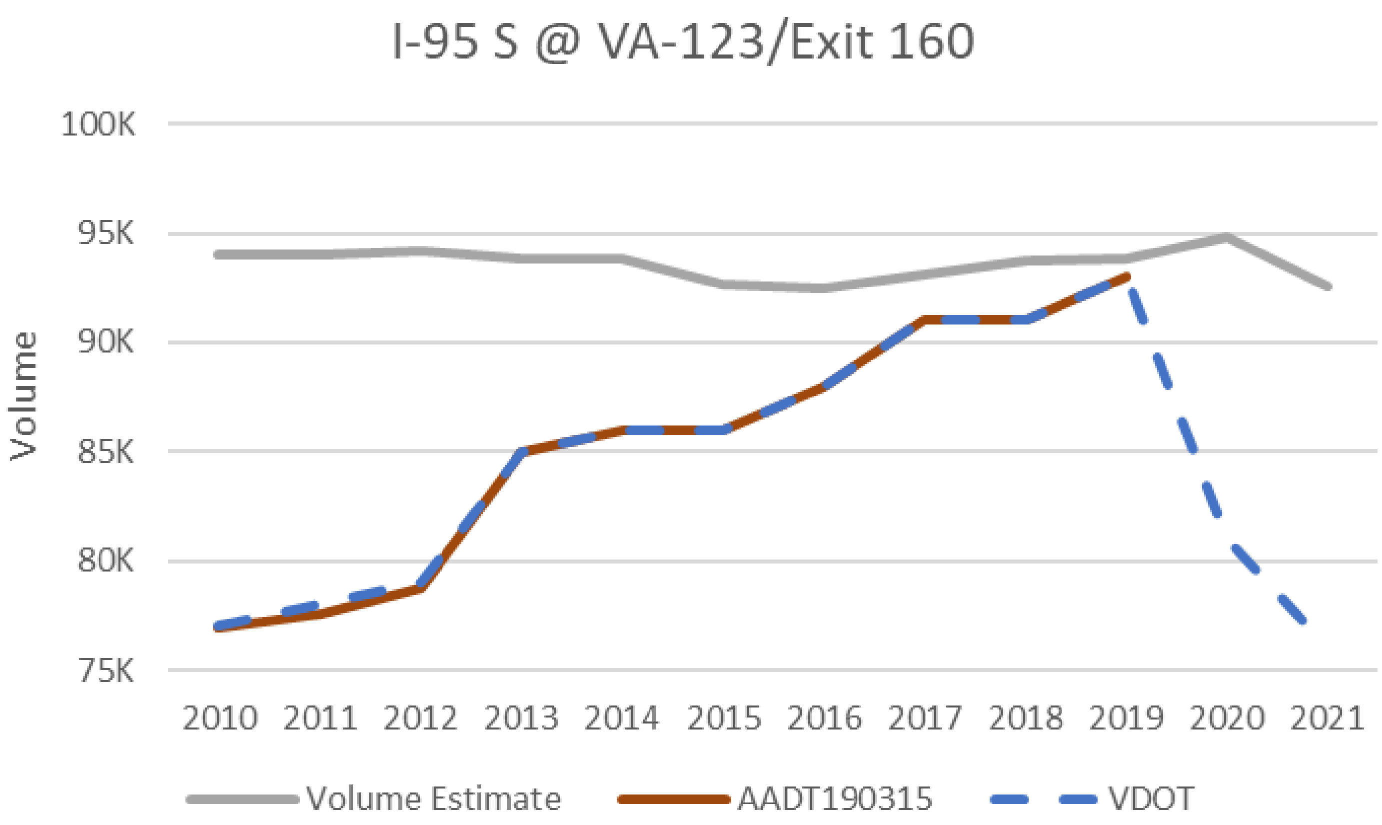
Exploring the Tool's Ranking Factors

- The PDA Suite Bottleneck Tool offers several ranking factors (e.g. to determine the region's "worst" bottleneck)
  - Queue lengths (average or cumulative); duration (average or cumulative); magnitude of speed drop versus reference speed; or combinations of these such as "base impact" (combining queue length and duration), "congestion" (queue length and speed drop), and "total delay" (speed drop weighted by traffic volume)
- For recent CMP Technical Reports and for our Congestion Dashboard, staff recently has used "base impact" as the ranking sorting factor
- For this analysis, staff performed a series of sensitivity tests by sorting rankings according to some of the other available factors

