COG/TPB GEN3 TRAVEL MODEL

Status report

Feng Xie
TPB Transportation Engineer

Travel Forecasting Subcommittee
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Overview

- Status of Gen3 Model, Phase 3, development, which is led by TPB staff with on-call support from RSG and Baseline Mobility Group (BMG):

  - Model enhancements and bug fixes (status update)

  - Progress on usability testing (status update)

    - Usability testing for out years

    - Sensitivity tests for base year

- Next Steps

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Model Enhancements and Bug Fixes

- RSG is working to address issues that COG staff noticed during usability testing. RSG provided status updates to COG on 1/9/25, 1/31/25, 2/27/25, and 3/12/25.

  - Update the tour/trip mode choice models to address the overestimation of SOV trips and underestimation of HOV trips.

  - Update the tour/trip time-of-day choice models to address the underestimation of trip departures in PM Period and overestimation in Night-Time (NT2) Period.

  - Investigate the suspicious volume increases on Screenline #26 and #27 and update the IX/XI auto-driver model as needed.

  - **Recently Added:** Reverse the global 15% increase of truck and CV trips due to the noticeable increase in emissions relative to the Gen2 Model.

  - **Recently Added:** Revert to the original telecommute frequency coefficients in the Daily Activity Pattern (DAP) Model due to a discrepancy noticed between scenario assumptions and model outcomes in the telecommute scenario analysis.

- **COG staff updated truck/CV trip distribution model to consider tolls on truck/CV trips.**

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Update to Truck/CV Trip Distribution Model

- Tolls were intentionally left out when developing the Gen2 internal truck trip distribution model, as tolls on trucks are usually paid by truck companies, not by truck drivers.

- This assumption, however, may lead to unreasonable results in a pricing analysis.
  - In a hypothetical congestion pricing study, which will be discussed later, staff noticed that truck/CV trips entering DC CBD did not decrease despite a large toll imposed on them.

- Furthermore, tolls on truck/CV trips are considered in both truck/CV external trip distribution model and highway assignment model, which is inconsistent with the treatment above.

- Staff proposed to include tolls in truck/CV internal trip distribution model, and conducted a sensitivity test to examine the model effects of this proposed change:
  - It had very marginal effects on model results at the regional level.
  - Truck/CV trips entering DC CBD significantly dropped. They were replaced by intra-CBD truck/CV trips.

- As such, staff implemented this model change for the next Gen3 Model version.

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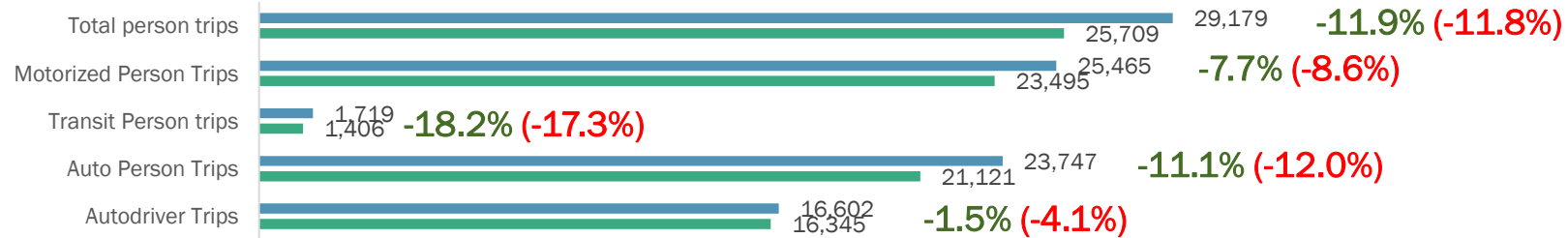**Transportation Planning Board**

Usability Testing for Out Years

- Air Quality Conformity (AQC) analysis of Visualize 2050 includes six analysis years (2025, 2026, 2030, 2040, 2045 and 2050) and two options for years 2040, 2045 and 2050 (Option A: No Southside Express Lanes; Option B: Southside Express Lanes); Gen3 Model usability testing includes the same base year 2025 and three select out years: 2030, 2045 (Option B only) and 2050 (Option B only).

- Gen3 Model usability tests are conducted based on model inputs that are largely consistent with the AQC analysis, enabling an apples-to-apples comparison of model outputs to the corresponding AQC model runs.

- Staff presented the 2025 testing results at the November TFS meeting, and the 2030 and 2045 results in January. Staff subsequently conducted the **2050** test, which will be presented today.

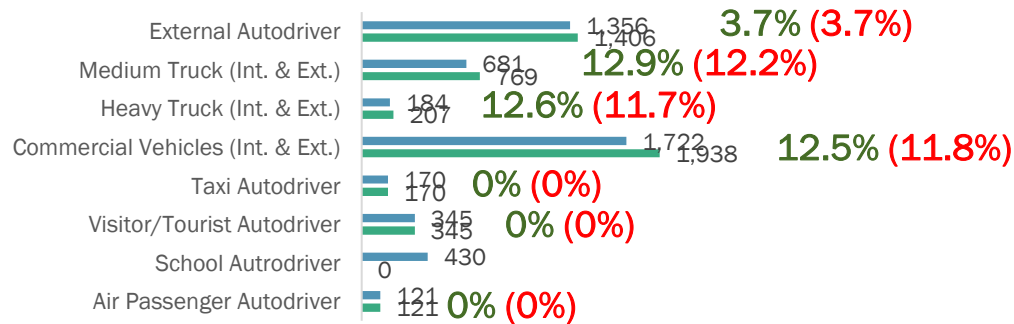- All numbers referenced in this presentation are in DRAFT.

