

**FHWA-VDOT PROGRAMMATIC AGREEMENT FOR
PROJECT-LEVEL AIR QUALITY ANALYSES FOR CARBON
MONOXIDE**

TECHNICAL SUPPORT DOCUMENT

Based on the NCHRP 25-25 Task 104 Template

September 2020

Table of Contents

1.	Executive Summary	1
2.	Background.....	3
2.1	Air Quality Standards for CO.....	3
2.2	Highway Projects & CO Requirements	3
2.3	Decline in CO Concentrations	5
3.	Regulatory Context and Prior Programmatic Agreements.....	8
3.1	Regulatory Requirements and Guidance	8
3.1.1	Prior Work on Template Programmatic Agreements for CO	9
3.1.2	FHWA-VDOT Programmatic Agreements for CO	10
4.	Modeling.....	15
4.1	Emission Modeling.....	15
4.1.1	Relative Humidity	16
4.1.2	Temperature	17
4.1.3	Link Source Type Hour Distribution	17
4.1.4	Age Distribution	19
4.1.5	Mileage Accumulation Rates.....	19
4.1.6	Fuel Supply and Formulation	19
4.1.7	Link Average Speed and Operating Mode Distribution	20
4.1.8	Emissions Processes	20
4.1.9	Inspection and Maintenance Program.....	20
4.2	Dispersion Modeling.....	20
4.2.1	Intersections, Freeways, and Arterials.....	20
4.2.2	Interchanges.....	25
4.2.3	Background Concentrations.....	27
4.2.4	Persistence Factor	28
4.3	Summary of Worst-Case Modeling Inputs.....	28
4.4	Comparison with the CO NAAQS	30
5.	Results	31
5.1	Freeway and Arterials	31
5.2	Intersections	31
5.3	Interchanges	32
6.	Conclusions.....	33
7.	Project Documentation and Other Terms of Agreement.....	35
	Appendix A – Worst-Case Modeling Results	
	Appendix B - MOVES Emission Factors Used in TSD	

List of Figures

Figure 1 – National Carbon Monoxide Emission Inventory	4
Figure 2 - Total National VMT (in billions of miles) on All Highways, 1994-2018. Source: FHWA.....	5
Figure 3 - National Trends in CO Concentration, 1980-2016 (Annual 2nd High 8-hour average N=62).....	6
Figure 4 - Sensitivity of CO Emission Rates to Temperature	17
Figure 5 - Intersection configuration used for modeling with link placement	23
Figure 6 - Typical Modeling Layout for Freeways and Arterials.....	24
Figure 7 - Intersection Geometry Modeled	24
Figure 8 - Geometry Modeled for 60-degree Skew Intersection.....	25
Figure 9 - Interchange Configuration with Nearby Freeway and Intersection/Ramp Layout	26

List of Tables

Table 1 – Current National Ambient Air Quality Standards (NAAQS) for Carbon Monoxide (CO)	3
Table 2 – Projected CO Reductions from EPA’s Tier 3 Program	7
Table 3 - MOVES Input Parameters by Scenario	16
Table 4 – Worst-Case Link Source Type Hour Fractions by Road Type.....	18
Table 5 – Fuel Types Listed for Source Types	19
Table 6– Worst-Case Fuel formulation	20
Table 7 – Simple Modeling Defaults for CAL3QHC	21
Table 8 – Nationwide Network of CO Monitoring Stations Ranked Concentrations 2014-2016	27
Table A-1: One-Hour CO Concentrations (ppm) for Freeways and Arterials ^a in Urban and Rural Locations of Varying Lane and Grade Configuration (Not Including Background Concentrations)	1
Table A-2: One-Hour CO Concentrations (Not Including Background Concentrations) for Rural and Urban Intersections ^b at Varying Skew Angles and Intersection Grades for a Six Approach Lane Intersection	2
Table A-3(a): One-Hour CO Concentrations at Varying Intersection-Freeway Distances, Intersection Grade, and Lane Configurations for 45° Skew Angle (Not Including Background Concentrations) ^c	3
Table A-3(b): One-Hour CO Concentrations at Varying Intersection-Freeway Distances, Intersection Grade, and Lane Configurations for 60° Skew Angle (Not Including Background Concentrations) ^d	7
Table A-3(c): One-hour CO Concentrations at Varying Intersection-Freeway Distances, Intersection Grade, and Lane Configurations for 90° Skew Angle (not including background concentrations) ^e	11
Table B-1: CO Idle Emission Rates Used in the Modeling, in Grams Per Vehicle-Hour, 2020	1
Table B-2: CO Running Emission Rates Used in the Modeling for Upgrade and Downgrade Conditions, Respectively, in Grams Per Vehicle-Mile, 2020, by Speed and Grade.....	3

1. Executive Summary

This Technical Support Document (TSD) provides background and technical information in support of an updated Programmatic Agreement (PA) between the Virginia Department of Transportation (VDOT) and the FHWA Virginia Division for project level carbon monoxide (CO) air quality analysis. The updated PA eliminates the need for project-specific analyses of potential CO impacts for all projects undergoing environmental studies for purposes of the National Environmental Policy Act (NEPA) based on the weight-of-evidence, including:

- Continued implementation of effective emission control technology, increasingly more stringent motor vehicle emission and fuel quality standards implemented over the past few decades by the Environmental Protection Agency (EPA) that have had the combined effect of substantially reducing CO emission rates nationwide, resulting in long-term downward trends in emissions and near-road ambient concentrations of CO despite increasing vehicle-miles-travelled (VMT);
- Extensive experience in project-specific modeling for CO for a wide variety of project types, configurations and operating conditions in which compliance with the national ambient air quality standards (NAAQS) established by EPA for CO is readily demonstrated given the substantially reduced CO emission rates, and despite the use of multiple worst-case assumptions for emission and dispersion modeling that have a compounding effect such that emissions and near-road ambient concentrations are substantially over-estimated;
- Extensive experience in programmatic agreements for project-level agreements for CO that establish ever-increasing thresholds for such analyses given the substantially reduced emission rates; and
- The results of worst-case modeling conducted for this PA for typical highway project types, configurations and operating conditions in which compliance with the NAAQS is readily demonstrated, and by a substantial safety margin.

In sum, the weight-of-evidence supports a conclusion that the time and cost for project-specific modeling or assessments for CO are not warranted given the typical foregone conclusion that the NAAQS for CO will be met and usually by a substantial margin. Therefore, as a reasonable and prudent approach to streamlining environmental clearances consistent with federal and state streamlining initiatives, NEPA documentation will reference the PA for all projects moving forward in lieu of project-specific CO modeling or assessments.

Notwithstanding the elimination of modeling analyses and screening assessments under the PA, VDOT retains the option to conduct at its discretion (and FHWA may request) project-specific CO modeling analyses and/or screening assessments for purposes of transparency, i.e., to show that there would be no significant CO impacts and that the project would reasonably be expected to meet the NAAQS.

For projects for which discretionary screening assessments are conducted, screening criteria have been developed based on conservative and worst-case modeling assumptions that establish the types of projects and project conditions that would meet the NAAQS for CO by a substantial safety margin. These project types and conditions would require only a general qualitative statement

that references this agreement. The project types covered by worst-case modeling are freeways, arterials, interchanges and intersections.

For context, FHWA guidance¹ for air quality analyses states that: *“A microscale CO analysis is unnecessary where such impacts (project CO contribution plus background) can be judged to be well below the 1- and 8-hour National Ambient Air Quality Standards (or other applicable State or local standards). This judgment may be based on (1) previous analyses for similar projects; (2) previous general analyses for various classes of projects; or (3) simplified graphical or “look-up” table evaluations. In these cases, a brief statement stating the basis for the judgment is sufficient.”*

In keeping with FHWA guidance, a weight-of-evidence assessment as provided above that references prior modeling assessments and programmatic agreements for which worst-case modeling was conducted for typical project types and configurations suffices for determining that CO analyses or assessments should not be routinely required in the future as it may reasonably be expected that the CO NAAQS would be met in all cases. Conducting project-specific modeling and/or screening assessments moving forward has diminishing utility and is not cost-effective, and therefore runs counter to state and federal streamlining efforts including the FHWA *Every Day Counts* initiative. Further, allowing for discretionary modeling analyses or screening assessments provides reasonable assurance that any specific cases of interest could still be addressed. Use of a programmatic agreement to eliminate all CO analyses and assessments moving forward, with appropriate allowance for discretionary analyses or assessments, is therefore reasonable, consistent with FHWA guidance, and supports implementation of state and federal streamlining initiatives.

