MEMORANDUM

TO: Metropolitan Washington Air Quality Committee Technical Advisory Committee (MWAQC TAC)
FROM: Jane Posey, TPB Transportation Engineer
SUBJECT: Historic Emissions Sensitivity Tests & MVEB Development
DATE: February 1, 2023

BACKGROUND

On January 7, 2021, the U.S. Environmental Protection Agency (EPA) officially released a new version of their MOtor Vehicle Emissions Simulator model, MOVES3, and required its use in all State Implementation Plan (SIP) development and transportation conformity analyses by January 2023. National Capital Region Transportation Planning Board (TPB) staff completed preliminary sensitivity test runs of the new model to determine the change in emissions from MOVES2014b to MOVES3. TPB staff conducted these initial tests by using the MOVES2014b assumptions from the 2022 Update to Visualize 2045 analysis and kept them the same in MOVES3 (where possible). The sensitivity test runs, as seen in Table 1 below, showed the greatest change in estimated Nitrogen Oxides (NOx) emissions with a 26% increase in 2030, a 52% increase in 2040, and a 54% increase in 2045 when using MOVES3 compared to using MOVES2014b. TPB staff shared these results with the Metropolitan Washington Air Quality Committee Technical Advisory Committee (MWAQC TAC) in September 2022, and informed the committee that, with the change in MOVES models, the region would find it challenging to remain below the current Motor Vehicle Emissions Budgets (MVEBs) which were established in the 2008 ozone maintenance plan. The MWAQC TAC agreed to update the MVEBs within the 2008 ozone maintenance plan.

Table 1: MOVES3 Preliminary Sensitivity Tests: NOx tons/day[1]

Year	MOVES2014B	MOVES3.0.3	MOVES3.0.3 versus MOVES2014B
2021	66.824	67.442	1%
2023	54.016	56.382	4%
2025	42.566	46.377	9%
2030	27.536	34.666	26%
2040	19.140	29.183	52%
2045	19.131	29.434	54%

[1] Vuksan, Dusan, Park, Jinchul, Son, Daniel. Memorandum to the Metropolitan Washington Air Quality Committee Technical Advisory Committee. "MOVES3 Model Sensitivity Testing," September 12, 2022. Presented to MWAQC TAC September 13, 2022. https://www.mwcog.org/events/2022/9/13/mwaqc-tac/

HISTORIC MVEB DEVELOPMENT

The region's current MVEBs, set with MOVES2014, are in the 2008 ozone maintenance plan. On-road mobile inventories in the SIP include a 2014 Attainment Year, a 2025 intermediate year, and a 2030 out year. The region developed two tiers of MVEBs, Tier 1, which was set at the mobile emissions inventory level, and Tier 2, which was set using a 20% "safety margin" above the mobile emissions inventories for each of the 2025 and 2030 analysis years. The MWAQC TAC asked TPB staff to provide data explaining the background of the selection of a 20% safety margin, introduced to account for future uncertainties in methods and input data used to estimate mobile emissions.

The region initially used a safety margin in the setting of MVEBs for a Fine Particles ($PM_{2.5}$) maintenance plan developed in 2012 for the 1997 National Ambient Air Quality Standards (NAAQS). The TPB ran sensitivity tests at that time to determine the impacts of various changes to travel model and emissions model inputs and used those to recommend a safety margin for the setting of MVEBs. The results of the sensitivity tests[2] and the safety margin recommendations were shared in a June 1, 2012 letter from TPB to MWAQC[3] (presented at the June 28, 2012 MWAQC meeting). The most significant changes to the inputs were related to the update of the vehicle fleet data. The TPB analyzed 2017 and 2025 years, which were the interim and out years for the PM2.5 maintenance plan, and found that by simply changing the vehicle fleet, there was a 25% increase in estimated NOx in 2017 and an 8% increase in estimated NOx in 2025. The emissions table from that sensitivity test is shown below.