Ranking Factor Observations

- Single factors (e.g., queue length, duration, or speed drop) do not seem to tell the whole story
- ***Base Impact*** (queue length and duration) – judged to be most consistent with TPB's prior (consultant) aerial photography-based analyses; emphasizes major roadways
- ***Congestion*** (queue length and speed drop) – inclusion of speed drop may increase emphasis on smaller roadways
- ***Total Delay*** (speed drop weighted by traffic volume) – the database's traffic volumes seem inconsistently derived, and are often a temporal mismatch (e.g. 2019 volumes weighting 2010 conditions)
- Others may choose different ranking factors based on the specific analysis they are doing, but TPB staff's observation is that "base impact" produces the most logical results for our bottleneck analyses

Volume Data for Our Top Bottleneck



This example shows that PDA Suite traffic volume estimates may not be consistent with DOT or HPMS sources.

Bottleneck Tool Caveats

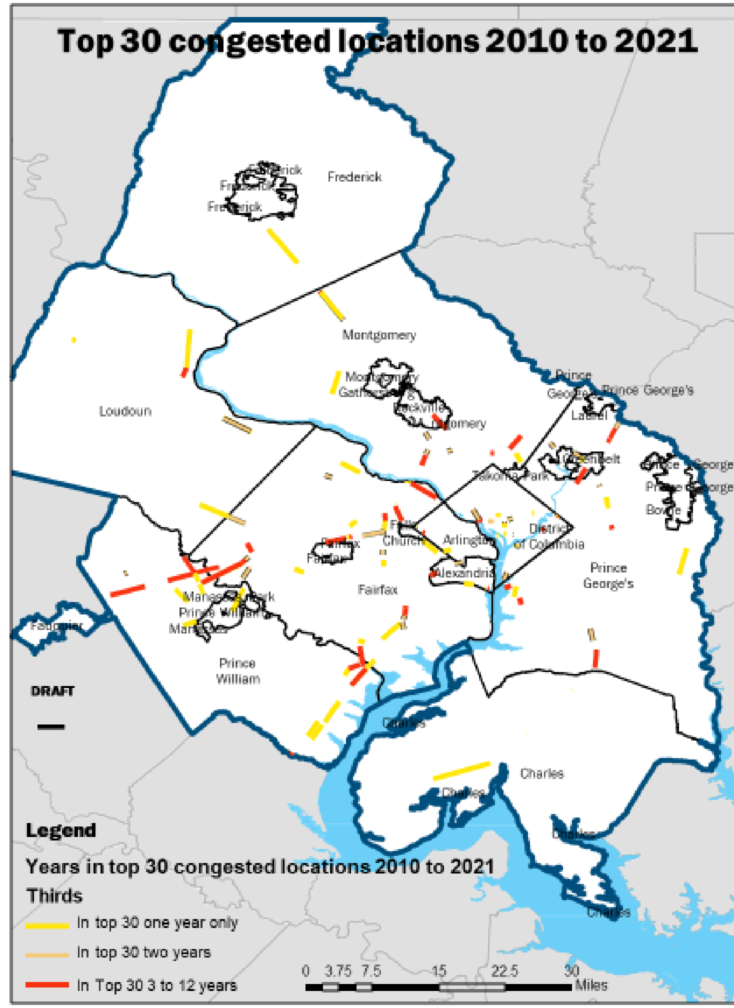
- Traffic Message Channel (TMC) networks are imperfect and change over time
- Tool allows analysis of no more than one year of data (i.e., we could not do a single 12-year analysis, just 12 one-year analyses)
- Time options include only a date range and days of the week (can screen out weekends, but cannot screen out holidays)
- The tool's default ranking factor is not what TPB staff uses for our products (make sure to re-sort by Base Impact to be consistent)
- Traffic volumes seem to be inconsistent across locations and time – not reliable for a multi-year/historical analysis
- "Black box" issues (e.g., how reference speeds are determined)
- Nevertheless, the tool is handy and useful

The 12-Year Analysis

- Vehicle probe speed data (from Inrix) are available in the PDA Suite back to the year 2010
- Staff chose to perform one-year bottleneck ranking analyses for each of the twelve years of 2010 to 2021
  - Determined top ten rankings for each year
  - As noted, base impact was used as the ranking factor
- Looked for persistent versus short-lived bottleneck locations, comparative severity, and trends

