ABM2+ Software Version 14.2.2

1. Executive Summary

This memo describes the features, improvements, bug fixes, and test results for ABM2+ version 14.2.2. It is a part of the documentation for *Peer Review Program (PRP) 130: Potential Use of ABM2+ Version 14.2.2 in Final 2021RP Modeling*.

In software release cycles, the stable release, also known as the production release, is the last release candidate that passed all verifications/tests. SANDAG has released 16 ABM versions since November 2013, including 2 ABM2+ versions, 14.2.0 and 14.2.1. Version 14.2.1 is the latest production release used for the draft 2021RP modeling.

Among the version 14.2.2 improvements, the warm start trip table bug fix [ABM-1382], the speed calculation bug fix [ABM-1380], and the skimming procedure added after the final assignment [ABM-1379] affected model results. Staff conducted a soft base year calibration and validation to align model estimated results with observed data. Draft version 14.2.2 was then tested on 2023, 2026, 2035 build, and 2050 build scenarios. There were two types of 2035 build scenarios; one with the same road user fee (RUC) as in the draft RP; the other with an additional 1 cent RUC fee (in 2010$).

Although most base year calibration and validation metrics are comparable between versions 14.2.1 and 14.2.2, some metrics, such as VMT and highway AM and PM peak period volume, validation results improved for 14.2.2. The version 14.2.2 VMT and GHG for the 2035 build scenario with no added RUC are 1.3% smaller and 0.4% larger than those in version 14.2.1, respectively. For the 2035 build scenario with an additional 1 cent RUC, version 14.2.2 VMT and GHG are 1.7% and 0.1% smaller when compared to the draft RP, respectively. The majority of RP performance metrics (PMs) for the 2035 and 2050 build scenarios are similar between the draft RP and version 14.2.2. Heavy-duty truck delay by facility type increased. For air qualify conformity (AQC) years 2023 and 2026, version 14.2.2 ROG and NOx are still below the SIP emission budgets.

Staff discussed version 14.2.2 bug fixes and test results with RSG, the ABM consultant. A series of documentations were prepared for PRP 130, including this memo, a software release report, a PowerPoint presentation, a validation story map, and an updated ABM wiki.

Based on comprehensive tests and analysis, staff recommends the PRP panel approves the use ofABM2+ version 14.2.2 for final 2021 RP modeling.

2. ABM Software Releases

Software release cycles range from initial software development to software release. Software updates, in the form of updated versions, are also included to improve software or fix existing software bugs. Also called the production release, the stable release is the last release candidate that passed all verifications/tests. Any remaining bugs are considered acceptable. This release is then deployed into production for use.

SANDAG released its first ABM production release in November 2013. Since then, SANDAG has released 16 ABM versions, including 2 ABM2+ versions, 14.2.0 (September 2020) and 14.2.1

(November 2020) for the 2021RP. Version 14.2.1 is the latest production release used for draft 2021RP model runs. Version 14.2.1 improved upon version 14.2.0 by including a bug fix for micromobility and microtransit costs, a bug fix for intermediate stop location choice, a bug fix to correct double counting on initial transit wait time, and better memory management. Accompanying each release is a release report summarizing new features, procedural improvements, and bug fixes. When changes in a release necessitate a base year calibration and validation, the calibration and validation results are published on the ABM wiki site.

The 14.4.2 production release includes the following improvements and bug fixes:

1. A new optional stochastic assignment feature [by INRO]
2. A new integrated model run time summary procedure [AMB-1361]
3. An updated INRIX-based speed validation procedure [AMB-1356]
4. Streamlined E-Bike ownership configurations [AMB-1329]
5. An added skimming procedure after final assignment [AMB-1379]
6. A bug fix for importing warm start trip tables [AMB-1382]
7. A bug fix for remote method calls that caused occasional model failures [by RSG]
8. A bug fix to correct speed computation [AMB-1380]

3. Bugs & Fixes

Since items 5, 6, and 8 affected model outputs, this document describes them and their subsequent impact on model outputs and the 2021 RP performance metrics (PMs).

3.1 Item 5-A skimming procedure after final assignment [AMB-1379]

Currently, auto skims, such as travel time, are generated by the 3rd iteration of ABM, and traffic volumes are generated by the final assignment. Through iterations 1 to 3, assignment uses a method of successive averages (MSA) algorithm to achieve fast convergence; however, this algorithm is not applied for the final assignment. When the warm start trip table differs significantly from the trip tables generated for final assignments, travel times could oscillate between the 3rd iteration and the final assignments. Such an oscillation is due to the weighting of MSA trip tables across all 3 iterations and the warm start trip table. Therefore, a skimming procedure was added after final assignments to keep the travel time and the assigned volume consistent. Although this fix does not affect base year calibration and validation, it affects performance metrics (PMs) derived from travel time. The level of impact varies depending on the difference between the warm start trip table and the final assignment trip table; impact is minor with a small difference and is non-negligible with a significant difference.

3.2 Item 6-A bug fix for importing warm start trip tables [AMB-1382]

Warm start trip tables represent initial travel demand during congested traffic conditions. The primary reason for using warm start trip tables is to reduce the number of iterations needed to reach convergence and subsequently reduce model run time. When free-flow rather than congested traffic conditions are used, more than 3 global iterations (the current default) are needed to reach convergence.