Table 2: Historic (2012) Sensitivity Tests: Impact of Vehicle Fleet Change on Estimated NOx and PM2.5

	2017		2025	
	NOx (t/yr)	PM2.5 (t/yr)	NOx (t/yr)	PM2.5 (t/yr)
2011VIN Basis	41,709 (1)	1,787 (4)	27,400 (7)	1,322 (10)
2005VIN Basis	33,468 (2)	1,465 (5)	25,406 (8)	1,187 (11)
Difference	8,241 (3)	322 (6)	1,994 (9)	136 (12)
Ratio	1.25	1.22	1.08 ⊛	1.11 ⊛

Slide 7. VIN = vehicle registration/Vehicle ID Number (VIN) data.

As noted in the letter from TPB to MWAQC, TPB recommended safety margins "based in part on the VIN data assessment reported above, and in part on previous experience with changes in EPA's mandated

[2] Constantine, Elena. "The Potential Impact of Changes in the Regional Vehicle Fleet on Future NOx and PM2.5 Emissions: A Sensitivity Test." Presented at the Technical Committee of the National Capital Region Transportation Planning Board, held at the Metropolitan Washington Council of Governments, Washington, D.C., June 1, 2012.

[3] Kirby, Ronald F., Director, Department of Transportation Planning. Letter to Phil Mendelson, Chair, Metropolitan Washington Air Quality Committee (MWAQC). "Provision of Additional Information from TPB Staff to MWAQC in Support of the TPB's March 21, 2012 Recommendation to Incorporate Safety Margins of 20 Percent and 30 Percent, Respectively, into out-Year Mobile Emissions Budgets for 2017 and 2025 in a PM2.5 Maintenance Plan under Development by MWAQC." Letter, June 1, 2012.

emissions estimating procedures, which have typically resulted in significantly higher emissions estimates from the same set of local inputs" (p. 2).

TPB staff update the vehicle registration/Vehicle ID Number (VIN)/fleet data approximately every three or four years. With most updates, staff has run sensitivity tests to determine the impacts of the fleet change on emissions. The impacts have varied, based on the pollutant and the year being analyzed. Tables 3a and 3b below show increases in estimated emissions related to the change from the 2008 to the 2011 vehicle fleet. Table 4 shows increases in estimated emissions related to the most recent change from the 2016 vehicle fleet to the 2020 vehicle fleet. Both tables show that the impacts of VIN data on estimated emissions can be significant. The analysis shows that introducing subsequent/multiple VIN datasets can have even more significant cumulative impacts on estimated emissions and the region's ability to adhere to the MVEBs. It is also important to keep in mind that the tables below indicate that changes in only one of the inputs (VIN data) have the capability to result in increases in estimated emissions greater than 20%, which is the current safety margin. In addition, uncertainties related to some of the other unknowns (travel demand model, non-travel-related inputs such as inspection and maintenance programs) can result in additional increases in emissions (Table 4). Finally, some of the variables that were not explicitly tested in isolation, such as the demographic data, can also result in changes in estimated emissions and could negatively impact our region's ability to adhere to the air quality planning requierments.

Tables 3a and 3b: Historic Sensitivity Tests: 2008 to 2011 Vehicle Fleet

2012 Constrained Long Range Plan

Year 2020

MOVES 2010a	Pollutants	Emissions Comparisons			
		2011 VIN Basis	2008 VIN Basis	Differences	Ratios
	VOC 8-hr (t/d)	47.25	42.43	4.82	1.114
	NOX 8-hr (t/d)	90.75	79.81	10.94	1.137
	Precursor NOX (t/y)*	32,777.29	29,007.95	3,769.34	1.130
	Direct PM2.5 (t/y)*	1,475.27	1,327.40	147.87	1.111

Year 2040

MOVES 2010a	Pollutants	Emissions Comparisons			
		2011 VIN Basis	2008 VIN Basis	Differences	Ratios
	VOC 8-hr (t/d)	46.76	43.26	3.50	1.081
	NOX 8-hr (t/d)	72.24	67.93	4.31	1.063
	Precursor NOX (t/y)*	26,546.14	25,094.21	1,451.93	1.058
	Direct PM2.5 (t/y)*	1,339.81	1,276.37	63.44	1.050