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2050 Test Results in a Nutshell

Resident Travel: Person/Auto-driver Trips in 000s

Total person trips	25,709 / 29,179 **-11.9% (-11.8%)**
Motorized Person Trips	23,495 / 25,465 **-7.7% (-8.6%)**
Transit Person trips	1,406 / 1,719 **-18.2% (-17.3%)**
Auto Person Trips	21,121 / 23,747 **-11.1% (-12.0%)**
Autodriver Trips	16,345 / 16,602 **-1.5% (-4.1%)**

Exogenous Travel: Auto-driver Trips in 000s

External Autodriver	1,356 / 1,406 **3.7% (3.7%)**
Medium Truck (Int. & Ext.)	681 / 769 **12.9% (12.2%)**
Heavy Truck (Int. & Ext.)	184 / 207 **12.6% (11.7%)**
Commercial Vehicles (Int. & Ext.)	1,722 / 1,938 **12.5% (11.8%)**
Taxi Autodriver	170 / 170 **0% (0%)**
Visitor/Tourist Autodriver	345 / 345 **0% (0%)**
School Autrodriver	0 / 430
Air Passenger Autodriver	121 / 121 **0% (0%)**

Note: % differences relative to Gen2 Model – 2050 figures in **green** and 2025 figures in **red**.
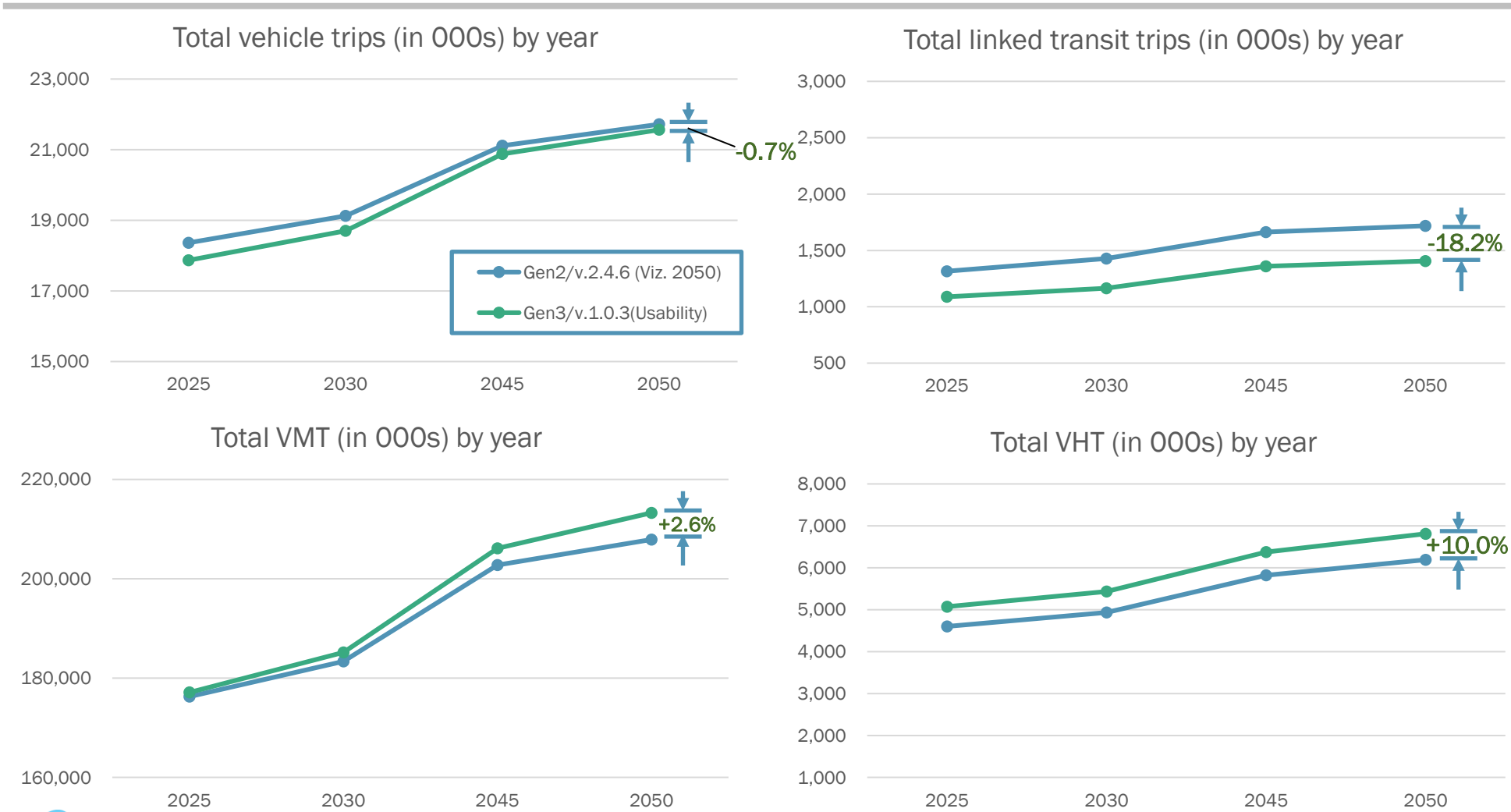
Regional Assignment Statistics in 000s