A bug was identified in the Python code used for importing warm start trip tables. The code, which was originally designed for ABM2, did not work properly for ABM2+. When ABM2+ warm start trip tables are used, the code imports empty trip tables and fails to terminate the model run. As a result, the model defaults to using free-flow speeds and travel times. This bug occurred during the transition from ABM2 to ABM2+. Staff fixed the bug after confirming the issue with consultants (code authors) and then performed a soft base year calibration and validation to align VMT, mode shares, trip length, trip rates, and traffic counts with the observed. The soft calibration was done via adjusting the CVM scaling factors described below.

The core ABM and the CVM are separate models developed by different consultants in 2013 and 2014, respectively. Each model was validated against its respective survey, but a joint validation was not performed. It was then found that the combined VMT from ABM and CVM was smaller than the observed 2012 VMT, the model base year at the time. The consultant hired to investigate this issue recommended two approaches to match the observed VMT: 1) increase CVM trip rates 2) update ABM from the 2006 survey to the 2016 survey. In ABM2, the core model was updated to the 2016 survey and CVM trip rates were increased by applying scaling factors of 1,2,3,2,1 for the 5 time of day periods. For ABM2+, the initial estimated VMT was about 1-2% greater than the VMT in ABM2. A series of investigations were performed on inputs and model configurations by both consultants and staff, but a clear reason for the VMT overestimation was not found. The development team decided to scale the CVM scaling factors down to 1,1,2.8,1,1, as CVM is the least understood due to the fast-changing last-mile delivery trips since the 2012 CVM survey. In hindsight, this issue was related to the warm start trip table bug mentioned above. Therefore, scaling factors were adjusted back to 1,2,3.5,2,1 for 14.2.2, similar to those in ABM2 with an uptick in the mid-day period. With the warm start trip table code fix and the updated CVM scaling factors, 14.2.2 scenarios have slightly lower total regional VMT than 14.2.1 given the same inputs and policy assumptions. The lower regional VMT results in lower VMT for all EMFAC vehicle classes except light-heavy-duty trucks, which has a minor impact on ROG and NOx emissions.

3.3 Item 8-A bug fix to correct speed computation [AMB-1380]

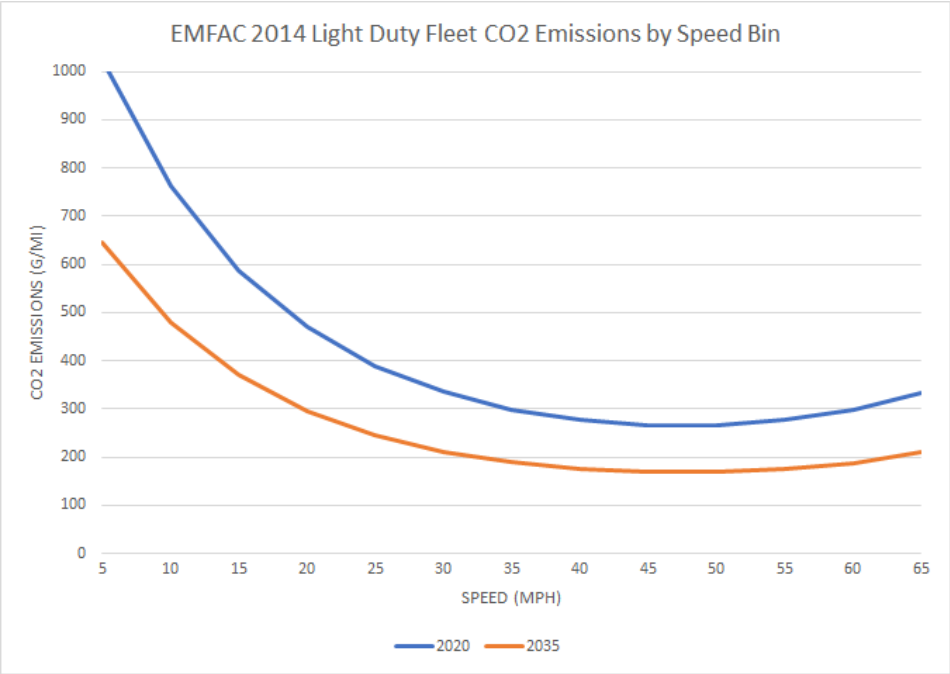
Travel time reliability, derived from INRIX data, represents travel time variance due to varying traffic congestion. Although overall travel time reliability accounts for approximately 5% of travel time, it could be over 10% for some freeway links. In ABM2+ data exporting, modeled link speed was derived from link length and AB_MSA_Time, an attribute that includes link travel time and reliability: AB_MSA_Time = AB_Time * (1+@reliability). However, the reliability term was incorrectly included in deriving link speed. The removal of travel time reliability in speed computation resulted in higher modeled link speed.

EMFAC 2014 SB375 GHG is affected by both total VMT and the distribution of VMT by speed bin for the light-duty vehicle class. CO2 emission factors vary by vehicle speed. The vehicle speeds with lower emission factors in 2035 are between 35 and 60 mph, as shown in Figure 1 below. Removing reliability from the denominator results in a higher speed bin (65mph) increase with higher SB375 GHG emissions despite a lower total VMT, as shown in the 2035 draft scenario SB375 GHG emission comparisons between ABM 14.2.2 and 14.2.1 (Figure 4).

The combined impact of slightly lower total regional VMT, slightly higher light-heavy-duty truck VMT, and an increased distribution of VMT in a higher speed bin (65mph) led to a slightly lower summer total ROG and slightly higher total NOx for ABM 14.2.2. The distribution of VMT in a higher speed bin has a slightly bigger impact on NOx running exhaust. This is reflected in the 2023 and

2026 air quality conformity analysis between ABM 14.2.2 and 14.2.1, as shown in a following section.