It is recognized that, from time to time, new emission and/or dispersion models may be developed and approved and/or that underlying ambient or technical conditions may change. As necessary, this TSD can be updated to reflect any substantive changes. Note the main agreement to eliminate CO analyses and assessments will remain in place and effective should any updates to the discretionary screening procedures in the appendix or to the TSD (including the underlying modeling) be needed, or upon mutual VDOT-FHWA agreement to remove the screening procedures altogether.

¹ FHWA, *“Guidance for Preparing and Processing Environmental and Section 4(F) Documents”*, Technical Advisory T6640.8A, October 30, 1987, Section 8(b). See: https://www.environment.fhwa.dot.gov/legislation/nepa/guidance_preparing_env_documents.aspx

2. Background

2.1 Air Quality Standards for CO

Under the Clean Air Act, EPA is required to set National Ambient Air Quality Standards for six principal air pollutants, including CO (**Table 1**). The standards are set to avoid adverse impacts to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards. Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly with an adequate margin of safety. Secondary standards provide public welfare protection, including protecting against decreased visibility and damage to animals, crops, vegetation, and buildings. There are currently no secondary standards for CO.

Table 1 – Current National Ambient Air Quality Standards (NAAQS) for Carbon Monoxide (CO)

Pollutant [final rule cite]	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide [76 FR 54293, Aug 31, 2011]	Primary	8-hour	9 ppm	Not to be exceeded more than once per year
		1-hour	35 ppm	

Source: <https://www.epa.gov/co-pollution/national-ambient-air-quality-standards-naaqs-carbon-monoxide-co>

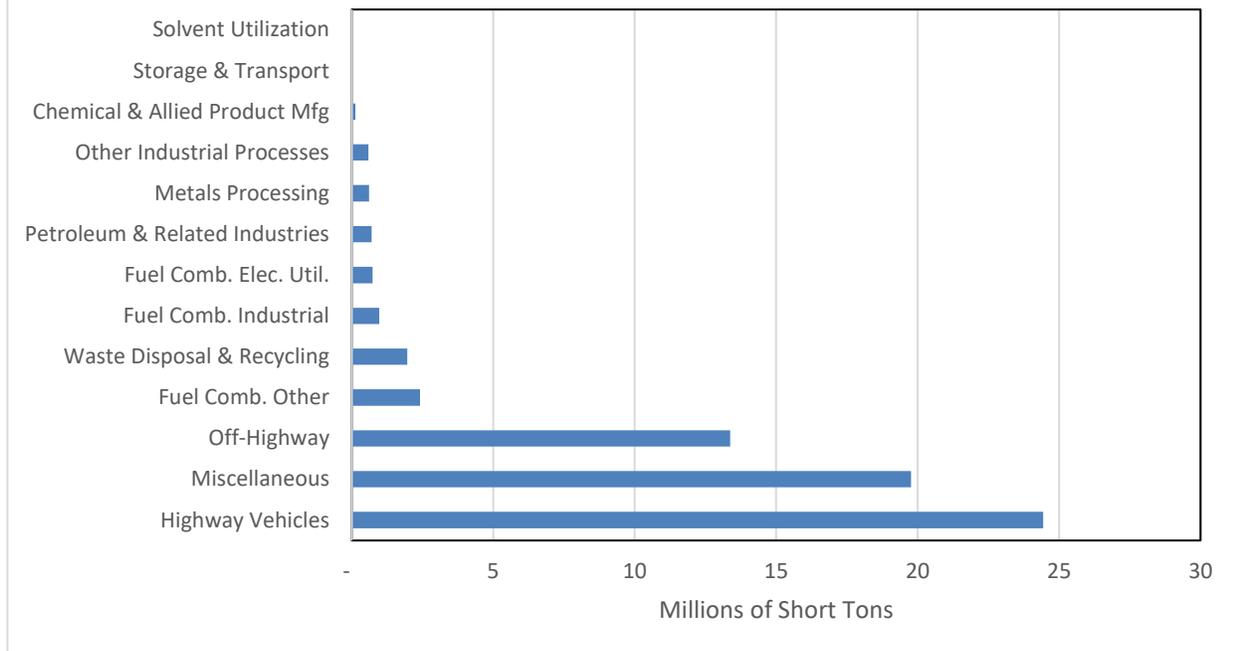
EPA designates geographic regions as in attainment or nonattainment of the NAAQS. Generally, regions that met NAAQS when the standards were promulgated and have continued to meet those standards for a given pollutant are designated attainment areas. Regions that were deemed out of compliance when NAAQS were promulgated and that continue to exceed the NAAQS for a given pollutant are designated nonattainment areas. Regions that were previously out of compliance with the standard but have since come into compliance are designated maintenance areas. As of September 27, 2010, all former CO nonattainment areas nationwide were determined to be in compliance for CO, and so have been re-designated as maintenance areas. At present, all areas in Virginia are in attainment of the CO NAAQS.

States with nonattainment or maintenance areas were required under the Clean Air Act to develop State Implementation Plans (SIPs) adopting transportation conformity requirements at least as stringent as the federal requirements. Some states also adopted additional requirements beyond those prescribed under the Clean Air Act.

2.2 Highway Projects & CO Requirements

Nationally, annual CO emissions in the US total over 82 million short tons. Mobile sources, including gasoline fueled cars, trucks, buses and off-road vehicles, are responsible for approximately 51% of this total.

National CO Air Emissions by Major Tiers, 2014



Source: 2014 National Emission Inventory²

Figure 1 – National Carbon Monoxide Emission Inventory

A similar situation exists at the state level.

Because of the significant CO pollution attributable to mobile sources, transportation agencies have been required to examine the effect of their highway projects on CO levels in the project area. Indeed, under Section 176(c) of the Clean Air Act (the conformity provision), in order to proceed, certain highway projects are required to demonstrate that the incremental addition of CO emissions as a result of the project will not cause or contribute to a violation of the CO NAAQS. The analysis necessary to demonstrate this is typically performed during the environmental studies undertaken to examine environmental impacts of the project.

For transportation projects involving federal funding or action, the environmental analysis is performed pursuant to the requirements of the National Environmental Policy Act (NEPA). Enacted on January 1, 1970, NEPA established a national environmental policy focused on federal activities with the goal of balancing a sustainable environment with other essential present and future needs. NEPA established a requirement for federal agencies to consider the potential environmental consequences of their proposals, document the analysis, and make this information available to the public for comment prior to implementation. NEPA also requires Federal agencies to use an interdisciplinary approach in planning and decision making for any action that adversely impacts the environment. As implemented by FHWA, this means investigating and avoiding potential impacts to the social and natural environment (such as a violation of the CO NAAQS) when considering approval of proposed transportation projects. FHWA's policy and regulations implementing NEPA are found at 23 CFR § 771.105.

² <https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data>

Many states have enacted a state version of NEPA to cover state actions and funding. Like NEPA, the state versions typically require an examination of potential environmental impacts and appropriate action to mitigate these impacts to the extent practicable.

As mentioned above, regions of the nation that did not meet the NAAQS for CO when the standards were promulgated were designated as nonattainment areas under the Clean Air Act. Those areas have since all reached attainment of the CO standard based on monitoring or modeling studies and most are now designated as maintenance areas. However, under Section 176(c) of the Clean Air Act (the transportation conformity provision), certain transportation projects in maintenance areas are required to demonstrate that the project will not cause or contribute to a violation of the CO standard.