Total Vehicle Trips	21,719 / 21,563 **-1.1% (-2.7%)**
Total VMT	207,891 / 213,272 **1.7% (0.5%)**
Total VHT	6,191 / 6,811 **9.5% (10.2%)**
Total VHD	2,336 / 2,844 **23.1% (32.4%)**
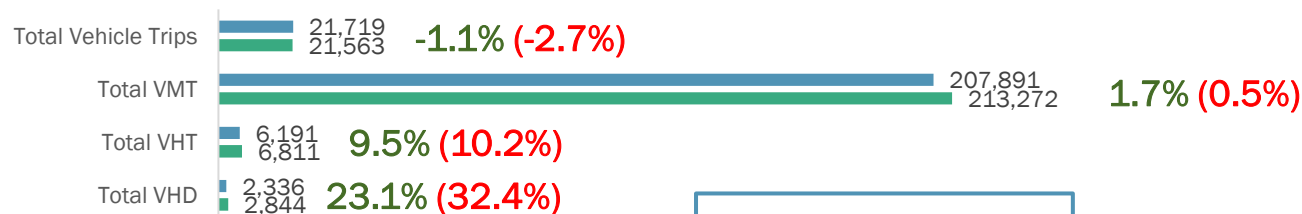
Legend: ■ 2050 (gen2) ■ 2050 (gen3)

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Trends by Year

Total vehicle trips (in 000s) by year

Legend:
- Gen2/v.2.4.6 (Viz. 2050)
- Gen3/v.1.0.3(Usability)

-0.7%

Total linked transit trips (in 000s) by year

-18.2%

Total VMT (in 000s) by year

+2.6%

Total VHT (in 000s) by year

+10.0%

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Main Take-Aways from the Out-Year Analysis

- Comparison of Gen2 and Gen3 modeling results for 2050 are largely in line with previous years:
  - Gen3 Model simulated roughly 12% fewer person trips because of 1) the declining household trip rates according to our household travel surveys, and 2) the slight under-estimation of household trip rates relative to the survey data to better match VMT.
    - RSG increased household trip rates as part of the ongoing model updates.
  - Gen3 Model simulated 17%-18% fewer transit person trips because it was calibrated and validated to 2018 conditions, which better captured the significant downward trend of transit ridership during the period of 2014-2018.
  - Gen3 Model simulated ~ 4% more external auto-driver trips due to change in methodology.
  - Gen3 Model used the same methodologies for simulating external and internal CV/truck trips but inflated internal trips by 15% to account for the rapid growth of e-commerce.
    - RSG reversed this 15% global increase of CV/truck trips.
  - Gen3 Model used the same methodologies and simulated the same number of miscellaneous trips (except that school trips are no longer simulated as exogenous travel).

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Main Take-Aways from the Out-Year Analysis

- Gen2 and Gen3 Models showed very similar trends by year between 2025 and 2050:
  - Total vehicle trips and VMT from Gen3 Model closely tracked their Gen2 counterparts over time.
  - Transit trips from Gen3 Model are consistently lower due to calibration and validation to the more recent 2018 data.
  - VHT from Gen3 Model are consistently higher due to the time-of-day shifts of auto-driver trips.
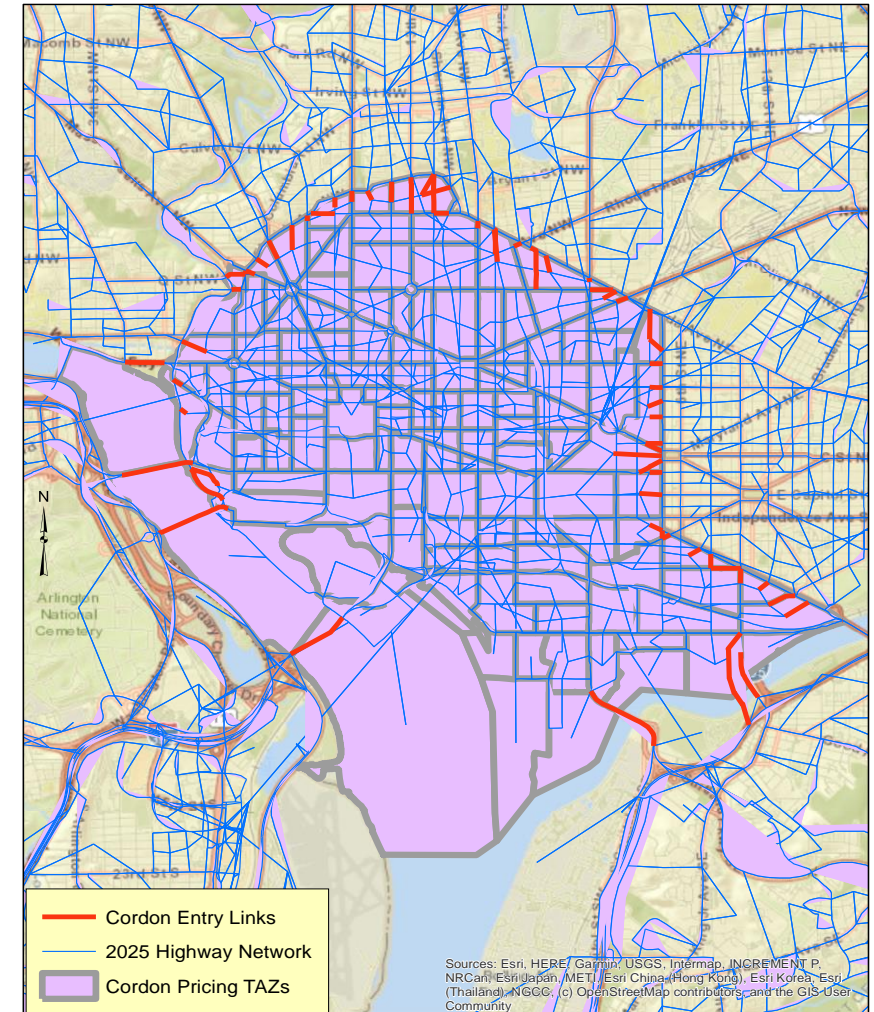
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Sensitivity Tests for Base Year