Figure 1: EMFAC 2014 Light Duty Fleet CO2 Emission Factors by Speed Bin



In version 14.2.1, the model overestimated highway AM and PM volumes by 14% and 13%, respectively. As part of the speed and AM and PM peak volume adjustments [AMB-1384], the parameters are updated in the volume delay function (VDF) for freeway in the AM and PM periods, as shown in Table 1. This update improved the alignment between estimated and observed AM and PM volumes on freeways (section 4.2) and higher vehicle delay for freeway facilities. This is reflected in the higher heavy-duty truck vehicle hour delay metrics.

Table 1: VDF Parameter Setting

Version	α	β
14.2.1 (Draft 2021 RP)	0.24	5.5
Draft 14.2.2	0.6	4

4. Results

This section summarizes the scenario results from three model versions: 14.1.1 used in 2019 Fed RTP, 14.2.1 used in draft 2021RP, and the draft 14.2.2 staff propose for 2021RP final modeling. Staff completed 5 test scenarios using the draft 14.2.2: 2016, 2023, 2035 build, 2035 build with an additional 1 cent RUC, and 2050 build.

4.1 Base Year 2016 Soft Calibration Results

Travel Demand

As shown in Table 2, regional resident individual and joint trips are similar across all 3 model versions. However, variability exists for CVM trips, least for version 14.2.1 and the most for version 14.2.2, consistent with the CVM scaling factors settings.

Table 2: Base Year Total Trips

Version	Resident Individual Trips	Resident Joint Trips	CVM Trips
14.1.1 (2020 Fed RTP)	12,216,015	1,249,561	1,263,962
14.2.1 (Draft 2021 RP)	12,513,684	1,284,117	1,000,403
Draft 14.2.2	12,369,738	1,272,559	1,342,141

Mode Shares

As shown in Table 3, the mode shares are similar between versions 14.2.2 and 14.2.1. Mode shares for both versions match the observed data well.

Table 3: Base Year Mode Shares

Version	DA	SR2	SR3	TNC	Walk	Bike	MM	Transit	Other
2016/17 Survey	47.3%	23.5%	18.5%	0.3%	6.9%	0.8%	-	1.6%	1.1%
14.1.1 (2019 Fed RTP)	47.0%	23.6%	18.6%	-	7.2%	0.8%	-	1.6%	1.1%
14.2.1 (Draft 2021 RP)	47.4%	23.4%	18.5%	0.5%	6.7%	0.8%	0.1%	1.5%	1.1%
Draft 14.2.2	47.3%	23.5%	18.3%	0.5%	6.8%	0.9%	0.1%	1.6%	1.1%

Trip Length

Average person trip length and CVM trip length decreased slightly from 6.3 and 8.1 miles in 14.2.1 to 6.2 and 7.4 miles in 14.2.2, respectively. The average trip length for both 14.2.2 and 14.2.1 match the observed data well.

Table 4: Base Year Trip Length

Version	Resident Person Trip Length	CVM Trip Length
2012 CVM Survey	-	8.0
2016/17 HH Survey	6.3	-
2019 SB1 Survey	6.2	-
14.1.1 (2019 Fed RTP)	6.4	7.6
14.2.1 (Draft 2021 RP)	6.3	8.1
Draft 14.2.2	6.2	7.4

VMT

For version 14.2.2, the model estimated base year VMT is 0.1% under the observed, compared to the 0.9% overestimation in 14.2.1. The estimated VMT for both 14.2.1 and 14.2.2 is within 1% of the observed VMT target.