Table 4: Historic Sensitivity Tests: 2016 to 2020 Vehicle Fleet- 2021 Analysis Year

		V2.3 vs V2.4 Travel Model		2016 vs 2020 VIN		Non-Travel-Related Data	
Pollutant	**Base**	**Δ**	**%Δ**	**Δ**	**%Δ**	**Δ**	**%Δ**
Ozone VOC (t/d)	38.375	-0.309	-0.8%	2.923	7.6%	1.298	3.4%
Ozone NOx (t/d)	61.214	0.236	0.4%	6.649	10.9%	-0.141	-0.2%
GHG (t/y)	22,367,921	-533,370	-2.4%	305,422	1.4%	1,378	0.0%

UNCERTAINTIES IN FUTURE CONFORMITY ANALYSES

Because the MVEBs are developed using one set of input assumptions and then the transportation conformity analyses have updated input assumptions, it is necessary to provide a safety margin when setting MVEBs to account for changes in future conformity analyses that are not known or quantified at the time when the MVEBs are set. These include changes to the vehicle fleet, changes to the land activity assumptions (Cooperative Forecasts), changes to emission model inputs such as Inspection/Maintenance programs, and changes to the travel demand model, among others. Many of these changes have nothing to do with projects in the regional long-range transportation plan and are out of the TPB's control.

The TPB completes transportation conformity analyses every year or two but there are many years between MVEB updates. Recently, when EPA promulgated the 2015 ozone NAAQS, the agency did not revoke the 2008 ozone NAAQS, so the region will have to show adherence to budgets set in the 2008 ozone NAAQS for an unknown time into the future. If not for the change in EPA's emissions model, the region would not be likely to update the MVEBs in the 2008 ozone maintenance plan. Updating SIPs, or even just the mobile inventories and MVEBs, is a time consuming process so the use of safety margins in the setting of MVEBs to account for many years of future uncertainties is crucial.

MVEB SAFETY MARGINS

The following graphs give a sense of scale for the 20% safety margin in the updated MVEBs. The 2025 and 2030 emissions inventories are from the preliminary MOVES3 sensitivity tests and will change slightly when TPB staff completes the MOVES3 runs for the updated 2008 ozone maintenance plan using inputs provided by the state air agencies. It should be noted that the 2014 inventory shown is from the 2008 ozone maintenance plan and was developed using MOVES2014b because in 2014, MOVES2014b and MOVES3 would produce similar results.