- Sensitivity tests are being conducted in Phase 3 as part of usability testing, mainly aiming to:
  - Compare Gen2 vs. Gen3 Model responses in same or largely consistent scenario setup.
  - Showcase Gen3 Model's capability for in-depth analysis with disaggregate data.
- Staff are currently working on three sensitivity tests for 2025:
  - Adding one lane, per direction, on I-95 between the DC and Baltimore beltways (Done)
  - **Imposing a hypothetical cordon pricing scheme in the CBD of DC (Done)**
  - Increasing the telecommute frequency in the TPB Planning Area (On Hold)

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DC CBD Cordon Pricing: Methodologies

- A hypothetical scenario in which a toll is charged on vehicles entering a restricted cordon zone in DC CBD (shown in the map on the right).

- Unrealistic toll values ($20 for peak or $5 for off peak) are assumed to amplify the modeled effects.

- Conducted model runs for the same Build scenario in both Gen2 and Gen3 models and compared them to their respective baseline scenarios.

- Compared model response (Build minus Baseline) between Gen2 and Gen3 models based on aggregated results generated by both models.

- For **Gen3 Model only**, examined changes for a subgroup of trips or a sub-population of interest using the disaggregate model output data.

Legend:
— Cordon Entry Links
— 2025 Highway Network
▨ Cordon Pricing TAZs

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

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DC CBD Cordon Pricing: Comparison of Model Response

- Differences in major aggregate-level model statistics between the Baseline and Build scenarios are comparable between the Gen2 and Gen3 models at different geographic scales.

Table 1. Differences in Total VMT (in 000s) in 2025

	Gen2/v.2.4.6 (Viz. 2050)			Gen3/v.1.0.3 (Usability)		
	Baseline	Build	% Diff	Baseline	Build	% Diff
Region	176,252	174,731	-0.9%	177,095	176,223	-0.5%
DC	8,014	6,922	-13.6%	7,904	7,038	-11.0%
Study Area	2,492	1,541	-38.2%	2,572	1,863	-27.6%

Table 2. Differences in Total VHD (in 000s) in 2025

	Gen2/v.2.4.6 (Viz. 2050)			Gen3/v.1.0.3 (Usability)		
	Baseline	Build	% Diff	Baseline	Build	% Diff
Region	1,372	1,297	-5.5%	1,817	1,757	-3.3%
DC	136	82	-39.6%	147	90	-39.0%
Study Area	53	11	-78.4%	61	17	-72.7%

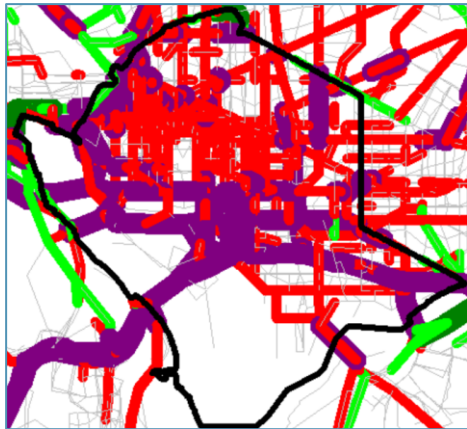National Capital Region
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DC CBD Cordon Pricing: Comparison of Model Response