2.3 Decline in CO Concentrations

The likelihood of highway projects leading to violations of the CO NAAQS has been significantly reduced over the last few decades. Indeed, vehicle miles traveled (VMT) have seen a long-term general increase over time. Figure 2 shows the trend in VMT at a national level. This has also been the case at the state level.

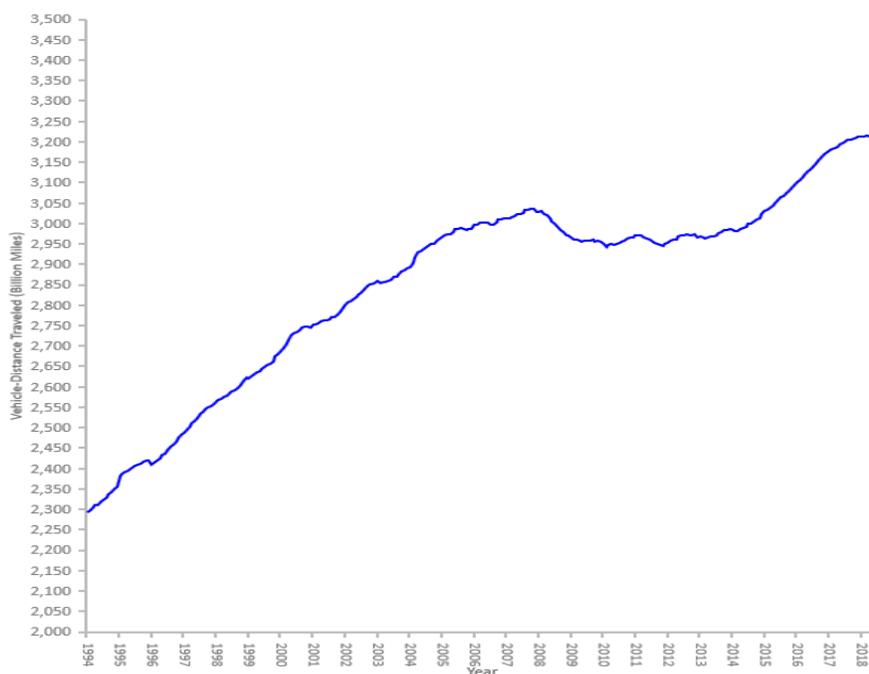


Figure 2 - Total National VMT (in billions of miles) on All Highways, 1994-2018. Source: FHWA.³

Background CO concentrations are critical in determining a project's impact in terms of NAAQS. At the national level, background CO concentrations have seen significant decreases over the past two decades or more. Indeed, the nationwide network of CO air quality monitoring sites have reported a 80% decline in the 90th percentile of maximum 8-hour CO concentration from 9.7 ppm,

³ FHWA Office of Highway Policy Information, Traffic Volume Trends. Available at: https://www.fhwa.dot.gov/policyinformation/travel_monitoring/18jultvt/figure1.cfm.

above the NAAQS for CO (9 ppm—see **Table 1**) in 1990 to 1.9 ppm, well below the NAAQS for CO, in 2016 (Figure 3). Similar reductions have been found at the state level.

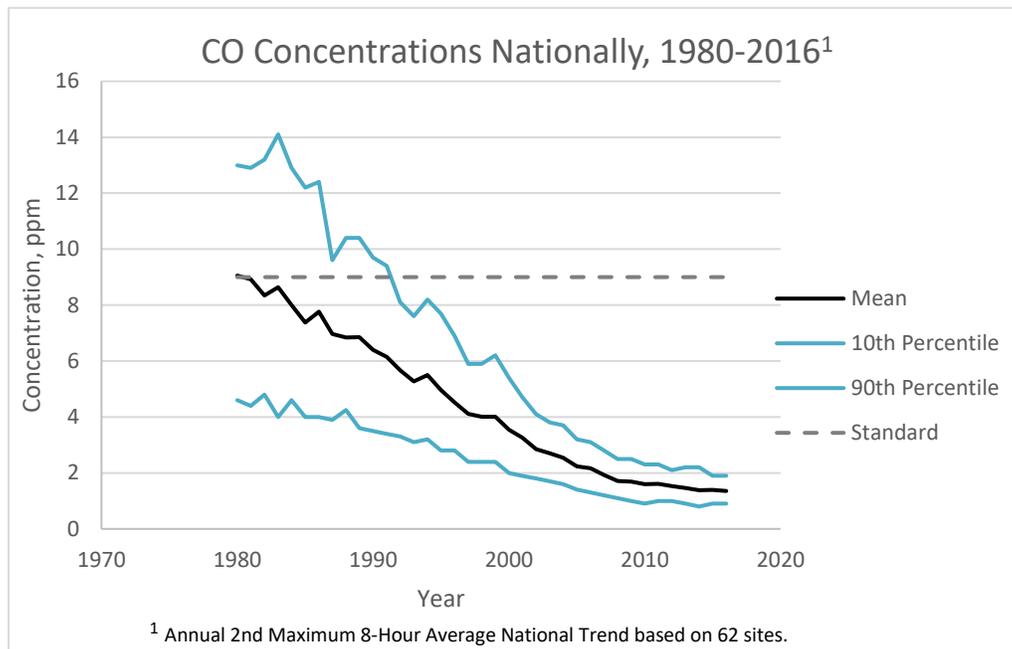
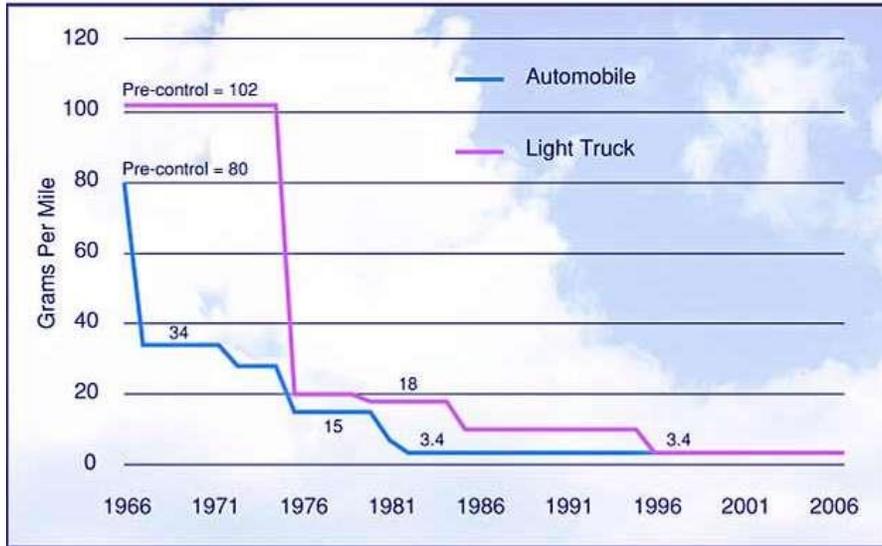


Figure 3 - National Trends in CO Concentration, 1980-2016 (Annual 2nd High 8-hour average N=62).⁴

The largest contributor to the substantial reductions in CO concentrations has been the Federal Motor Vehicle Emission Control Program, which sets emission limits for on-road vehicles. This program since implementation has been responsible for a 95% reduction in CO emissions from light-duty vehicles. Comparably large reductions have also been realized in emissions from light-duty trucks (Figure 4). Additional CO emissions reductions are expected to result from EPA’s Tier 3 Control Program, enacted in April 2014, which places limits on the sulfur content of gasoline. Although CO emission rates are not directly regulated under the Tier 3 Control Program, the additional stringency on sulfur content in gasoline will reduce CO emissions by extending the effective life of vehicle catalysts. When fully implemented, by 2030, Tier 3 is expected to produce an additional 24% reduction in CO emissions (**Table 2**).

⁴ The black line represents the average of all sites, the top blue line the 90th percentile concentration and the bottom the 10th percentile. Source: EPA Air Trends. Available at: <http://www.epa.gov/airtrends/carbon.html>.