Figure 1: 20% MVEB Safety Margin for Updated 2008 Ozone Maintenance Plan

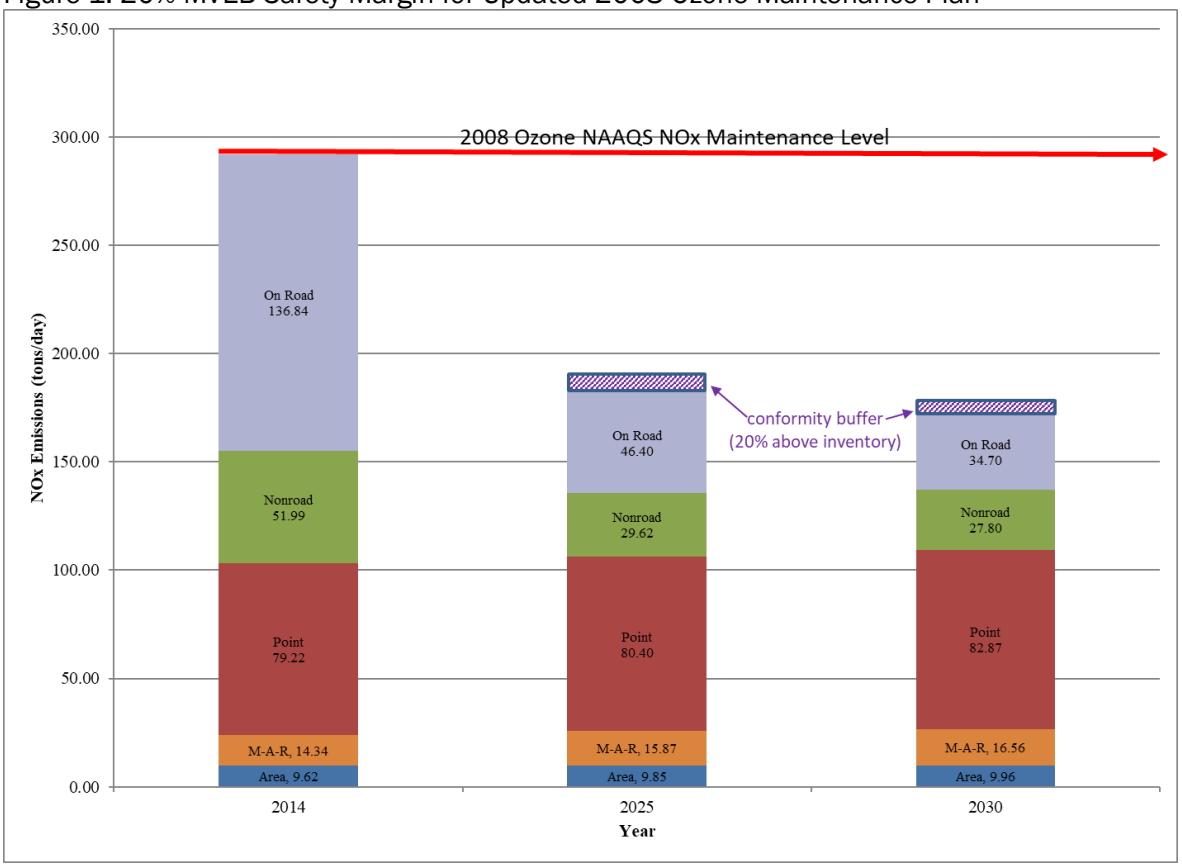
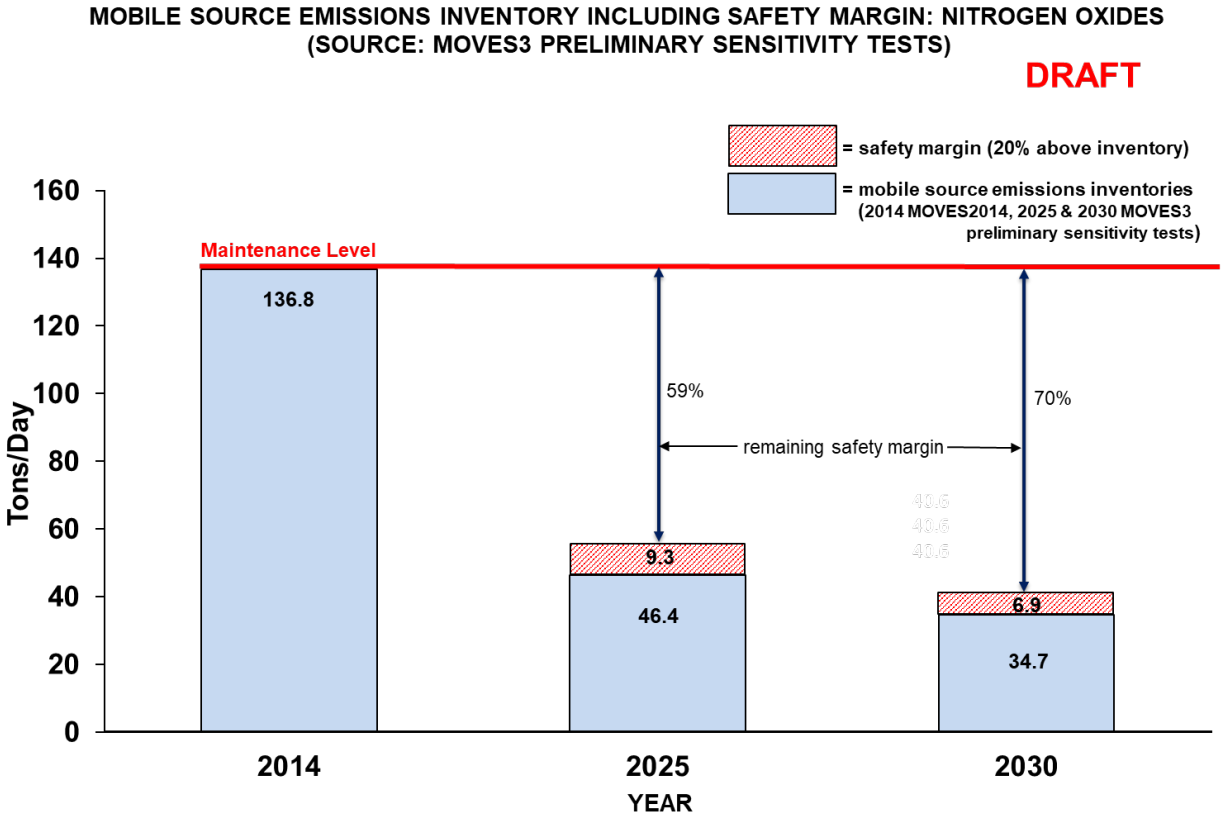