Top 30 Congested Locations 2010-2021

- Persistent bottlenecks were in a relatively limited number of locations
- Other locations appear for only a year or two
- Top bottleneck in the region: I-95 S @ VA-123/Exit 160
  - #1 in all 12 years using the staff-recommended ranking factor (“Base Impact”)



2021 Bottlenecks by Delay, Max Length

	Location	Ranked by Base Impact	Ranked by Total Delay	Ranked by Maximum Length of Queue
1	I-95 S @ VA-123/EXIT 160	1	1	43
2	I-95 N @ VA-123/EXIT 160	2	3	27
3	DC-295 S @ EAST CAPITOL ST	3	4	303*
4	BALT-WASH PKWY N @ POWDER MILL RD	4	8	110
5	I-95 N @ VA-617/BACKLICK RD/EXIT 167	5	5	42
6	US-301 S @ MCKENDREE RD/CEDARVILLE RD	6	16	149
7	I-495 INNER LOOP @ I-270-SPUR	7	2	9
8	I-66 W @ VA-234/VA-234-BR/EXIT 47	8	9	8
9	I-270 S @ MD-109/EXIT 22	9	32	47
10	I-270 N @ MD-109/EXIT 22	10	34	21

*Anomalously high values may indicate data glitches for a given year rather than actual conditions.

History of 2021 Bottlenecks

Rankings for each individual year 2010-2021

2021 Rank	Location	Highest Rank 2010-2021	Lowest Rank 2010-2021	Number of Times in Annual Top Ten 2010-2021
1	I-95 S @ VA-123/EXIT 160	1	1	12
2	I-95 N @ VA-123/EXIT 160	2	>100	8
3	DC-295 S @ EAST CAPITOL ST	2	>100	7
4	BALT-WASH PKWY N @ POWDER MILL RD	2	6	10
5	I-95 N @ VA-617/BACKLICK RD/EXIT 167	5	>100	1
6	US-301 S @ MCKENDREE RD/CEDARVILLE RD	3	31	10
7	I-495 INNER LOOP @ I-270-SPUR	2	>100	8
8	I-66 W @ VA-234/VA-234-BR/EXIT 47	3	66	3
9	I-270 S @ MD-109/EXIT 22	9	35	2
10	I-270 N @ MD-109/EXIT 22	10	>100	1