Source: U.S. Department of Energy, Office of Energy Efficiency and Renewal Energy. Transportation Energy Data Book: Edition 24, ORNL-6973. December 2004

Figure 4 - Federal Emission Standards for CO for New Automobiles and Light Trucks

Table 2 – Projected CO Reductions from EPA’s Tier 3 Program

	[Annual U.S. tons]	
	2018	2030
Reduction from pre-Tier 3 fleet due to sulfur standard	122,171	17,734
Reduction from Tier 3 fleet due to vehicle and sulfur standards	156,708	3,440,307
Total reduction	278,879	3,458,041
Percent reduction in on road CO emissions	2%	24%

Source: <https://www.federalregister.gov/articles/2014/04/28/2014-06954/control-of-air-pollution-from-motor-vehicles-tier-3-motor-vehicle-emission-and-fuel-standards>

The low ambient CO concentrations and the anticipated continued decline of these concentrations suggest that violations of the current CO NAAQS are unlikely today and into the future. As a result, any changes to local CO concentrations resulting from highway projects are highly unlikely to cause or contribute to a violation of these standards. It is reasonable, therefore, to reduce the number of project-specific CO analyses for highway projects to the maximum extent while still monitoring situations that could lead to high levels of ambient CO concentrations.

3. Regulatory Context and Prior Programmatic Agreements

3.1 Regulatory Requirements and Guidance

For highway projects involving federal funding or action, project-level CO analyses are performed pursuant to the National Environmental Policy Act (NEPA). Enacted on January 1, 1970, NEPA established a national environmental policy requiring federal agencies to take consideration of the environmental impact of proposed projects in their planning and decision making. Specifically, NEPA established a requirement for federal agencies to perform an environmental assessment that considers the potential environmental consequences of their proposed projects. If the environmental assessment finding is that the project will have significant impact, then the federal agency must prepare an environmental impact statement (EIS). The EIS details the environmental consequences of the project and provides reasonable alternatives or amendments that would mitigate these impacts. NEPA requirements encompass any project, public or private, that receives federal funding, though it is the burden of the federal agency to perform the analysis. When applied to FHWA highway projects, NEPA requires consideration of potential environmental impacts—including violation of CO NAAQS, when considering approval of the projects. FHWA’s policy and regulations implementing NEPA are found at 23 CFR § 771.105.

Nineteen states have enacted a state version of NEPA to cover state funded projects. Thus, for state level highway projects, CO analysis may be required in accordance with state NEPA analogues. Like NEPA, the state versions typically require an examination of potential environmental impacts and proposal of efforts to mitigate these impacts to a practical extent. States may also require CO analyses in order for a project to comply with transportation conformity requirements. Project transportation conformity requirements are found in 40 CFR Parts 51 and 93.

Guidance related to performing these analyses may be found in the FHWA Technical Advisory T6640.8A (October 30, 1987). With respect to air quality, the guidance recognizes that microscale air quality analyses may be performed for some projects but does not offer any methodological guidance beyond adding background concentrations to the project contribution or the preferred alternative to arrive at a total CO concentration for comparison to the NAAQS. Using this general guidance, many states developed their own guidelines and procedures tailored to state policies and air quality status.

The EPA transportation conformity rule requires project-level (“hot-spot”) analyses for CO for areas subject to conformity for that pollutant. As a means to streamline analyses, the conformity rule provides the option of a categorical finding (CF), which is analogous to a PA that may be executed for purposes of NEPA but with key differences: 1) A CF is applicable for areas subject to conformity for CO (and not for NEPA), and is approved by FHWA in consultation with EPA and not state DOTs, and 2) a PA is applicable for NEPA (not areas subject to conformity for CO) and is typically executed between a state DOT and its respective FHWA Division office. The option exists in concept for a CF for CO to also be designated as applicable for NEPA (i.e., making it both a CF and an PA), although this has not been done to date.

3.1.1 Prior Work on Template Programmatic Agreements for CO

Historically, PAs have been implemented by state DOTs to address a range of environmental topics (e.g., NEPA, noise, air quality). At the national level, work began on the development of a template PA and TSD for CO with a National Cooperative Highway Research Project (NCHRP) (“Task 78”) study⁵ initiated in 2012 by state DOTs to build upon successful state experiences⁶ in streamlining project-level air quality clearances for purposes of NEPA with state-specific PAs. The intent was to create a national template PA and associated TSD for CO that state DOTs could customize and implement for their respective jurisdictions. A national template would save state DOTs the cost of development of a PA and TSD for CO and also serve to provide greater consistency nationally in how projects are screened for CO. Completed in 2015, the NCHRP Task 78 study examined a variety of project types and conditions in order and identified multiple highway facility types and configurations that would not reasonably be expected to result in violation of the CO NAAQS. It tested even the remote possibility of CO ambient air quality standard violations using worst-case modeling (following FHWA guidance on worst-case assumptions) and maintaining consistency as appropriate with EPA guidance for CO hot-spot analyses.⁷ It applied EPA-approved emission and dispersion models, namely MOVES2010b as the emission model and CAL3QHC (version 04244) as the dispersion model.

Subsequently, the PA and TSD templates developed in the NCHRP Task 78 study were updated in a second NCHRP study (“Task 104”).⁸ The NCHRP Task 104 study, which was completed in 2020, covered a greater range of road grades compared to the original Task 78 Templates and also added coverage of a range of intersection skew angles. As with the NCHRP Task 78 study, the modeling for the NCHRP Task 104 update was conducted using EPA-approved emission and dispersion models for project-level CO screening analyses. MOVES2014a was applied as the emission model (which was updated by EPA in the interim period since the original NCHRP Task 78 study was completed), and CAL3QHC (version 04244) was again applied as the dispersion model. The screening procedures included in the FHWA-VDOT 2020 PA and TSD are based on the updated templates developed in the NCHRP Task 104 study.

For reference, in a parallel effort conducted following the initiation of the NCHRP Task 78 study, the FHWA developed a categorical finding (CF) that could be implemented in areas subject to EPA conformity requirements for CO, i.e., in areas in which a PA designed for NEPA applications typically would not be applicable but the functionally-equivalent CF could be applied. State DOTs could then use the NCHRP PA for NEPA and the FHWA CF for conformity. Completed in 2014, the FHWA CF⁹ documented conditions for a single facility type (i.e., urban intersections) in areas subject to conformity requirements for CO that would not require project-specific emission and

⁵ ICF, Zamurs and Associates, and Volpe Transportation Center, NCHRP 25-25/Task 78, “*Programmatic Agreements for Project-Level Air Quality Analyses*”, 2015. See: <http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3311>

⁶ As noted in the 2015 NCHRP 25-25 Task 78 report, following a review of state agreements in place at that time, the 2009 Virginia DOT PA and TSD were selected as the model for the new national templates. Due to limited funding, however, the 2015 NCHRP Task 78 templates did not include skew angles, which had been included in the Virginia DOT version. This update to the 2015 NCHRP Task 78 templates includes both skew angles and road grades.

⁷ US EPA, Guideline for Modeling Carbon Monoxide from Roadway Intersections, EPA-454/R-92-005, Nov. 1992; and Using MOVES in Project-Level Carbon Monoxide Analyses, EPA-420-C-10-041 December 2010

⁸ E. Carr, S. Hartley, G. Noel & A. Eilbert, NCHRP 25-25 Task 104, “*Streamlining Carbon Monoxide Project-Level Air Quality Analyses with Programmatic Agreements*”, 2020. <http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4100>

⁹ FHWA Carbon Monoxide Categorical Hot-Spot Finding (*Superseded*), February 2014. Available at: http://www.fhwa.dot.gov/environment/air_quality/conformity/policy_and_guidance/cmcf/

dispersion modeling. The FHWA CF was based on a set of worst-case assumptions similar in concept to those applied in the NCHRP PAs. In 2017, FHWA published a revision¹⁰ to its original 2014 CF based on updated emission modeling (with MOVES2014a) and the CAL3QHC dispersion model. However, the FHWA CF remained limited to large urban intersections; its coverage was not expanded to include the additional highway facility types and configurations covered by this PA. The 2017 FHWA CF is applicable to all states and territories (except California) that are subject to conformity requirements for CO¹¹.