Figure 2: Base Year VMT

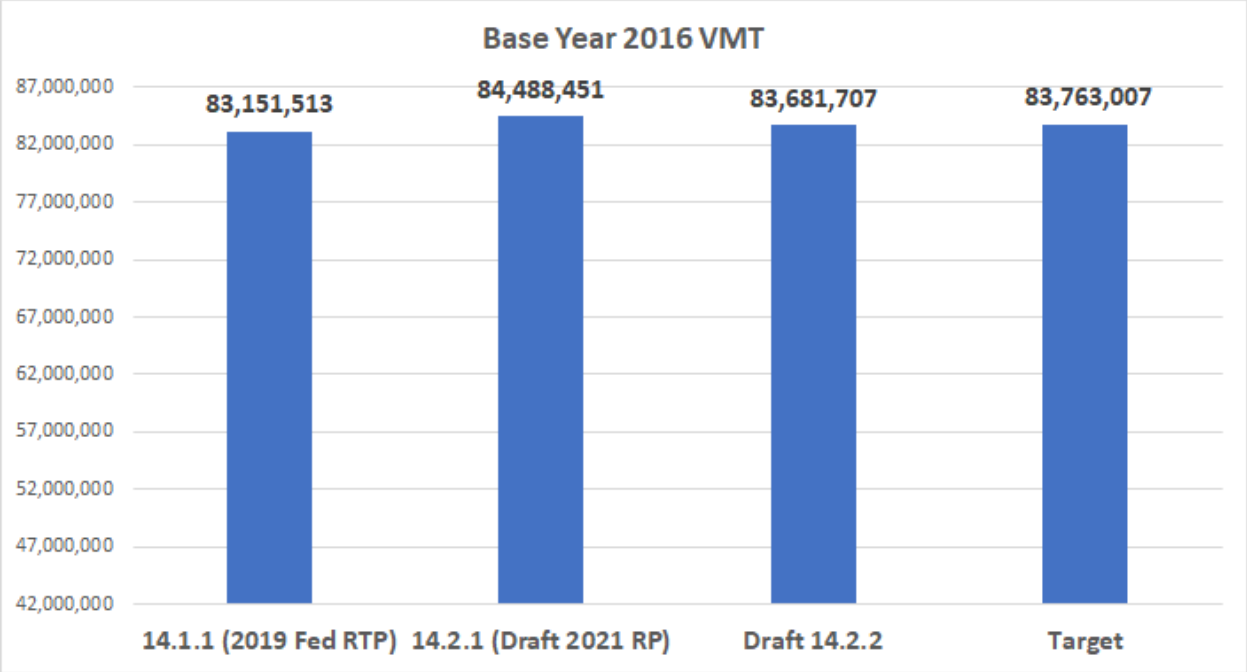
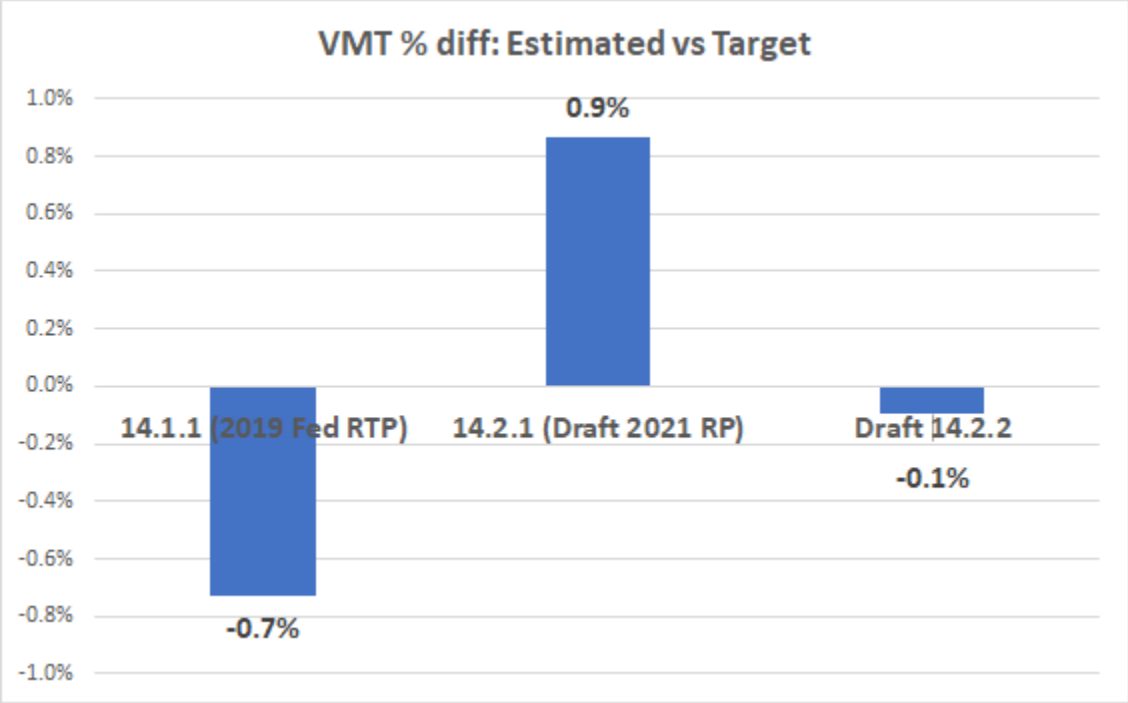


Figure 3: VMT: Model Estimated vs Observed



4.2 Base Year 2016 Validation Results

Regional Results

The following regional validation metrics are used to compare the model validation results for versions 14.2.2 and 14.2.1:

- R-squared: R-squared estimates the correlation between the observed traffic counts and the model estimated traffic flow. It is a statistical measure of how close the data is to the fitted regression line. The R-squared value is between 0 and 1; a value of 0 indicates that the model explains none of the variability of the response data around its mean, a value of 1 indicates that the model explains all the variability of the response data around its mean.
- Percent Root-Mean Squared Error (PRMSE): PRMSE measures the accuracy of the entire model, representing the average error between the observed and estimated traffic flow.
- Slope: A slope smaller than 1 indicates regionwide model underestimation, a slope greater than 1 indicates overestimation.

As shown in Table 5, validation results are comparable between version 14.2.1 and 14.2.2. These metrics satisfy the Federal Highway Administration (FHWA) guidelines for acceptable R-squared and PMRSE. The recommended thresholds are R-squared >= 0.88 and PRMSE < 40% (**Source: The Travel Model Validation and Reasonableness Checking Manual, II Second Edition, September 2010.)*.

Table 5: Base Year Validation Results

Version	R-Squared	PRMSE	Slope
14.2.1 (Draft 2021 RP)	0.96	21.57%	1.01
Draft 14.2.2	0.96	21.08%	0.97

Table 6 and Table 7 show the slope and PRMSE comparisons at the freeway corridor level. For AM and PM peak volume, version 14.2.2 outperformed version 14.2.1 by slope and PRMSE by daily, AM, and PM. In version 14.2.1, AM and PM volumes on freeways were overestimated by 14% and 13%, respectively. In version 14.2.2, the overestimations were reduced to 6% and 5%.