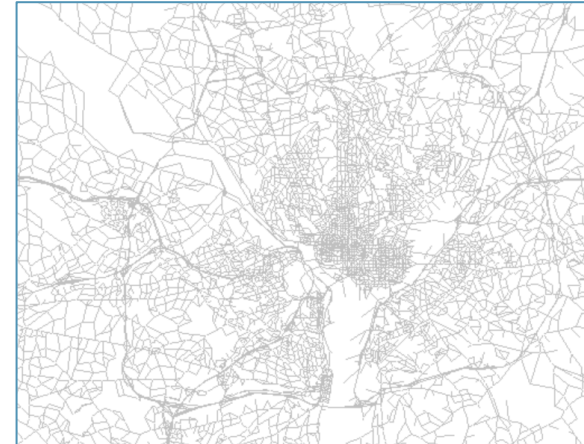**Map 1. Daily Link Volume Differences**
(Build minus Baseline)

Gen2

Gen3

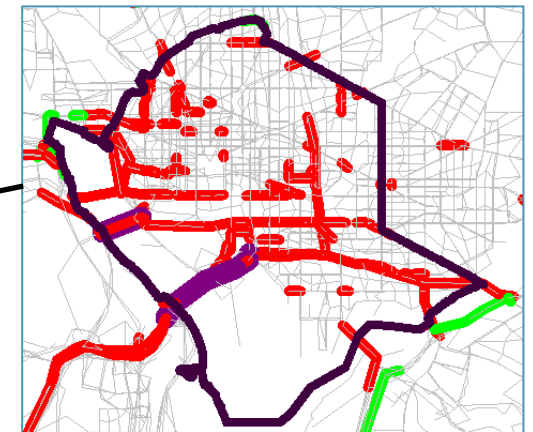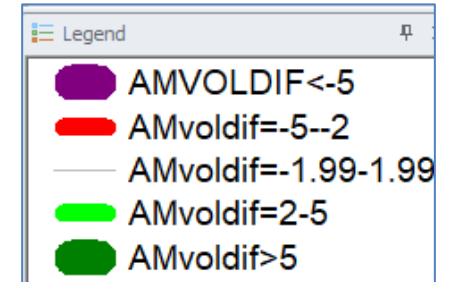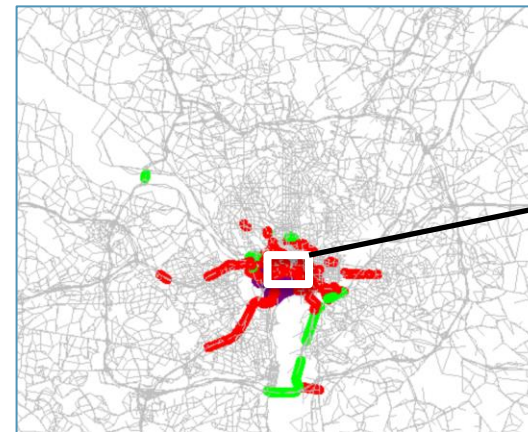**Map 2. AM Peak Link Volume Differences**
(Build minus Baseline)

Gen2

Gen3

Legend

- AMVOLDIF<-5
- AMvoldif=-5--2
- AMvoldif=-1.99-1.99
- AMvoldif=2-5
- AMvoldif>5

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DC CBD Cordon Pricing: Comparison of Model Response

- Comparison of O-D trip tables shows similar responses in the Gen2 and Gen3 models in terms of changes in person/vehicle trips entering DC CBD. Specifically,
  - Auto person trips and auto driver trips significantly dropped due to the cordon toll.
  - SOV and HOV2 trips shifted to HOV3+ trips.
  - Auto modes shifted to transit modes and non-motorized modes.
- There are differences in O-D trip patterns, however, mostly due to the differences in Gen2 vs Gen3 modeling methodologies (e.g., trip purpose, destination choice, mode choice, etc.).
- As discussed earlier, truck/CV trips entering the cordon zone did not respond to the cordon toll, as truck/CV trip distribution model did not consider tolls. This was fixed in a model update.
- O-D trip tables and assumed toll rates by time of day and vehicle type also enabled a back-of-envelope calculation of daily toll revenue, excluding tolls paid by the through trips. The Gen2 estimate ($3.9M) and Gen3 estimate ($4.5M) are in the same ballpark. Although the tolls were purposely chosen to be large, the estimated revenues are comparable to what has been found for other cities.

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DC CBD Cordon Pricing: Can Gen3 Model Tell Us More?

- The disaggregate data generated by the Gen3 Model enabled us to examine the impact of the hypothetical cordon pricing scheme on a subset of trips or travelers.

- Impact on the subgroup of auto person trips entering the cordon zone, broken down by:
  - Mode - # Trips across all modes ↓; SOV share ↓; HOV3+, transit, bike/walk shares ↑
  - Trip purpose - # Trips across all purposes ↓; discretionary share ↓; work/at-work shares ↑
  - Trip departure time – # Trips across all time periods ↓; AM/PM shares ↓; Off-peak shares ↑

- Impact on the subgroup of travelers entering the cordon zone by auto, broken down by :
  - Person type – # Travelers across all person types ↓; Share of full-time workers ↑
  - Age category – # Travelers across all ages ↓; Shares for age groups 20-34, 35-64 ↑
  - Gender – # Travelers across gender ↓; No noticeable shift in gender distribution
  - Home jurisdiction – # Travelers across all jur. ↓; Shares from DC/Arlington/Alexandria ↓
  - Household income – # Travelers across all income segments ↓; Shares for high- or very-high-income ↑

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DC CBD Cordon Pricing: Can Gen3 Model Tell Us More?