3.1.2 FHWA-VDOT Programmatic Agreements for CO

FHWA and VDOT have an extensive history in developing, implementing and applying programmatic agreements for project-level air quality studies for CO that goes back to the 1970s. The agreements were updated periodically, e.g., to accommodate changes in applicable regulatory models and ambient CO data. A chronology of the agreements is presented below, including summaries of the principal terms for each agreement.

Prior to November 1979 (as referenced in an FHWA mid-1990s summary):

- US EPA criteria for indirect sources:
 - macroscale analyses for projects exceeding 50,000 ADT, and
 - microscale analyses for projects exceeding 20,000 ADT.
- The referenced indirect source regulation was later rescinded by EPA.

November 2, 1979 (as referenced in the August 15 and November 7, 1985 letters cited below):

- FHWA agreement to use a nomograph developed by the Virginia Department of Highways and Transportation (VHT) for predicting ambient concentrations of CO for roadway projects.

August 15, 1985: “Current procedures” as described in an August 15, 1985 FHWA memo (A.Solury to J.Tomlin & R.Gatz) addressing a July 9, 1985 VHT letter proposal for new criteria:

- Level One - Qualitative Statement: A “*standard simplified one-page statement*” is “*placed in the project file documenting that there are no air quality impacts*”, for projects normally outside of a standard metropolitan statistical area.
- Level Two – Nomograph: Method (as approved in 1979 by the FHWA) applied for projects for which future year ADT is less than 20,000 but exceeds 10,000.
- Level Three – Microscale Computer Analysis: The AIRPOL 4-A model is applied for projects for which the nomograph method indicates future year build concentrations to be within 2 parts per million (ppm) of either the 1- or 8-hour NAAQS for CO.

November 7, 1985:

- FHWA letter response to VHT listing “*acceptable simplified procedures... in line with the methodology proposed in your July 9 letter*”:
 - Level One - Qualitative Statement: indicating that “*the project will not adversely affect air quality in the project area*” for projects for which the future year ADT is less than

¹⁰ FHWA Carbon Monoxide Categorical Hot-Spot Finding, 2017. Available at:

https://www.fhwa.dot.gov/environment/air_quality/conformity/policy_and_guidance/cmcf_2017/index.cfm

¹¹ State DOTs have encouraged FHWA to explore options for expanding its CF, e.g., by incorporating the project types and configurations covered by this template PA, and also, very importantly, explicitly making the CF applicable for NEPA in addition to conformity, i.e., in effect making it both a PA and CF. For this purpose, certain of the modeling inputs for the 2020 NCHRP Task 104 update were made consistent as appropriate with the inputs applied in the 2017 FHWA CF.

- 20,000,
- Level Two – Nomograph: Method (as approved in 1979 by the FHWA) applied for projects for which the future year ADT exceeds 20,000,
- Level Three - Computer Analysis: The AIRPOL 4-A model is applied for projects for which the nomograph method indicates future year build concentrations to be within 2 parts per million (ppm) of either the 1- or 8-hour NAAQS for CO. A computer analysis would also be conducted for “*unique or controversial projects related to air quality*”.
- The future or design year should be 10 to 20 years from the start of construction.
- Each project would be subject to a conformity review similar to then current practice.
- The discussion of air quality in the environmental document should be commensurate with the level of analysis. For projects for which a computer analysis is conducted, a technical report should be prepared but only the “*important portions*” included in the environmental document. The latter should include a statement that the complete technical report is available on request.

February 10, 1988:

- FHWA Letter (M.Tumlin to J.Hodge) reiterating support for the 20,000 ADT threshold.
- VACAL3 model in use as the standard model for CO analyses.

August 22, 2000:

- Letter Update to the prior agreement, increasing the ADT threshold to 30,000 and adding the requirement for “*VDOT to conduct a project level carbon monoxide analysis for all major Federal-aid projects processed with an Environmental Impact Statement in accordance with FHWA Technical Advisory T 6640.8A regardless of the design year ADT. This will ensure a comprehensive analysis of all the environmental issues that may be of concern on these types of projects.*”
- Based on the MOBILE5.0A model then in use, with a requirement to update the Agreement upon the release and phase-in of the MOBILE6 model.

April 21, 2004:

- FHWA email (E.Sundra to K.Myers, FHWA & A.Costello, VDOT) concluding that: “*Given the wealth of prior air quality analyses that have been conducted and given that the categories of projects covered by the [FHWA and VDOT] Programmatic CE [categorical exclusion] Agreement [PCE Agreement*] do not readily, generally speaking, lend themselves to significant environmental impacts of any kind, we can safely conclude that projects processed with a Programmatic CE under our agreement (including those processed under 23 CFR 771.117(c) which are referenced in the agreement) do not need a CO air quality analysis. This e-mail will serve as our formal determination on this [matter].*”
- FHWA follow-up email (K.Myers to E.Sundra, A.Costello) suggesting (informally): “*As far as streamlining, maybe we should consider exempting "listed CE's"; i.e. those "old fashioned" ones that don't add capacity or otherwise require inclusion [in] the ... transportation models. The "unlisted CE's", those requiring further study, would need to be considered on a case by case basis for AQ [air quality] analysis.*”

August 4, 2004:

- Letter update to the prior agreement, increasing the ADT threshold to 42,500 for projects with intersection/interchange LOS C or better and leaving it at 30,000 for projects with

intersection/interchange LOS D or worse.

- Provides qualitative text for projects meeting the ADT thresholds as well as ones identified as exempt in the federal conformity rule at 40 CFR 93.126.
- Exempts projects that qualify for a PCE.
- Specifies the use of the MOBILE6.2, CAL3QHC and CALINE3 models.

October 28, 2004:

- FHWA guidance related to the prior agreement, addressing when updated design assumptions should be used to reassess air quality impacts and prepare new air quality analyses.
- FHWA decision for NEPA re-evaluations, and VDOT for projects that have been otherwise delayed with resulting changes in design year, traffic forecasts, or other factors relevant to the air analysis.

February 2009:

- New agreement, incrementally increasing the ADT threshold within limits for intersection/interchange skew angles and to update the text of the Agreement.
- Based on worst-case modeling inputs for traffic, emissions and dispersion.
- New thresholds:
 - 59,000 ADT for any project affecting capacity for roadways that either have no intersections or interchanges or have ones that have skew angles no less than 60 degrees;
 - 49,000 ADT for skew angles from 45 degrees up to 60 degrees; and
 - 39,000 ADT or skew angles from 30 degrees up to 45 degrees.
- Subject to intersection/freeway interchange LOS E limits or reasonable proxies, such as peak hour vehicle per hour per lane (vphpl) limits of 1037 for arterial streets and 2200 for freeways or limited access roadways without intersections, which were assumptions made for the worst-case analysis.
- Qualitative text updated for: 1) exempt projects and ones that qualify for a PCE, and 2) ones that meet the ADT, skew angle (as applicable), and LOS thresholds.
- Specifies models to be applied as the latest ones approved by the US EPA and agreed by FHWA for project-level analyses, namely, MOBILE6.2, which was expected to be updated in the near term to a “next generation” model for emissions, and CAL3QHC and CALINE3 for dispersion, and updates or replacements thereto.
- As a limitation of the EPA MOBILE model, the effect of road grades on emissions could not be modeled or included in this agreement.

