RESULTS AND FINDINGS FROM GEN3 MODEL, PHASE 1, SENSITIVITY TESTING

Item #3, Part 2: COG Tests

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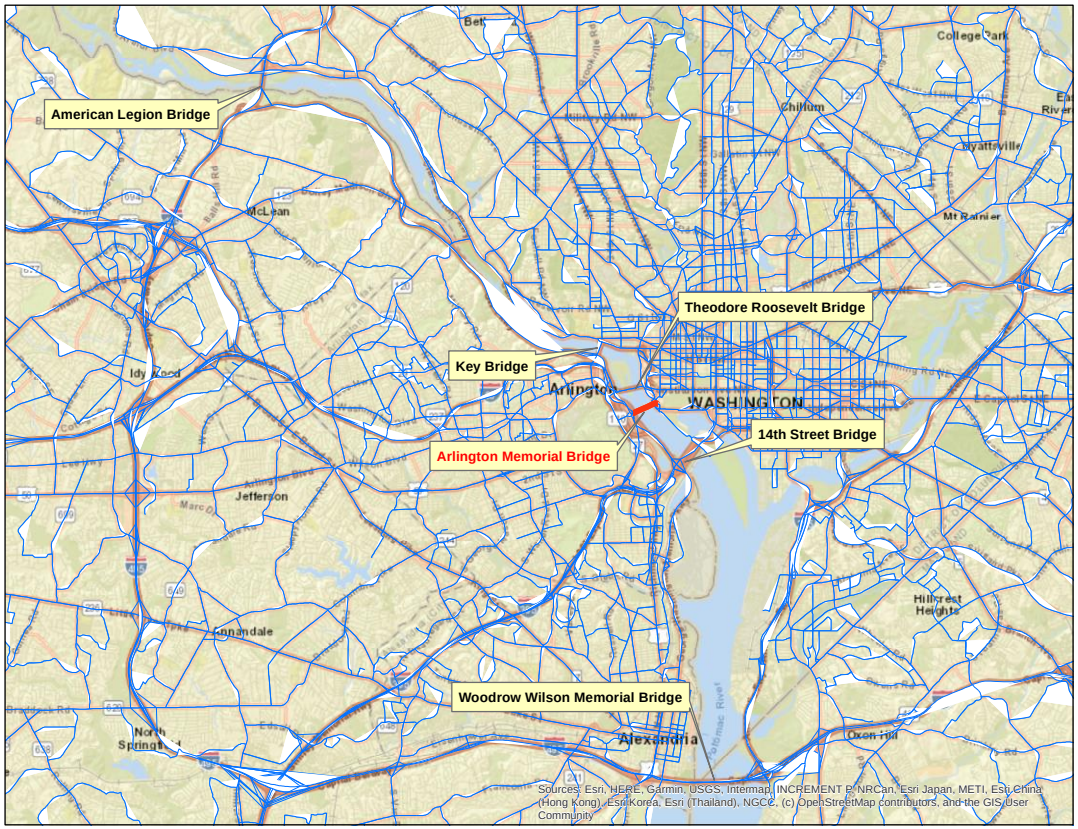
Background

- According to a plan laid out in August 2021, COG was tasked with conducting one to three of the following sensitivity tests for Gen3, Phase 1, Model:
  - Arlington Memorial Bridge Closed to Auto and Truck Traffic
  - Frequency of All High-Capacity Transit (HCT) Services Doubled
  - Peak-period Toll Rates Increased by 50%
- COG received the model from RSG on January 8 and conducted all three tests for the base model year of 2018.
- COG staff performed sensitivity analysis using an array of tools:
  - Demand Side: ABM Visualizer, trip flow summaries, etc.
  - Supply Side: View-from-Space (VFS), volume diff. plots and LineSum
- COG staff documented the three tests as part of the Phase 1 model sensitivity testing report.

Memorial Bridge Closure Scenario

- Arlington Memorial Bridge (shown below in RED) is closed to Auto and Truck Traffic for all time periods.