- The disaggregate data generated by the Gen3 Model also enabled us to examine the impact of the hypothetical cordon pricing scheme on a sub-population of interest ("**SPI**").

- Four SPIs were selected for analysis:
  - **SPI 1:** Residents of the DC CBD, including both workers and non-workers
  - **SPI 2:** Residents of the City of Alexandria who work in the DC CBD
  - **SPI 3:** Residents of Montgomery County who work in the DC CBD
  - **SPI 4:** Residents of Loudoun County who work in the DC CBD

- As show below, the impact on the four SPIs is much more significant than that on the entire population ("**EP**") in terms of % change in major travel metric in Baseline vs. Build.
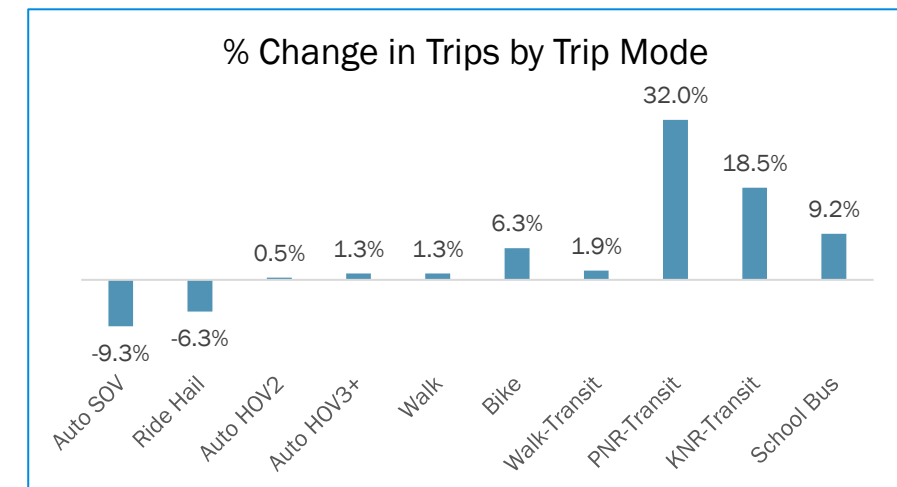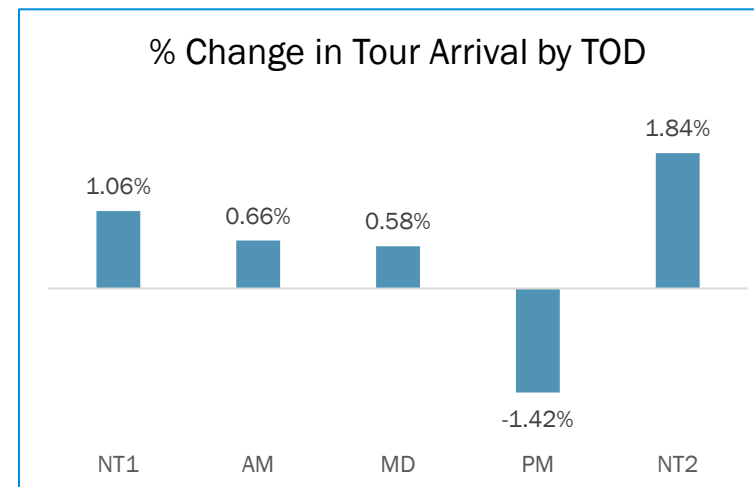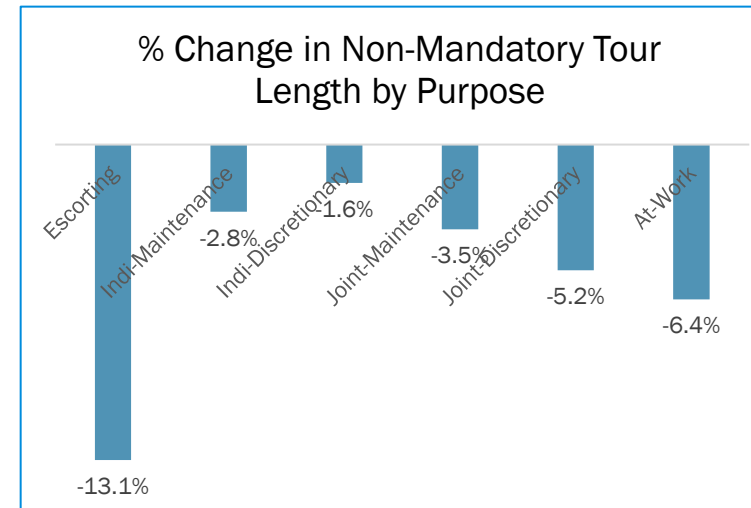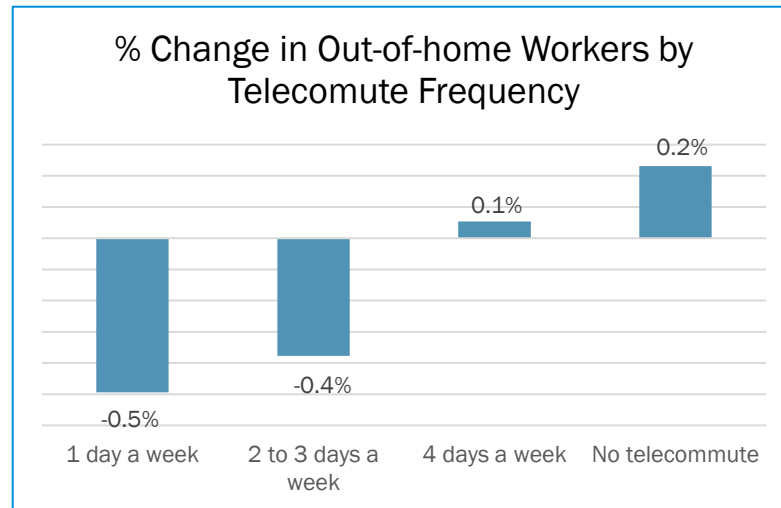
	SPI 1	SPI 2	SPI 3	SPI 4	EP
	DC CBD	City of Alexandria	Montgomery County	Loudoun County	Region
Total trips	-0.1%	-0.5%	-1.8%	-5.8%	-0.1%
Total VMT	-14.4%	-15.1%	-12.7%	-11.4%	-0.8%