Table 6. Base Year Highway Validation Results - Slope

Slope	EA	AM	MD	PM	EV	Daily
14.2.1 (Draft 2021 RP)	1.13	**1.14**	1.00	**1.13**	0.67	1.01
Draft 14.2.2	1.12	**1.06**	1.00	**1.05**	0.65	0.98

Table 7. Base Year Highway Validation Results – PRMSE

PRMSE	EA	AM	MD	PM	EV	Daily

14.2.1 (Draft 2021 RP)	60.98%	**26.59%**	14.69%	**26.38%**	40.67%	12.70%
Draft 14.2.2	60.33%	**21.61%**	15.33%	**20.50%**	42.07%	12.28%

Sub-Regional and Corridor Results

Validation results at the sub-regional and corridor levels are comparable between versions 14.2.2 and 14.2.1. Detailed validation results can be found in the Story Map.

4.3 Draft 2035 Build Scenario Results

2021 RP Performance Metrics

Most 2021 RP PMs in 14.2.2 are within plus or minus 0% to 6% difference compared to version 14.2.1. However, heavy-duty truck delay by facility type (SM-9-b) increased by up to 60%, mainly due to VDF parameter updates for freeways. Due to time constraints, some PMs such as cost-benefit effectiveness were not calculated and are labeled as 'Not Available'. Population and job access to Tier 1, 2, and 3 transit stops and population access to bike facilities remain the same, as networks and population inputs are the same.

Table 8: Draft 2035 Build Scenario 2021RP Performance Metrics

Primary Measures	Description	Version 14.2.1 vs Draft 14.2.2
M-1-a	Access to Basic Needs	comparable
M-1-b	Access to Basic Needs	comparable
M-1-c	Access to Basic Needs	comparable
M-3	GHG Emissions	comparable
M-4	Vehicle Miles Traveled	comparable
M-5-a	Access to Opportunities via transit	comparable
M-5-b	Access to Opportunities via transit	comparable
M-5-c	Access to Opportunities via transit - All employment centers	comparable
M-5-d	Access to Opportunities via transit	comparable
M-6	Fiscal and Social Responsibility	Not Available
Social Equity Performance Measures		
SE-M-1-a	Access to Basic Needs	comparable
SE-M-1-b	Access to Basic Needs	comparable
SE-M-1-c	Access to Basic Needs	comparable
SE-M-5-a	Access to Opportunities via transit Tier 1 employment centers	comparable

SE-M-5-b	Access to Opportunities via transit Tier 2 employment centers	comparable
SE-M-5-c	Access to Opportunities via transit - All employment centers	comparable
SE-M-5-d	Access to Opportunities via transit Higher education access	comparable
SE-M-6	Fiscal and Social Responsibility	Not Available
SE-SM-2	Number/percent of people within 0.5 miles of a commuter rail, light rail, or next gen Rapid (Tier 1/Tier 2/Tier 3) transit stop	No change
SE-SM-4	Number/percent of people within 0.25 miles of a bike facility (class I and II, cycletrack or bike boulevard)	No change
SE-SM-8	Average Particulate Matter (PM 2.5)	Not Available
SE-SM-10	Percent of Income Consumed by Out-of-Pocket Transportation Costs	comparable
Supporting Measures		
SM-1	Mode share	comparable
SM-2	Number/percent of people within 0.5 miles of a commuter rail, light rail, or next gen Rapid (Tier 1/Tier 2/Tier 3) transit stop	No change
SM-3	Number/percent of jobs within 0.5 miles of a commuter rail, light rail, or next gen Rapid (Tier 1/Tier 2/Tier 3) transit stop	No change
SM-4	Number/percent of people within 0.25 miles of a bike facility (class I and II, cycletrack or bike boulevard)	No change
SM-5	Daily transit boardings	comparable
SM-6	Physical activity	comparable
SM-7	Average truck/commercial vehicle travel times to and around regional gateways and distribution hubs (minutes)	comparable
SM-8	Average Particulate Matter (PM2.5)	Not Available
SM-9-a	Truck travel time index	comparable
SM-9-b	Heavy Duty Truck delay by facility type (average daily)	Longer delay in 14.2.2 in general
SM-10	Transportation system use costs	comparable

Mode Share, Trip Length, & Travel Time

As shown in Table 9, mode share and trip length results for the 2035 build scenarios are similar between versions 14.2.1 and 14.2.2. Average travel time by purpose and mode increased in version 14.2.2. This increase is likely related to the added skimming after the final assignment resulting in greater travel demand than the MSA-averaged travel demand in version 14.2.1.

Table 9: 2035 Build Scenarios Mode Shares, Average Trip Length, & Average Travel Time