Major Potomac River bridges ranked by 2018 AADT:

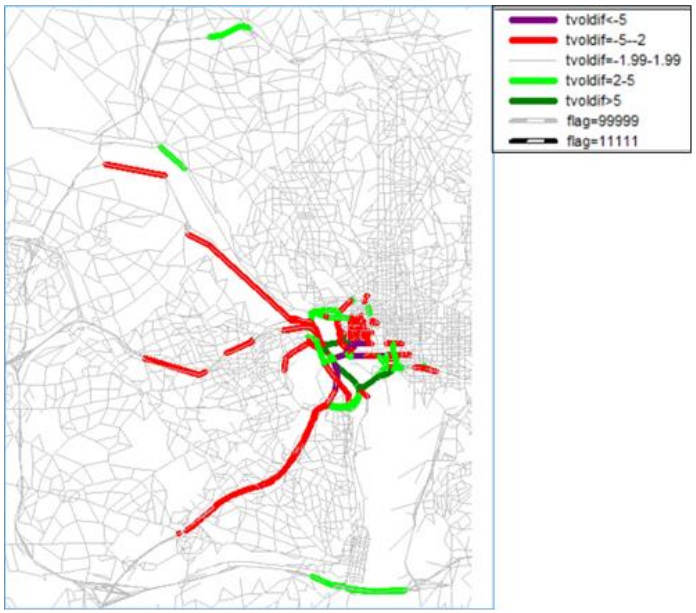
1. American Legion Bridge: 251k
2. 14th Street Bridge: 249k
3. Woodrow Wilson Bridge: 238k
4. Theodor Roosevelt Bridge: 95k
5. Arlington Memorial Bridge: 62k
6. Key Bridge: 52k
7. Chain Bridge: 21k

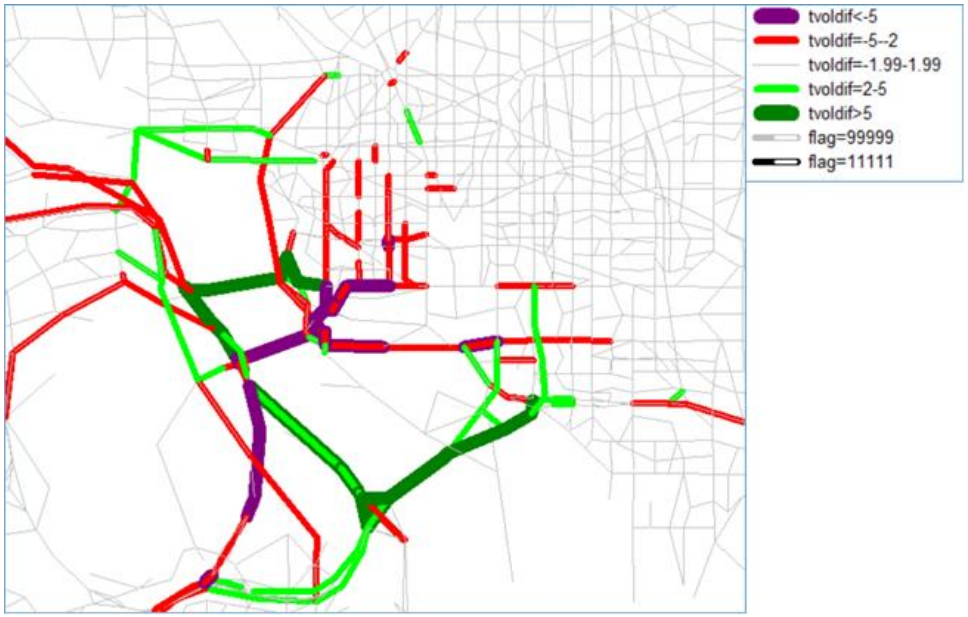
MB Closure Test: Expected and Actual Outcomes