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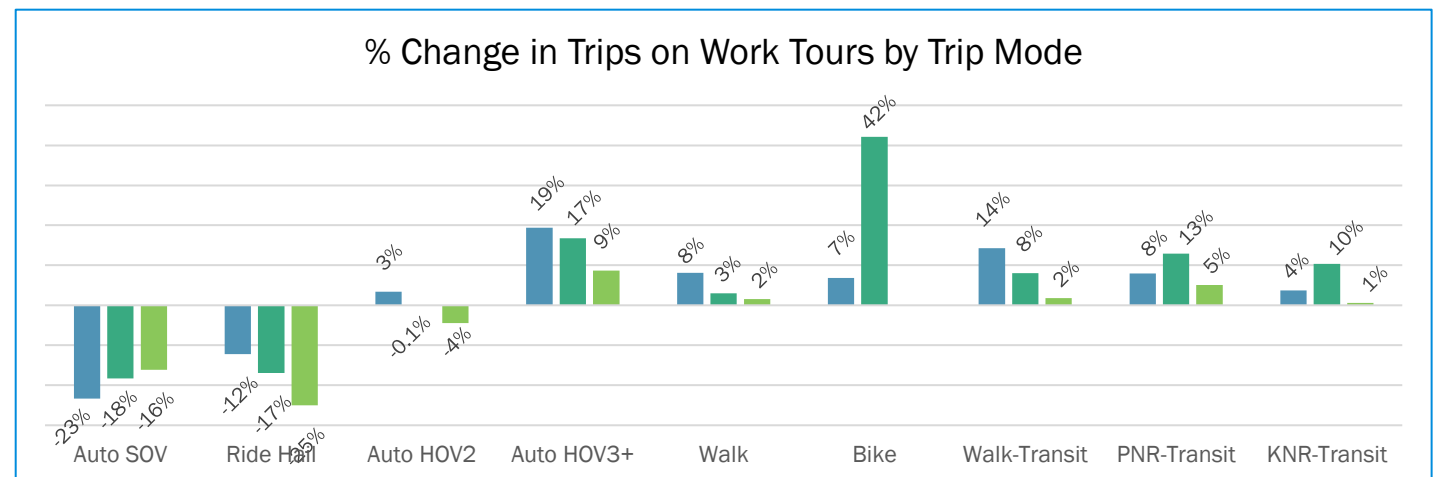**Transportation Planning Board**

DC CBD Cordon Pricing: Can Gen3 Model Tell Us More?

- Changes in travel behaviors for residents of the CBD.

% Change in Out-of-home Workers by Telecommute Frequency

- 1 day a week: -0.5%
- 2 to 3 days a week: -0.4%
- 4 days a week: 0.1%
- No telecommute: 0.2%

% Change in Non-Mandatory Tour Length by Purpose

- Escorting: -13.1%
- Indi-Maintenance: -2.8%
- Indi-Discretionary: 1.6%
- Joint-Maintenance: -3.5%
- Joint-Discretionary: -5.2%
- At-Work: -6.4%

% Change in Tour Arrival by TOD

- NT1: 1.06%
- AM: 0.66%
- MD: 0.58%
- PM: -1.42%
- NT2: 1.84%

% Change in Trips by Trip Mode

- Auto SOV: -9.3%
- Ride Hail: -6.3%
- Auto HOV2: 0.5%
- Auto HOV3+: 1.3%
- Walk: 1.3%
- Bike: 6.3%
- Walk-Transit: 1.9%
- PNR-Transit: 32.0%
- KNR-Transit: 18.5%
- School Bus: 9.2%

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DC CBD Cordon Pricing: Can Gen3 Model Tell Us More?