May 2016:

- Major update expanding coverage of project types, configurations (including road grades) and settings (urban/rural), and adding terms to facilitate the screening process
- Based on templates developed in NCHRP 25-25 Task 78 (2015), which are available on the following website: <https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3311>
 - VDOT proposed the NCHRP study and participated in the project panel.
 - As noted in the NCHRP report (Executive Summary, page X, and main report, page 14), the NCHRP 25-25 Task 78 study conducted a survey of programmatic agreements in place across the nation and selected the 2009 FHWA-VDOT PA and TSD as the model for its new national templates. This selection reflects well on the FHWA-VDOT process

for developing and implementing such agreements. Excerpt from NCHRP 25-25 Task 78, p.14: “...Virginia’s [PA] is applicable to a wide range of project types and conditions and can be tailored to NEPA or state environmental requirements. Consequently, Virginia’s 2009 PA was chosen as the model for developing the draft PA and Technical Support Document (TSD) templates...”

- Worst-case modeling conducted using the new next-generation EPA emission model (MOVES2010b) and the EPA dispersion model CAL3QHC (version 04244).
- Expanded coverage:
 - Coverage of project types increased over the prior agreement to include freeways, arterials, and freeways with adjacent congested intersections in addition to arterial intersections.
 - Coverage of road grades was added to the agreement for the first time, taking advantage of the new capability to account for road grades provided by the new MOVES model for that purpose. Modeling was conducted for road grades up to 7% for freeways and arterials, and up to 2% for intersections.
 - Urban and rural locations were modeled for freeways, arterials and intersections.
- Replaced the use of forecast ADT as a screening criterion with the number of lanes, assuming a worst-case volume per lane, to simplify the clearance process.
- As the NCHRP 25-25 Task 78 templates did *not* include modeling for intersections with skew angles, the 2016 FHWA-VDOT PA incorporated the 2009 FHWA-VDOT PA by reference to provide the needed coverage as it covered multiple skew angles.
- New terms added to the agreement to facilitate and customize its application for Virginia, including: use of Virginia-specific background concentrations and persistence factors, mutual applicability of the PA and the FHWA Categorical Finding, application of the PA to locally administered projects, determinations of substantive differences, coverage of build and no-build alternatives, projects of de minimis scope, exempt projects, and relationship of the PA to the VDOT Resource Document.

September 2020 (this update):

- Major update
- Following the recommendation of FHWA Headquarters staff, the new agreement completely eliminates the need for project-specific CO analyses or assessments, based on weight-of-evidence.
- VDOT retains the option (and FHWA may request) to conduct project-specific modeling or assessments at its discretion for purposes of transparency, i.e., to show that there would be no significant CO impacts and that the project would reasonably be expected to meet the NAAQS. Such discretionary assessments may include screening based on worst-case modeling results for typical project types and configurations.
- Update based on templates developed in NCHRP 25-25 Task 104 (2020), which were updated versions of the templates developed originally in NCHRP 25-25 Task 78 (2015) that were the basis for the 2016 FHWA-VDOT PA.
 - VDOT proposed the NCHRP 25-25 Task 104 study to expand the coverage of road grades and skew angles using the updated EPA MOVES model relative to the Task 78 template PA, and served on the project panel. Project report and templates available at: <https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4100>
 - Worst-case modeling conducted using an updated version of the EPA emission model

(MOVES2014a) and the same EPA dispersion model applied in the previous agreement (CAL3QHC, version 04244).

- Expanded Coverage:
 - Road grades covered up to 7% for all project types. For intersections, this is an increase from the limit of 2% modeled in the previous agreement.
 - Skewed intersections (15, 30, 45, and 60 degrees) were added, expanding coverage from just square intersections in the previous agreement.
 - Project types covered include freeway and arterial segments, arterial intersections, and freeways with adjacent congested intersections, as in the previous agreement.
 - Both urban and rural locations were modeled, as in the previous agreement.
- NEPA clearance process streamlined by replacing the need for traffic forecasts (ADT and operating speeds) with respectively the number of lanes (each carrying worst-case volumes, as in the previous agreement) and posted speeds. This allows projects to be cleared for CO early in the NEPA process, i.e., when the build number of lanes and posted speeds are known but traffic forecasts for both volume and speed that are typically delivered late in the NEPA process are not yet available.
- Safety margin qualitatively assessed, noting the substantial over-estimation of emissions and near-road concentrations resulting from the assumption of multiple conservative or worst-case modeling inputs that not only individually serve to increase the modeled estimates but also in combination have a significant compounding effect on the results.
- New terms added to the agreement to facilitate its application for Virginia, including recognition of the substantial safety margin afforded by use of multiple worst-case inputs for both emission and dispersion modeling, interpolation or proration of modeling results, and enduring applicability of the PA.

4. Modeling

The models used in CO air quality analysis have evolved over time. For emissions, the MOBILE series of models were used until the 2010 release of the first version of MOVES (Motor Vehicle Emission Simulator). Similarly, dispersion models have undergone changes over time. Highway sources have historically been treated as line sources using Gaussian dispersion to deliver CO from the source to the receptor. The HIWAY and CALINE series of models were developed to allow for modeling of roadways. However, it was realized that congested intersections, with most vehicles experiencing idling and acceleration and deceleration associated with a traffic signal, may be more of a concern for CO levels than free-flowing highways. To account for intersection scenarios, queuing algorithms were added to dispersion models, resulting in the current series of CAL3QHC and CAL3QHC(R) models. This analysis used MOVES (version MOVES2014a) and CAL3QHC (version 042440) for emissions and dispersion modeling, respectively.

The assumptions and inputs to the modeling process were conservative and/or worst-case that, by design, tend to over predict concentrations. If a project does not cause a violation with these conservative inputs and assumptions, then a violation under “real-world” conditions is extremely unlikely to occur. This is standard practice in transportation air quality modeling. A summary of the worst-case modeling inputs as applied here are provided later in this section, and generally includes very conservative assumptions for traffic volumes, facility geometrics, receptor locations, and meteorology. Further discussion of how this very conservative approach to emission and air dispersion modeling was conducted is provided in the remainder of this section.

The use of a number of conservative/worst-case modeling inputs effectively provides a substantial safety margin for the PA. Given the degree of conservatism, the criteria to be specified in the PA for its application to proposed projects may reasonably be limited to only the most critical. For example:

- The PA may not specify meteorological data as criteria for its application for proposed projects, as worst-case meteorological inputs (e.g., low wind speeds) were assumed for the dispersion modeling for the TSD.
- The PA may specify limits on the number of freeway lanes as a criterion but not project-specific forecast traffic volumes, as worst-case volumes per lane for each facility type were assumed for the modeling for the TSD.
- Similarly, the criteria for application of the PA may reasonably be based on posted speeds (within specified speed ranges) as a reasonable proxy for forecast speeds.

4.1 Emission Modeling

Emission modeling was performed using the EPA MOVES model (version MOVES2014a). The emissions parameters for MOVES were specified in the Run Specification file (Runspec) and in the Project Data Manager (PDM). All applications of the MOVES model were conducted at the project level scale. Multiple MOVES runs were conducted for varying roadway grades to establish CO emissions rates. Other MOVES input parameters such as temperature and relative humidity were fixed to be conservative and consistent with the dispersion modeling component of the analysis (see section 4.3.3). **Table 3** describes the input parameters that were used in the Runspec and PDM for the MOVES component of the analysis. **Appendix B-1** lists the emission factors from the

application of the MOVES model for all combinations of speeds, roadway type and grade based on the input parameters discussed in this section.