- A decrease in worker flows, particularly between jurisdictions that likely use the Memorial Bridge to cross the Potomac River.
  - Confirmed. For example, the largest drop in worker flows was between Fairfax and DC (1,572 daily trips, 2% drop). The second largest drop was between Prince William Co. and DC (523 daily trips, a 2% drop). Worker flows also decreased between jurisdictions that less likely use Memorial Bridge to cross the river, e.g., the Montgomery to Alexandria worker flow decreased by 288 trips. Commuting flows on the same side of the river showed small increases, e.g., an increase of 317 trips (1%) from Fairfax to Arlington.
- In general, slightly shorter trip lengths as fewer people cross the river.
  - Confirmed. For example, average lengths for work tours originating from both Arlington and Fairfax were 0.2% shorter. There was also a slightly shorter average length (0.1% shorter) for non-mandatory tours at the regional level.
- No noticeable change in time-of-day choice due to the bridge closure for all periods.
  - Confirmed by tour departure/arrival time distributions from ABM Visualizer.

MB Closure Test: Expected and Actual Outcomes

- More traffic using other bridges crossing the Potomac River, such as Theodore Roosevelt Bridge and 14th Street Bridge.
- More congestion and lower vehicle travel speeds, particularly in the regional core (DC, City of Alexandria and Arlington County).
  - Both confirmed by daily link volume difference plots shown below.





MB Closure Test: Expected and Actual Outcomes

- A decrease in total travel measured by Vehicle Miles of Travel (VMT) or Vehicle Hours of Travel (VHT), and an increase in Vehicle Hours of Delay (VHD).
  - Confirmed by the VFS summaries. Both total VMT and VHT decreased, by 0.07% and 0.01%, respectively; Total VHD increased by 0.12%.
- A shift from auto to transit modes. The tour mode choice will likely show some reductions in auto tours between Virginia and DC.
  - Confirmed by the transit ridership by mode summary from LineSum (shown below) and trip flow summaries (e.g., total auto drivers flow between DC and Northern Virginia declined by 3.5%).

	Gen3 Base	Gen3 noMemBr	Diff (noMemBr - Base)	% Diff
Metrorail	535,695	538,374	2,679	**0.50%**
Commuter Rail	43,030	43,155	125	**0.29%**
MARC	30,121	30,362	241	0.80%
VRE	12,909	12,793	-116	-0.90%
All Bus	528,868	531,315	2,447	**0.46%**
Total	***1,107,593***	***1,112,844***	***5,251***	***0.47%***

HCT Capacity Increase Scenario

- Frequency of all HCT services, including Metrorail, commuter rail, streetcar, and Bus Rapid Transit (BRT), is doubled for all time periods.
- No light rail (Mode 5) service in 2018.
- No transit volumes were loaded on Mode 10 (streetcar/BRT) links due to a model glitch associated with the Non-Transit (NT) leg generation for Mode 10 stations.

HCT Capacity Test: Expected and Actual Outcomes

- Decreases in auto ownership due to increased transit accessibility, particularly for jurisdictions that are well connected by HCT services.
  - Confirmed by the auto ownership by jurisdiction summaries. There were fewer households owning at least one vehicle, especially in jurisdictions with good HCT services, e.g., there were 1,654 (or 0.68%) fewer such HHs in DC and 883 (or 0.25%) fewer in Montgomery.
- A decrease of VMT, VHT, and VHD due to the shift from auto travel to HCT.
  - Confirmed by the VFS summaries. Total VMT decreased by 0.28%, VHT by 0.82% and VHD by 1.71%.

HCT Capacity Test: Expected and Actual Outcomes

- More transit boardings across Metrorail and commuter rail lines and fewer bus boardings and auto trips as HCT becomes more attractive.
  - The overall increases in Metrorail and commuter rail boardings (by 10.3% and 49.7%, respectively) and decrease in bus boardings (by 2.0%) from the transit ridership by mode summaries met our expectation. However, the transit ridership by line summary below shows notable declines in ridership on some Metrorail lines (e.g., “WMBLUA”, “WMSILV”) despite frequency increases, which is counterintuitive.