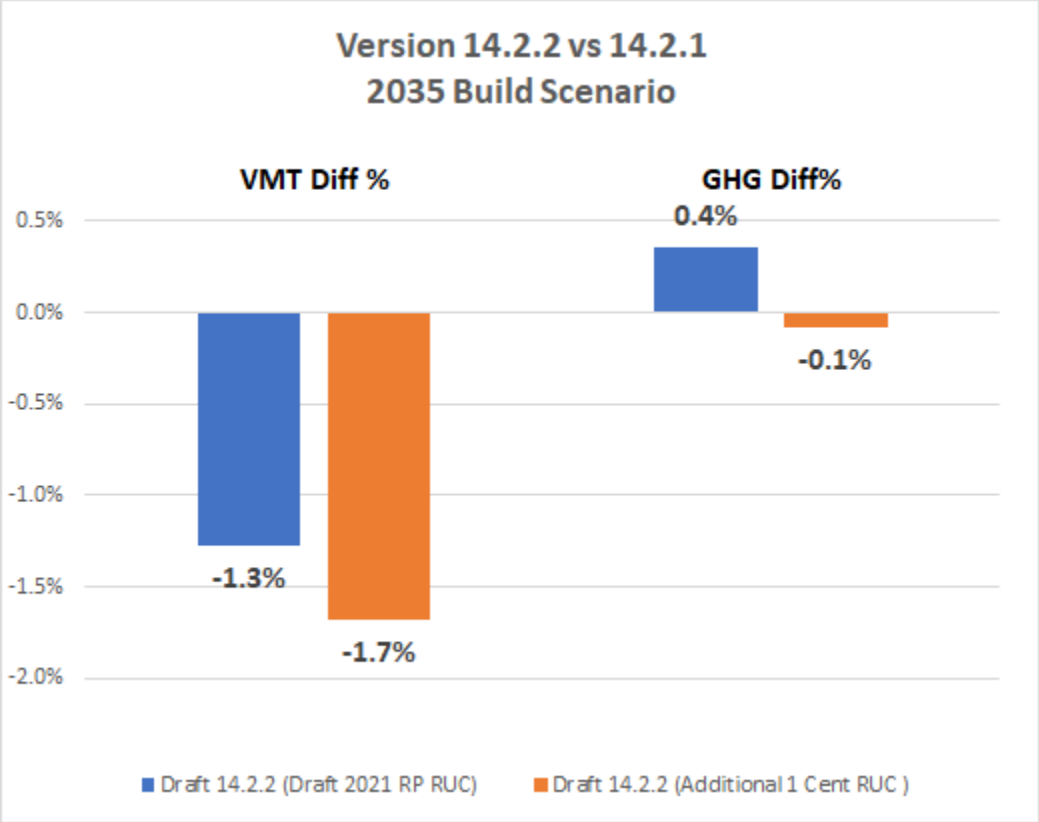
Performance Metrics	14.2.1 (Draft 2021 RP)	Draft 14.2.2	Draft 14.2.2 (Additional 1 Cent RUC)
Average Trip Length by Mode (miles)			
Drive Alone	7.4	7.3	7.2
Shared ride (2 persons)	5.7	5.6	5.5
Shared ride (3+ persons)	5.8	5.9	5.8
Drive-to-transit (PNR, KNR, TNC to transit)	15.3	15.7	15.7
Walk-to-transit (Walk, micromobility, microtransit to transit)	8.2	8.2	8.2
Bike	3.5	3.6	3.6
Walk	0.7	0.8	0.8
All Modes	6.0	5.9	5.9
Average Travel Time by Trip Purpose (minutes)			
Commute Trip	25.3	26.8	26.8
Non-Commute Trip	13.5	14.3	14.3
Average Travel Time by Mode (minutes)			
Drive Alone	13.3	14.7	14.7
Shared ride (2 persons)	11.0	12.0	12.0
Shared ride (3+ persons)	10.9	12.0	12.0
Drive-to-transit (PNR, KNR, TNC to transit)	52.7	49.3	49.3
Walk-to-transit (Walk, micromobility, microtransit to transit)	50.2	45.2	45.2
Bike	17.8	18.1	18.3
Walk	14.9	15.0	14.9
All Modes	14.2	15.1	15.1
Average Travel Time for Low-Income Populations by Mode (minutes)			
Drive Alone	12.9	14.1	13.0
Shared ride (2 persons)	10.7	11.7	10.7
Shared ride (3+ persons)	10.5	11.5	10.6
Drive-to-transit (PNR, KNR, TNC to transit)	52.9	49.1	49.8
Walk-to-transit (Walk, micromobility, microtransit to transit)	50.5	45.6	48.8
Bike	20.0	20.1	19.6
Walk	15.5	15.5	15.5
All Modes	15.5	16.0	15.8
Mode Share (%)			
Drive Alone	41.0%	40.8%	39.0%
Shared ride (2 persons)	24.0%	23.8%	24.0%

Shared ride (3+ persons)	16.6%	16.7%	16.5%
Drive-to-transit (PNR, KNR, TNC to transit)	0.7%	0.7%	0.8%
Walk-to-transit (Walk, micromobility, microtransit to transit)	3.9%	3.9%	4.2%
Bike	1.4%	1.4%	1.7%
Walk	10.3%	10.4%	11.6%

VMT and SB375 GHG

Compared with version 14.2.1 VMT from the draft RP 2035 scenario, version 14.2.2 VMT for the 2035 scenario and the 2035 scenario with 1 cent additional RUC are 1.3% and 1.7% smaller, respectively, and SB375 GHG are 0.4 % larger and 0.1% smaller, respectively.

Figure 4: 2035 Build Scenario VMT and SB375 GHG



4.4 Draft 2050 Build Scenario Results

2021 RP Performance Metrics

The PM patterns of the 2050 build scenario are similar to those of the 2035 build scenario (Table 6).

Mode Share, Trip Length, & Travel Time

As shown in Table 10, mode share and trip length results for the 2050 build scenario are similar between versions 14.2.1 and 14.2.2. Average travel time by purpose and by mode increased in version 14.2.2.