Table 3 - MOVES Input Parameters by Scenario

Parameter	Freeway	Arterial	Intersection
Scale	Project Level Domain		
Year	2020		
Month	January		
Time Span - Hour	08:00 AM		
Time Span - Day	Weekday		
Geographic Bounds	Custom Domain		
Temperature	78° Fahrenheit		
Relative Humidity	100%		
Fuel Formulation	Gasoline – Formulation ID - 3505		
	Diesel – Formulation ID - 25005		
	CNG – Formulation ID - 30		
Fleet Mix	All Emission Source Type and Fuel Combinations for 2020 (refer to Table 4 and Table 5)		
Age Distribution	2020 National Default		
Link Source Type Distribution	Variable - Based on 2020 National Default VMT for Urban and Rural Restricted Access Road Type with Truck Percentage adjustments	Variable - Based on 2020 National Default VMT for Urban and Rural Unrestricted Access Road Type with Truck Percentage adjustments	Variable - Based on 2020 National Default VMT for Urban and Rural Unrestricted Access Road Type with Truck Percentage adjustments
Road Type	Urban and Rural Restricted Access	Urban and Rural Unrestricted Access	Urban and Rural Unrestricted Access
Link Average Speed	19 to 75 mph, with 74mph having the highest emission rate	15 to 56 mph, with 15 mph having the highest emission rate	15 to 56 mph, with 15 mph approach and idle having the highest emission rate
Grade	Multiple Grades between ±0% to ±7%		
Inspection & Maintenance	None		

4.1.1 Relative Humidity

A value of 100% relative humidity was used and was only applicable for the emission modeling, which yields the highest CO emission rates for any temperature over 75 degrees Fahrenheit.

4.1.2 Temperature

Sensitivity tests with MOVES show that emission rates are sensitive to high temperatures for running exhaust and crankcase exhaust emissions (**Figure 4**)¹². MOVES2014a predicts higher CO beginning at T > 75 degrees Fahrenheit due to air conditioning use. A review of historical meteorological data (2014-2016) from the top 35 non-overlapping 8-hour CO monitored values from all CO reporting sites in the United States showed that the 8-hour average temperature was never higher than 78 degrees Fahrenheit, after excluding four high CO readings due to nearby wildfires. To be conservative, 78 degrees Fahrenheit was then used in the analysis.

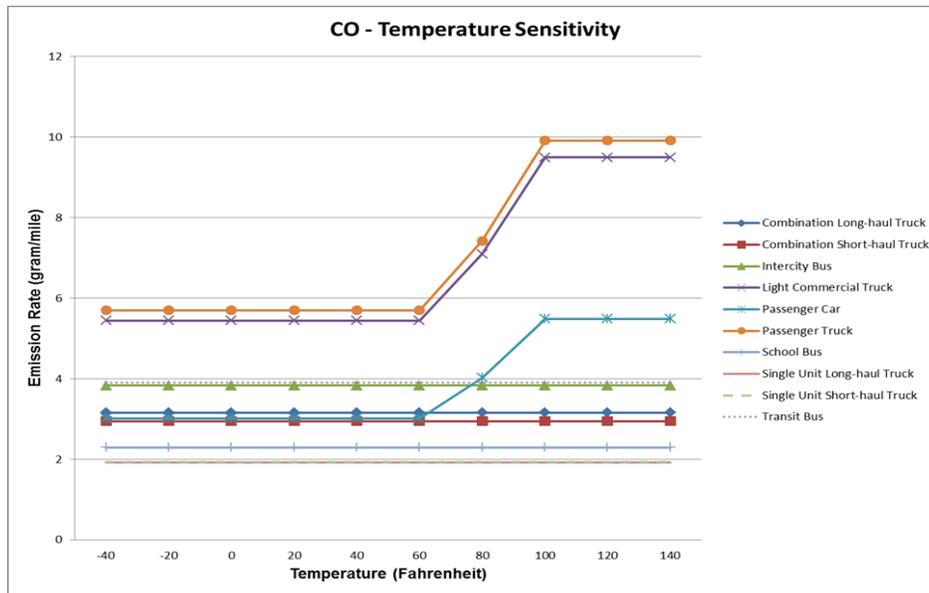


Figure 4 - Sensitivity of CO Emission Rates to Temperature

4.1.3 Link Source Type Hour Distribution

The national default Link Source Type Hour Distribution was obtained from a national scale MOVES run for the 2020 calendar year. Using the vehicle miles traveled (VMT) information from the 'movesActivityOutput' table within the output database, the Link Source Type Hour Distributions were transformed into Link Source Type Hour Distributions for intersection, arterial, and freeway scenarios. To ensure conservative results, the national default Link Source Type Hour Distributions were adjusted in two steps to reflect a higher proportion of vehicles that have higher CO emissions rates. These two adjustments are detailed below.

First, gasoline vehicle types typically have higher CO emission rates compared to diesel vehicle types within MOVES. The Source Type Hour Fractions of heavy-duty trucks for the all road types were adjusted to yield higher CO emission rates. As a worst-case assumption, the Source Type Hour Fractions of short-haul and long-haul trucks were modeled as totaling 20% for all road types.

¹² See <http://ntl.bts.gov/lib/46000/46500/46598/DOT-VNTSC-FHWA-12-05.pdf> and <http://www.epa.gov/ttnchie1/conference/ei19/session6/choi.pdf>

Typically, most heavy-duty trucks will utilize diesel fuel. However, gasoline usage among heavy duty trucks produce significantly higher CO emission rates. In order to yield higher CO emission rates, and as an added worst-case assumption, all short and long-haul trucks were modeled as gasoline powered. It is also more likely that Single Unit Short-Haul and Single-Unit Long-Haul Trucks utilize gasoline than Combination Short-Haul Trucks (Gasoline Combination Long-Haul Trucks cannot be modeled in MOVES). As a further worst-case assumption, given that gasoline usage among Combination Short-Haul Trucks is extremely low and gasoline Combination Long-Haul Trucks are not modeled with MOVES, their Source Type Hour Fractions were set to zero for the all scenarios.

Second, Single Unit Short-Haul Trucks have a significantly higher gasoline usage percentage than Single Unit Long-Haul Trucks. However, gasoline Single Unit Long-Haul Trucks have a significantly higher CO emission rate compared to gasoline Single Unit Short Haul Trucks. As another worst-case assumption, given these factors, a 50/50 proportional split between Single Unit Short-Haul Truck and Single Unit Long-Haul Trucks was assumed.

These two adjustments are reflected in **Table 4** for the worst-case Link Source Type Hour Fractions utilized for the freeway, arterial, and intersection scenarios, by road type.

Table 4 – Worst-Case Link Source Type Hour Fractions by Road Type

Source Type ID	Description	Source Type Hour Fraction			
		Rural Restricted Access	Rural Unrestricted Access	Urban Restricted Access	Urban Unrestricted Access
11	Motorcycle	0.005148815	0.006517137	0.004624823	0.005437676
21	Passenger Car	0.351670565	0.350773406	0.356868392	0.356671678
31	Passenger Truck	0.351670565	0.350773406	0.356868392	0.356671678
32	Light Commercial Truck	0.078288293	0.083983908	0.074416577	0.075599511
41	Intercity Bus	0.000886219	0.000596595	0.000521725	0.000449224
42	Transit Bus	0.001753513	0.001202121	0.001050873	0.000910747
43	School Bus	0.0048217	0.003306813	0.002890741	0.002505633
51	Refuse Truck	0.004170256	0.001595545	0.001659885	0.000819345
52*	Single Unit Short-haul Truck	0.1	0.1	0.1	0.1
53*	Single Unit Long-haul Truck	0.1	0.1	0.1	0.1
54	Motor Home	0.001590074	0.001251068	0.001098592	0.000934507
61*	Combination Short-haul Truck	0	0	0	0
62*	Combination Long-haul Truck	0	0	0	0

* Worst-case values were assumed for these inputs.

Table 5 lists the source type and fuel type combinations that were modeled in all scenarios. All fuel type and source type combinations were chosen in the runspec files to account for all VMT.

Table 5 – Fuel Types Listed for Source Types

Source Types	Fuel Type(s)
Motorcycle	Gasoline
Passenger Car	Diesel Fuel, Gasoline, Electricity, E-85
Passenger Truck	Diesel Fuel, Gasoline, Electricity, E-85
Light Commercial Truck	Diesel Fuel, Gasoline, Electricity, E-85
Refuse Truck	Diesel Fuel and Gasoline
Motor Home	Diesel Fuel and Gasoline
School Bus	Diesel Fuel and Gasoline
Transit Bus	Diesel Fuel, Gasoline, CNG
Intercity Bus	Diesel Fuel
Single Unit Short-haul Truck	Diesel Fuel and Gasoline
Single Unit Long-haul Truck	Diesel Fuel and Gasoline
Combination Short-haul Truck	Diesel Fuel and Gasoline
Combination Long-haul Truck	Diesel Fuel

4.1.4 Age Distribution

The 2020 national default age distribution was utilized and is consistent with the analysis year that was modeled.