Transit Route Name	Mode No.	Baseline Ridership	Build Scenario Ridership	Difference	Percent Difference
WMBLUA	3	98,226	89,048	-9,178	-9.3%
WMGRNA	3	115,507	133,174	17,667	15.3%
WMORNA	3	110,350	176,417	66,067	59.9%
WMREDA	3	159,812	246,793	86,982	54.4%
WMREDB	3	106,496	43,801	-62,695	-58.9%
WMSILV	3	80,539	42,735	-37,804	-46.9%
WMYELA	3	69,975	90,361	20,386	29.1%
MARC BRUNSWICK LINE	4	6,438	12,070	5,632	87.5%
MARC CAMDEN LINE	4	4,026	7,158	3,132	77.8%
MARC PENN LINE	4	19,657	21,736	2,079	10.6%
VRE MANASSAS LINE	4	4,344	8,678	4,334	99.8%
VRE FREDERICKSBURG LINE	4	5,079	8,980	3,901	76.8%

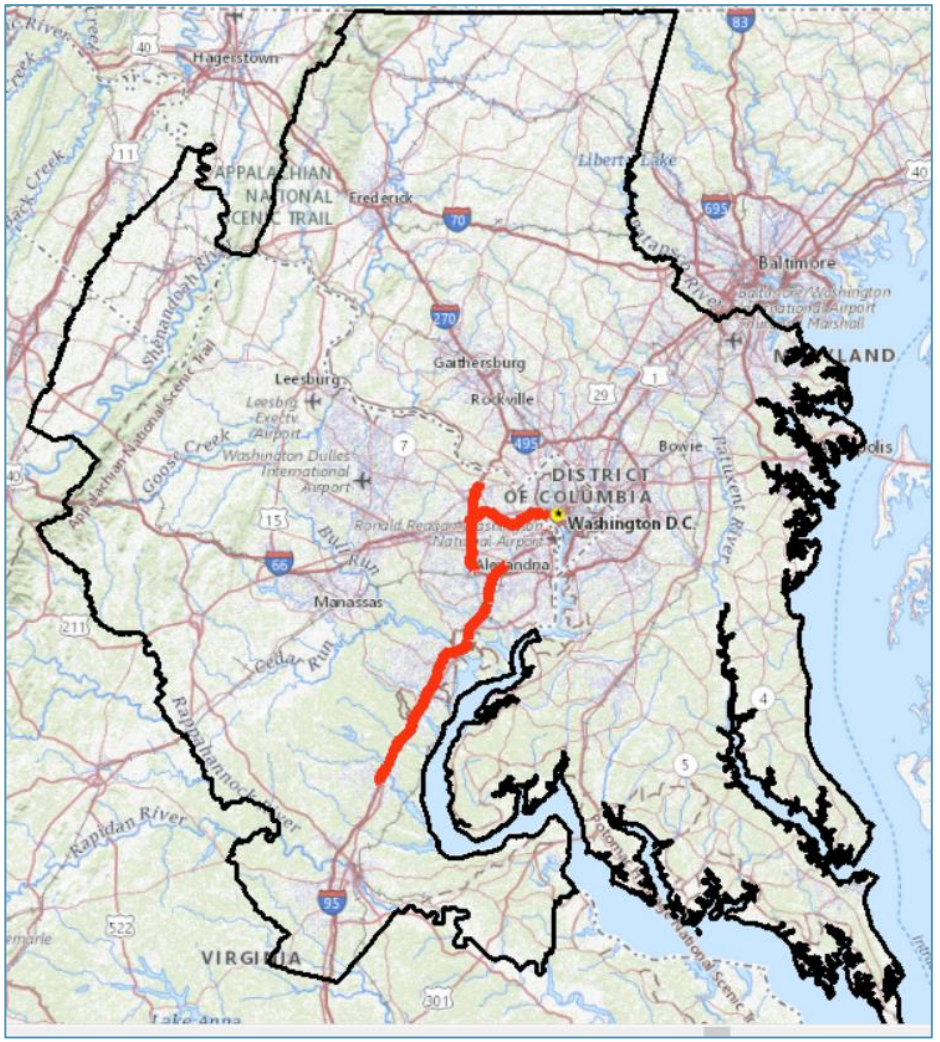
HCT Capacity Test: Expected and Actual Outcomes