Table 10: 2050 Build Scenario Mode Shares, Average Trip Length, & Average Travel Time

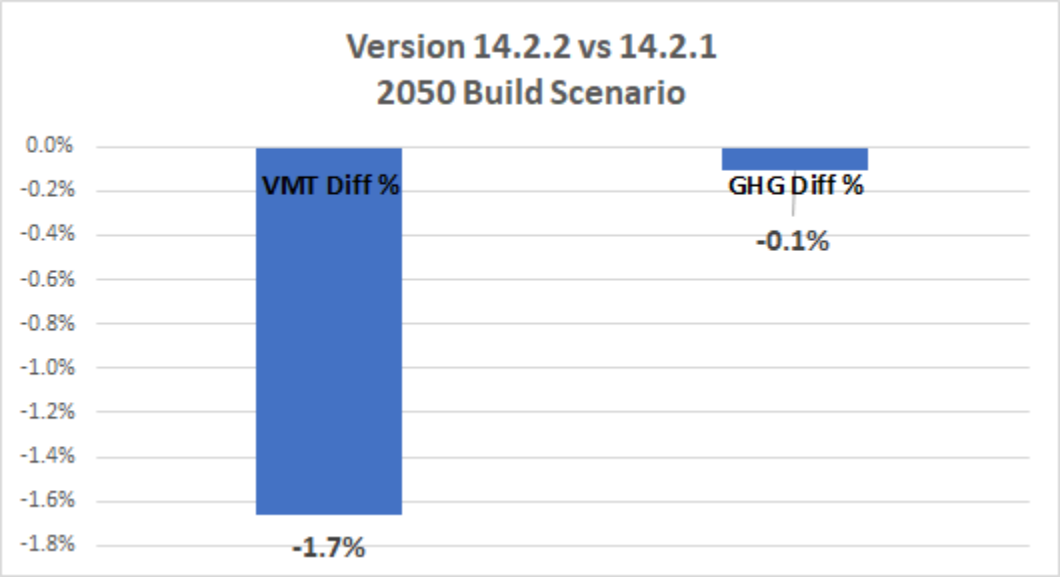
Performance Metrics	14.2.1 (Draft 2021 RP)	Draft 14.2.2
Average Trip Length by Mode (miles)		
Drive Alone	7.5	7.3
Shared ride (2 persons)	5.8	5.6
Shared ride (3+ persons)	5.9	6.0
Drive-to-transit (PNR, KNR, TNC to transit)	15.1	15.3
Walk-to-transit (Walk, micromobility, microtransit to transit)	8.2	8.2
Bike	3.8	3.9
Walk	0.8	0.8
All Modes	5.9	5.9
Average Travel Time by Trip Purpose (minutes)		
Commute Trip	25.9	27.2
Non-Commute Trip	13.6	14.4
Average Travel Time by Mode (minutes)		
Drive Alone	13.3	14.8
Shared ride (2 persons)	11.1	12.1
Shared ride (3+ persons)	11.0	12.2
Drive-to-transit (PNR, KNR, TNC to transit)	49.9	45.9
Walk-to-transit (Walk, micromobility, microtransit to transit)	48.5	43.5
Bike	17.3	17.8
Walk	15.0	15.1
All Modes	14.4	15.2
Average Travel Time for Low-Income Populations by Mode (minutes)		
Drive Alone	13.0	14.3
Shared ride (2 persons)	10.7	11.8
Shared ride (3+ persons)	10.6	11.7
Drive-to-transit (PNR, KNR, TNC to transit)	49.8	46.0
Walk-to-transit (Walk, micromobility, microtransit to transit)	48.8	43.8
Bike	19.6	19.7
Walk	15.5	15.6
All Modes	15.8	16.2
Mode Share (%)		
Drive Alone	39.0%	38.7%
Shared ride (2 persons)	24.0%	23.8%
Shared ride (3+ persons)	16.5%	16.7%

Drive-to-transit (PNR, KNR, TNC to transit)	0.8%	0.8%
Walk-to-transit (Walk, micromobility, microtransit to transit)	4.2%	4.3%
Bike	1.7%	1.8%
Walk	11.6%	11.7%

VMT and SB375 GHG

The VMT for the 2050 build scenario using version 14.2.2 is 1.7% smaller than that using version 14.2.1. The SB375 GHG change is insignificant.

Figure 5: 2050 Build Scenario VMT and SB375 GHG



4.5 2023 and 2026 Air Quality Conformity Results

As shown in Table 11 and Table 12, for air qualify conformity (AQC) year 2023 and 2026, EMFAC 2017 Summer pollutant metrics are similar between versions 14.2.1 and 14.2.2. ROG and NOx for version 14.2.2 are still below the SIP emission budget. The VMT, mode share, and trip length comparisons between versions 14.2.1 and 14.2.2 for 2023 and 2026 are shown in Figure 6 and Table 13.

Table 11: 2023 Air Quality Conformity Metrics

Version	ROG	NOx
14.2.1 (Draft 2021 RP)	13.5	17.2
Draft 14.2.2	13.4	17.3
SIP Emissions Budget	13.6	19.3

SAFE Rule adjustments applied

Table 12: 2026 Air Quality Conformity Metrics

Version	ROG	NOx
14.2.1 (Draft 2021 RP)	11.4	14.7
14.2.1 (Draft 2021 RP no RUC)	11.6	14.8
Draft 14.2.2 (no RUC)	11.5	14.9
SIP Emissions Budget	12.1	17.3