Figure 2: 20% MVEB Safety Margin for Updated 2008 Ozone Maintenance Plan



CONCLUSION

The region first used a safety margin when developing MVEBs for a Fine Particles Maintenance Plan in 2012. TPB ran a number of sensitivity tests to determine the impact of changes to various inputs to the travel and emissions models, and based on these, the region agreed on the use of 20% safety margins to account for uncertainties in future modeling. The 20% safety margins were again used for the development of the current MVEBs in the 2008 ozone maintenance plan which was approved by MWAQC in 2017. Observed/monitored mobile emissions have decreased significantly through time and are expected to continue to decrease into the future with an increased percentage of hybrid and electric vehicles in the fleet and with new federal fuel and engine standards, especially those just released for heavy duty vehicles. Monitored ozone and fine particles levels have decreased dramatically through time, such that the region attained the PM2.5 standard over a decade ago and just recently attained the current 2015 ozone standard.[4]

Using a safety margin when setting MVEBs is necessary because of the inherent uncertainties regarding methods and input data used to estimate mobile emissions, and historically a 20% margin has been shown to be appropriate for the Washington region. Setting MVEBs without a safety margin to account for these changes over time, especially given that these uncertainties have nothing to do with projects in the regional transportation plan, could result in a conformity lapse. A conformity lapse would significantly impact the region's access to federal transportation funding and no new transit or highway projects would be able to move forward. Even with the 20% safety margins set in the MVEBs developed since 2012, the region's monitored/observed data has shown a significant decrease in ozone and fine particles pollutants over time, with the greatest reduction coming from the on-road mobile sector.

Therefore, it is recommended that the region update the MVEBs in the 2008 ozone maintenance plan with a 20% safety margin to account for many years of future uncertainties in the transportation conformity process. It should also be noted that when the safety margin is completely exceeded by a modeling change, such as what recently occurred with the introduction of the MOVES3 model, the MVEBs should be updated, as is currently happening.

[4] "Clean Data Determination; District of Columbia, Maryland, and Virginia; Washington, DC-MD-VA Nonattainment Area for the 2015 Ozone National Ambient Air Quality Standard Clean Data Determination," 88 Fed. Reg., pp. 6688-6691 (U.S. Environmental Protection Agency, February 1, 2023), https://www.govinfo.gov/content/pkg/FR-2023-02-01/pdf/2023-01973.pdf.