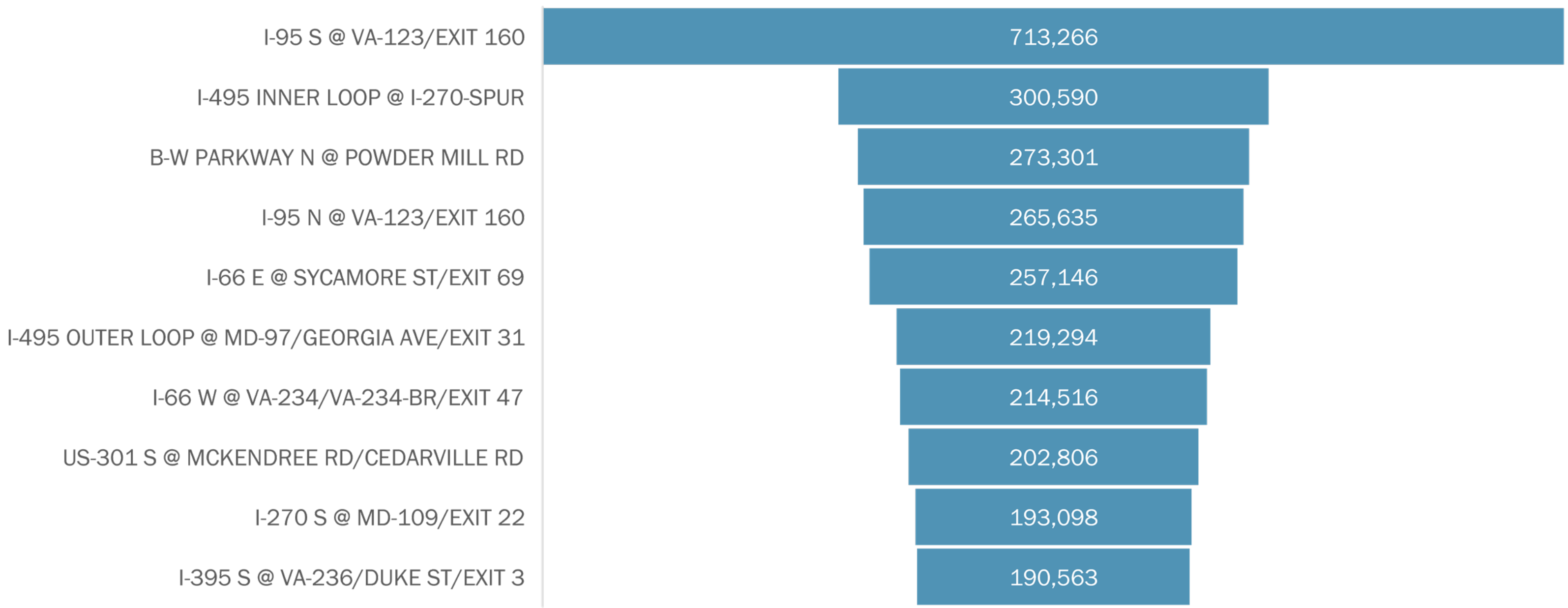
Persistent & Past Bottlenecks

Persistent Bottleneck Locations	Highest Rank 2010-2021	2021 Rank	Number of Times in Annual Top Ten 2010-2021
I-95 S @ VA-123/EXIT 160	1	1	12
BALT-WASH PKWY N @ POWDER MILL RD	4	2	10
US-301 S @ MCKENDREE RD/CEDARVILLE RD	6	3	10
I-95 N @ VA-123/EXIT 160	2	2	8
I-495 INNER LOOP @ I-270-SPUR	7	2	8
Past Bottleneck Locations	**Highest Rank 2010-2021**	**2021 Rank**	**Number of Times in Annual Top Ten 2010-2021**
I-66 E @ SYCAMORE ST/EXIT 69	2	>100	10
I-495 OUTER LOOP @ MD-97/GEORGIA AVE/EXIT 31	4	44	10
I-95 S @ MCB QUANTICO/EXIT 148	2	>100	5
I-66 W @ VADEN DR/EXIT 62	3	>100	4
I-66 E @ VADEN DR/EXIT 62	8	>100	4

Some Major Projects 2010-2021

- 2011: MD-200 (InterCounty Connector) (east end connection to US-1 completed 2014); included I-95 interchange
- 2012: 495Express lanes between VA-620 and north of VA-267
- 2012/2013: Woodrow Wilson Bridge approaches (main bridge was completed 2009)
- 2013: 11th Street Bridge
- 2014: Silver Line Metro to Wiehle–Reston East
- 2014: 95Express reversible lanes from VA-294 to VA-610
- 2017: I-66 inside the Beltway converted from HOV to HOV/toll lanes
- 2019: 395Express reversible lanes from Turkeycock Run to Potomac River

Bottleneck Magnitudes (2019 Example)



Provided as an example, the magnitude of 2019's top bottleneck (measured in Base Impact [integrating queue length and bottleneck duration]) was more than twice as much of the second-ranked bottleneck, and almost four times as much as the 10^{th}-ranked bottleneck

Observations from the 12-Year Analysis

- Southbound I-95 at VA-123/Exit 160 (near the Occoquan River) is unrivaled as the region's top bottleneck in both frequency and severity
- Several other locations appeared in the top ten bottlenecks seven or more times in the 12-year period
- Some previous bottleneck locations appear to have lessened over time, particularly on I-66
- Locations that appeared in the top ten a limited number of times may have been due to temporary conditions, likely construction
    - Pandemic-impacted 2020, with its disrupted traffic patterns, did have a few 2020-only top ten locations

12-Year Analysis Caveats

- Results of this analysis are currently in draft form, subject to refinement
- The databases and geographic networks in the PDA Suite tool are generally reliable, but missing data or technical glitches may occur
- Traffic Message Channel geographic networks (developed by companies in the navigation industry for their own needs) vary in lengths, which may impact results
  - Staff removed reversible roadways (e.g. 395Express, Rock Creek Parkway) from analysis networks due to unreliable data/results
- The PDA Suite Bottleneck tool provides options for analysis – staff's choices for this analysis underpins this presentation's results, and other choices will result in other outcomes
- Staff may not have information as to why results came out as they did

Why Bottlenecks May Change Over Time

- Temporary impacts of construction zones
- Long-term impacts after construction projects
- Regional and national population and business growth
- Regional and national economic ups and downs
- Year-to-year variations in the impacts of storms and major incidents
- Still-evolving long-term travel demand impacts of the pandemic
- Changes within the PDA Suite tool and its underlying databases

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