SAFE Rule adjustments applied

Figure 6: 2023 and 2026 VMT

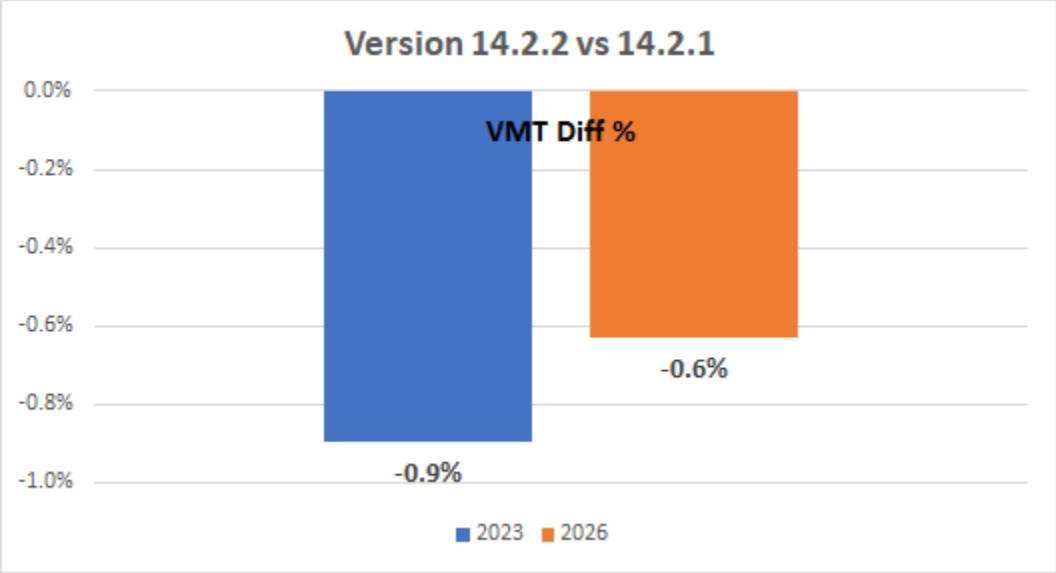


Table 13: 2023 and 2026 Mode Shares and Average Trip Length

Performance Metrics	2023		2026	
	14.2.1 (Draft 2021 RP)	Draft 14.2.2	14.2.1 (Draft 2021 RP)	Draft 14.2.2 (no RUC)
Average Trip Length by Mode (miles)				
Drive Alone	7.5	7.4	7.5	7.4
Shared ride (2 persons)	5.6	5.6	5.7	5.6
Shared ride (3+ persons)	5.5	5.5	5.7	5.7
Drive-to-transit (PNR, KNR, TNC to transit)	14.5	14.8	14.7	14.8
Walk-to-transit (Walk, micromobility, microtransit to transit)	8.1	8.0	8.3	8.3
Bike	2.9	3.1	3.3	3.4
Walk	0.8	0.8	0.8	0.8

All Modes	6.1	6.0	6.1	6.0
Average Travel Time by Trip Purpose (minutes)				
Commute Trip	23.0	25.6	23.6	26.0
Non-Commute Trip	13.0	14.2	12.9	13.9
Average Travel Time by Mode (minutes)				
Drive Alone	14.1	15.7	13.6	15.0
Shared ride (2 persons)	11.4	12.5	11.1	12.1
Shared ride (3+ persons)	11.2	12.2	10.9	12.0
Drive-to-transit (PNR, KNR, TNC to transit)	51.6	53.4	50.7	52.4
Walk-to-transit (Walk, micromobility, microtransit to transit)	51.6	51.4	50.0	50.0
Bike	16.8	17.8	18.3	19.1
Walk	15.4	15.5	15.0	15.4
All Modes	13.7	14.9	13.5	14.7
Average Travel Time for Low-Income Populations by Mode (minutes)				
Drive Alone	13.5	14.9	13.1	14.4
Shared ride (2 persons)	11.0	12.1	10.8	11.8
Shared ride (3+ persons)	10.7	11.7	10.5	11.5
Drive-to-transit (PNR, KNR, TNC to transit)	50.1	51.7	50.2	51.4
Walk-to-transit (Walk, micromobility, microtransit to transit)	51.7	51.3	50.4	50.4
Bike	19.3	19.9	21.4	21.8
Walk	16.0	16.1	16.0	16.1
All Modes	13.6	14.7	13.9	14.9
Mode Share (%)				
Drive Alone	44.8%	44.6%	42.4%	42.2%
Shared ride (2 persons)	24.4%	24.3%	24.7%	24.7%
Shared ride (3+ persons)	18.5%	18.5%	18.6%	18.6%
Drive-to-transit (PNR, KNR, TNC to transit)	0.3%	0.3%	0.4%	0.4%
Walk-to-transit (Walk, micromobility, microtransit to transit)	1.4%	1.5%	2.1%	2.1%
Bike	1.0%	1.0%	1.2%	1.2%
Walk	7.8%	8.0%	8.6%	8.9%

5. Conclusions

ABM release 14.2.2 includes new model features, procedural improvements, and bug fixes. Fixes to some bugs, such as the warm start trip table and the speed calculation bugs, affected model outputs. To align model results with observed data, staff performed a soft base year calibration and

validation by adjusting CVM scaling factors and VDF parameters. After the bug fixes and adjustments, most calibration and validation results are comparable to those of release 14.2.1. Some validation results, such as VMT and AM and PM peak period volume results, improved. The majority of 2021RP performance metrics (PMs) for the 2035 and 2050 build scenarios are similar between the draft 2021RP and release 14.2.2. Additionally, compared to the results of the 2035 and 2050 build scenarios in the draft 2021RP, the release 14.2.2 tests reveal comparable mode shares and trip lengths but slightly lower VMT and higher heavy-duty truck delay. Lastly, the 2023 and 2026 air quality conformity metrics, such as ROG and NOx, for version 14.2.2 are still below the 2023 and 2026 budgets. Staff recommends releasing version 14.2.2 for its application in the final 2021RP scenario runs.