- Increases in both walk-access and drive-access transit trip flows between jurisdictions that are well connected by HCT services.
  - Confirmed by trip flow summaries (e.g., changes in walk-acc transit trip flow below)

	Alexandria	Anne Arundel	Arlington	Calvert	Carroll	Charles	Clarke	DC	Fairfax	Fauquier	Frederick	Fredericksburg	Howard	Jefferson	King George	Loudoun	Montgomery	Prince George's	Prince William	Spotsylvania	St. Mary's	Stafford	Total
Alexandria	258	5	237	0	0	1	0	874	219	0	1	-1	0	0	0	-3	100	89	2	0	0	0	1,782
Anne Arundel	2	-43	-2	0	0	0	0	22	-3	0	0	0	2	0	0	0	-3	21	0	0	0	0	-4
Arlington	269	-2	1,071	0	0	10	0	2,320	552	0	-4	0	4	0	0	10	432	353	-21	0	0	1	4,995
Calvert	-1	0	-1	-4	0	0	0	3	1	0	0	0	0	0	0	0	-1	-1	0	0	0	0	-4
Carroll	0	0	0	0	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-2
Charles	0	0	4	0	0	3	0	-3	-1	0	0	0	0	0	0	0	1	0	0	0	0	0	4
Clarke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DC	908	21	2,287	-1	0	-2	0	8,923	765	0	1	6	0	0	0	13	1,357	1,729	23	0	-1	1	16,030
Fairfax	232	-4	431	-1	0	-1	0	768	774	0	1	3	-2	0	0	20	222	123	39	0	0	-1	2,604
Fauquier	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Frederick	1	0	-4	0	0	0	0	3	0	0	-7	0	0	0	0	0	13	-2	0	0	0	0	4
Fredericksburg	-1	0	1	0	0	0	0	2	5	0	0	-16	0	0	0	0	0	0	1	2	0	3	-3
Howard	0	4	2	0	0	0	0	1	1	0	0	0	-13	0	0	0	4	15	0	0	0	0	14
Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2
King George	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loudoun	0	0	-1	0	0	0	0	22	26	0	0	0	0	0	0	-10	0	-2	0	0	0	0	35
Montgomery	75	1	455	-1	0	0	0	1,304	221	0	12	1	2	2	0	7	2,579	217	4	0	0	0	4,879
Prince George's	82	12	405	-1	0	1	0	1,588	129	0	-1	0	13	0	0	-1	257	573	-5	0	0	0	3,052
Prince William	3	0	-11	0	0	0	0	11	50	0	0	2	0	0	0	0	2	-3	-55	1	0	2	2
Spotsylvania	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
St. Mary's	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	-2
Stafford	-1	0	2	0	0	0	0	0	-2	0	0	2	0	0	0	0	0	0	1	0	0	2	4
Total	1,827	-6	4,876	-8	-2	12	0	15,837	2,737	0	3	-3	6	2	0	36	4,964	3,113	-11	4	-2	8	33,393

Increase Toll Scenario

- Per mile toll rates for all variably priced toll facilities (shown in RED) are increased by 50% in AM and PM Peak Periods relative to the Baseline.
- Toll rates were re-estimated for the Baseline scenario.
- In 2018, HOV2+ vehicles can use the tolling facilities on I-66 for free while HOV3+ vehicles can use the tolling facilities on I-95 and Capital Beltway for free.