- Changes in travel behaviors for residents of Alexandria, Montgomery County and Loudoun County

% Change in Out-of-home Workers by Telecommute Frequency

% Change in Tour Departure by TOD

% Change in Trips on Work Tours by Trip Mode

Legend:
- City of Alexandria (region core)
- Montgomery County (inner suburbs)
- Loudoun County (outer suburbs)

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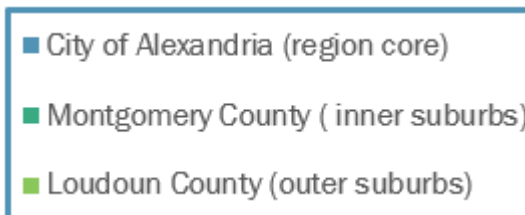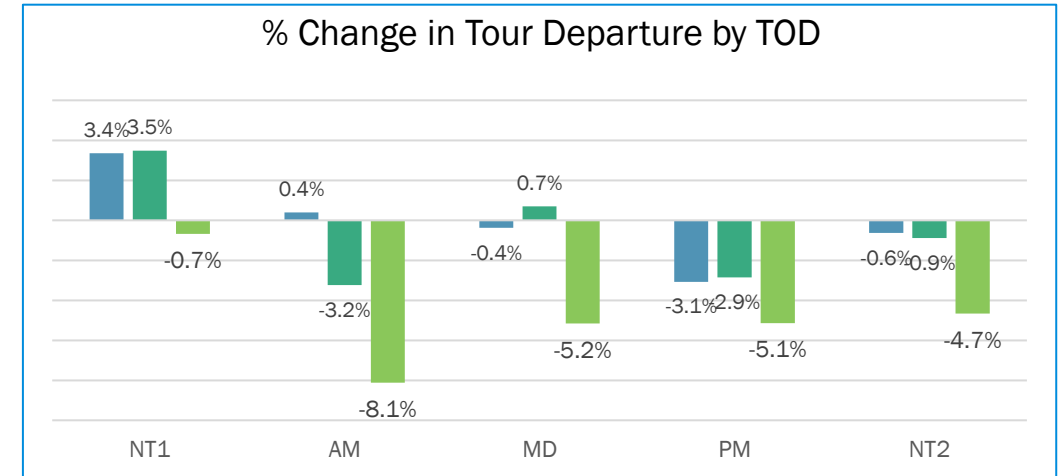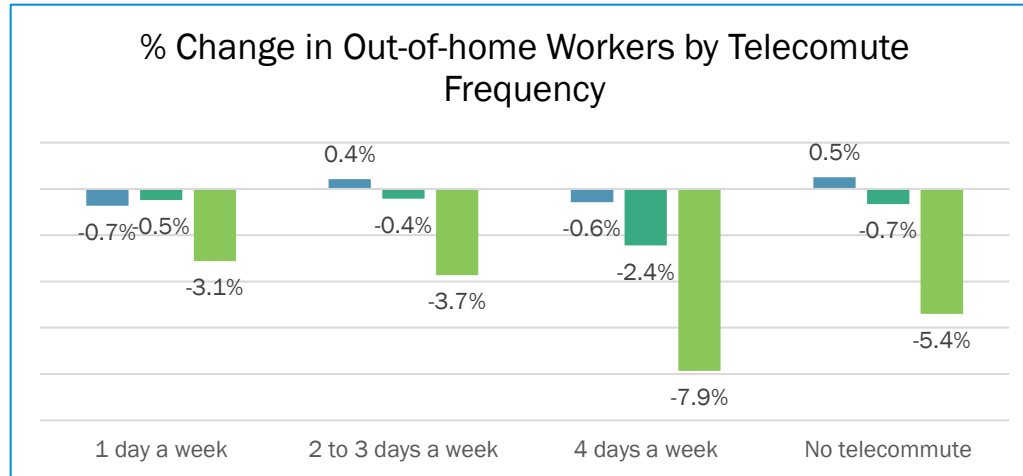
Next Steps

- RSG staff are working to finish the model updates and update the model documentation.
- After RSG delivers the updated model, COG staff plan to do the following:
  - Improve the toll setting process to better match the Gen2 Model data.
  - Redo the 2025 and 2050 usability tests.
  - Resume the 2025 telecommute frequency sensitivity test.
  - Perform plan performance analysis using the Gen3 Model.
  - Perform Title VI related analysis using the Gen3 Model.
  - Perform additional sensitivity tests as needed.

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Acknowledgement

- Special thanks to:

    - Andrew Rohne and Joel Freedman, who provided on-call consultant assistance on this project.

    - Bahar Shahverdi, who conducted the 2050 usability test run and summarized model results.

    - Meseret Seifu and Glenn Lang, who conducted the cordon pricing sensitivity test and documented the results.

    - Other project members, including Mark Moran, Dusan Vuksan, Ray Ngo, Nazneen Ferdous, and others, who have provided comments and assistance during this study.

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Feng Xie

TPB Program Manager, Model Development

(202) 962-3259

fxie@mwcog.org

777 North Capitol Street NE, Suite 300

Washington, DC 20002

mwcog.org

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