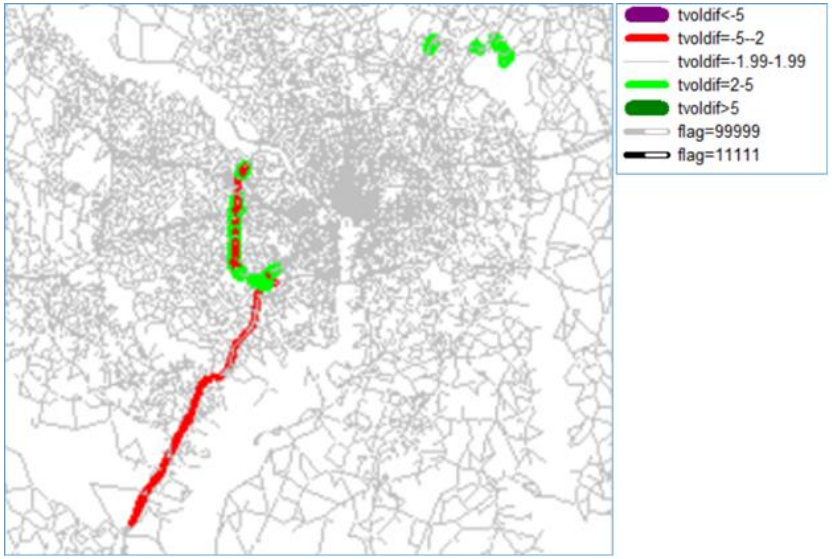


Increase Toll Test: Expected and Actual Outcomes

- Shifts in traffic from peak to off-peak periods to avoid the increased tolls.
  - Expected shifts in tour departure/arrival times to off-peak periods are NOT shown in ABM Visualizer, suggesting that the time-of-day model may not be sufficiently sensitive to the toll rate change.
- Decreases in auto SOV trips and increases in auto 3+ person trips.
  - At the tour level, there were small shifts from SOV, HOV2, and ride hail tours to HOV3+ and PNR transit tours, e.g., SOV tours decreased by 0.01% and HOV3+ tours increased by 0.07%, which met our expectation as the toll increase did not affect HOV3+ or transit.
  - At the trip level, the trip flow summaries also showed overall decreases in SOV trips and increases in HOV3+ trips. However, there were some unexpected movements at the interchange level, e.g., drops in HOV3+ trips from Virginia to DC, drops in HOV3+ trips from DC to Prince George's. It is also unclear why there were some large changes in intra-jurisdictional trip flows, e.g., a decrease of 3,810 trips in DC and an increase of 5,496 trips in Prince George's County.

Increase Toll Test: Expected and Actual Outcomes

- Shifts in traffic from HOT lanes to parallel highways and local roads.
  - Confirmed by the volume difference plot shown to the right.



- Increases in transit trips that offset decreases in auto trips.
  - As mentioned earlier, there were small shifts from SOV, HOV2, and ride hail tours to HOV3+ and PNR transit tours. It is unclear, though, why walk-access transit tours decreased by 0.05%.
  - At the trip level, we saw similar modal shifts, but there were also some unexpected subregional movements, e.g., drops in transit trips from Virginia to DC.
  - While overall transit ridership increased by 0.1% as expected, the decrease in Metrorail ridership (by 0.4%) is counterintuitive.

Concluding Remarks and Next Steps

- With some exceptions, the actual outcomes of the three sensitivity tests generally aligned with our expectations.
  - At the regional level, while the directionality of model responses was generally reasonable, the magnitude of them was usually small. Thus, staff had to carefully distinguish meaningful model changes from model noise when dissecting sensitivity testing results.
  - At the sub-regional or sub-modal level, there were some unexpected model changes that may warrant an in-depth analysis in the future.
- The lack of sensitivity of time-of-day choices to the toll increase in peak periods should be examined in Gen3, Phase 2, Model development.
- Next steps: COG staff plan to repeat the three tests when Gen3, Phase 2, Model becomes available. COG staff may conduct additional sensitivity tests and scenario tests. COG staff may conduct at least one of these tests for the horizon year of 2045.

Acknowledgements

- This is a collective effort. I would like to express my sincere thanks to:
  - Ray, Meseret and Sanghyeon, who prepared model inputs, conducted model runs, performed sensitivity analysis and documented the results.
  - Mark and Dusan, who reviewed the documentation and provided valuable comments and suggestions.
  - RSG and BMG staff, who developed the Gen3, Phase 1, Model for testing.

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