4.1.5 Mileage Accumulation Rates

No adjustments were made to weight the modeled fleet average emission factor for CO based on annual average mileage accumulation rates by model year. The MOVES model automatically does this for regional modeling but not for project-level. Weighting is needed as mileage accumulation rates tend to decline with vehicle age (older vehicles are driven less, on average, than newer) and newer vehicles are constructed to meet increasingly more stringent EPA emission standards. As a result, unweighted fleet average emission factors for CO tend to be higher than those weighted based on mileage accumulation rates. Therefore, the use of emission factors that are unweighted for mileage accumulation rates for this analysis serves as another worst-case modeling assumption.

4.1.6 Fuel Supply and Formulation

Fuel formulation parameters can significantly affect CO emission rates. The FHWA CF determined the effects of certain fuel parameters on CO emission rates. Fuel parameters that can affect CO

emission rates include Reid vapor pressure (RVP), sulfur content, ethanol (ETOH), percent of fuel evaporated at 200° and 300° Fahrenheit (E200/E300), and distillation parameters T50 and T90. The FHWA CF found that fuel formulation ID 3812 yields higher CO emission rates than other relevant fuel formulations. As previously noted, for consistency, this study applied the same worst-case assumptions for certain inputs as the FHWA CF. Fuel formulation is one example where the inputs were made consistent. **Table 6** lists the fuel formulation that was used in both the FHWA CF and, as another worst-case assumption, this analysis.

Table 6– Worst-Case Fuel formulation

Fuel Type	Fuel Formulation ID	RVP	Sulfur Content (ppm)	ETOH Volume	e200	e300	T50	T90
Diesel	20	0	11	0	0	0	-	-
Gasoline	3505	13.92	10	10	56.12	84.2	187.33	323.96
CNG	30	0	0	0	0	0	0	0

4.1.7 Link Average Speed and Operating Mode Distribution

When average speed is utilized in the ‘Links’ input file, entered through the MOVES’ PDM, MOVES creates an operating mode distribution based upon the default drive schedules located in the default database. This operating mode distribution was used to represent the freeways, arterials and intersection scenarios. The speeds used in the analysis for each facility type are shown in Table 3.

4.1.8 Emissions Processes

The ‘Running Exhaust’ and ‘Crankcase Running Exhaust’ emissions process were utilized in the intersection, freeway, and arterial scenarios.

4.1.9 Inspection and Maintenance Program

As a worst-case assumption, any emission reduction benefits for CO that would be obtained from an inspection and maintenance I/M program were not included in this analysis.

4.2 Dispersion Modeling

The dispersion modeling was conducted following FHWA guidance on worst-case modeling as well as EPA’s 1992 Guidance for CO determinations. The modeling was conducted using CAL3QHC (version 04244)¹³, with the modeling inputs made consistent to the extent feasible as noted above with the approach used by the FHWA CF (which was limited to intersections). As done for emissions modeling, the dispersion modeling used conservative and, in many cases, worst-case inputs and assumptions. The modeling approach is described in greater detail below for each facility type assessed in this document.

4.2.1 Intersections, Freeways, and Arterials

Table 7 provides a summary of those input parameters that are EPA CO screening values for near

¹³ CAL3QHC modeling was completed without the use of FHWA’s CAL3i graphical user interface.

roadway dispersion modeling. Other inputs, or those that vary by facility type, are given in bullet format.

Table 7 – Simple Modeling Defaults for CAL3QHC

Source Types	Fuel Type(s)
Wind Speed	1.0 m/s
Wind Direction	Varying wind direction 0 to 350 degrees at 10-degree increments
Atmospheric Stability Class	Urban – stability Class D; Rural – Stability Class E
Mixing Height	1000 meters
Receptor Heights	1.8 meters

- For urban modeling, a surface roughness (z_0) of 108 cm (3.54 ft) was used, corresponding to a single-family residential setting. The single-family residential setting is the least rough setting for an urban environment and is conservative. The recommended surface roughness in urban areas can vary from 108 to 370 cm (3.54 to 12.1 ft). For rural areas, a surface roughness of 1.0 cm (0.03 ft) was used, which corresponds to a moderately short grass height (6-8 cm; 0.20-0.26 ft) as identified in the Kansas prairie grass¹⁴. Shorter grass heights are unlikely to be found most rural locations.
- Receptor Placement
 - Freeways and Arterials:
 - Receptors were modeled per the CAL3QHC and 1992 EPA Guidance and were located starting at 20 feet from the outside lane for freeways to account for off-road safety clearance. Receptors were located starting at 10 feet from roadway edge for arterials (where the general public has access and within the limitations of the model to predict valid concentrations).
 - Receptors were evaluated perpendicular to and at the center of the defined link to avoid end effects.
 - Receptors were placed on both sides of the roadway at increments of 10 feet for freeways and 25 feet for arterials, extending out to 295 feet from the roadway. These were modeled to establish decreasing CO concentrations with distance from the roadway edge.
 - Intersections:
 - Receptors were modeled per the CAL3QHC and 1992 EPA Guidance and began at 10 feet from roadway edge.
 - Receptors were placed in each quadrant consistent with the 1992 CO Guideline¹⁵

¹⁴ Businger, J.A., J.C. Wingard, Y. U. Isumi and E. F. Bradley, 1971 “Flux Profile Relationships in the Atmospheric Surface Layer”, *J. Atm Sci.*, 28:181-191

¹⁵ U.S. Environmental Protection Agency, Guideline for Modeling Carbon Monoxide from Roadway Intersections, EPA-454/R-92-005,

to ensure the worst-case concentrations were identified. The closest receptor was grid spacing started at the corner, 10 feet from each roadway and then at 25 feet and 50 feet from the roadway edge (along the adjacent roadway leg), and at the mid-block position.

- **Figure 5** shows a typical intersection receptor configuration with link geometry.
- Link Geometries and Traffic Activity Levels
 - Freeways and Arterials
 - Links 5,000 feet in length were evaluated to avoid end effects.
 - Freeway facilities were evaluated from 2 to 22 total lanes, in two lane increments. Arterials were evaluated from 2 to 12 total lanes, in two lane increments.
 - Median width was 3.3 feet for freeways and 0 feet for arterials
 - Lane width was 12 feet in all cases.
 - Traffic volumes were conservatively modeled as 2,400 vehicles-per-lane-per-hour for multi-lane freeways and 2,200 vehicles-per-lane-per-hour for multi-lane arterials. Two lane arterials and freeways were modeled at 1,700 vehicles-per-lane-per-hour.
 - Grades from ± 0 to ± 7 percent were modeled, with one leg uphill and one leg downhill.
 - **Figure 6** shows a typical modeling scenario.
 - Intersections
 - Approach and departure links extended 3,000 feet from the center of the intersection to ensure end effects at receptor locations are not encountered.
 - Links were input for the start and end locations per the guidance in the CAL3QHC User Manual. **Figure 7** shows an example of the link placement for the six-lane intersection with 4 through lane and 2 left turn lanes per approach for a right-angle (90-degree skew) intersection.
 - Lane width was conservatively modeled as 11 feet in all cases.
 - In addition to the right-angle intersections, skew angles of 60°, 45°, 30°, and 15° angles were considered. **Figure 8** shows this configuration for a 60-degree skew.
 - Queue lengths were determined by CAL3QHC internal algorithm.
 - Grades from ± 0 to ± 7 percent were modeled, with a side-of-a-hill configuration, where the northbound approach and the westbound approach are up hill.
 - Turn movement were 15% left turn and 5% right turn.
 - Signalization cycle length of 130 seconds with average green time length of 14 seconds for left turn and average green time length for right and through of 41 seconds
 - Traffic volume of 2,640 vehicles per hour on each approach

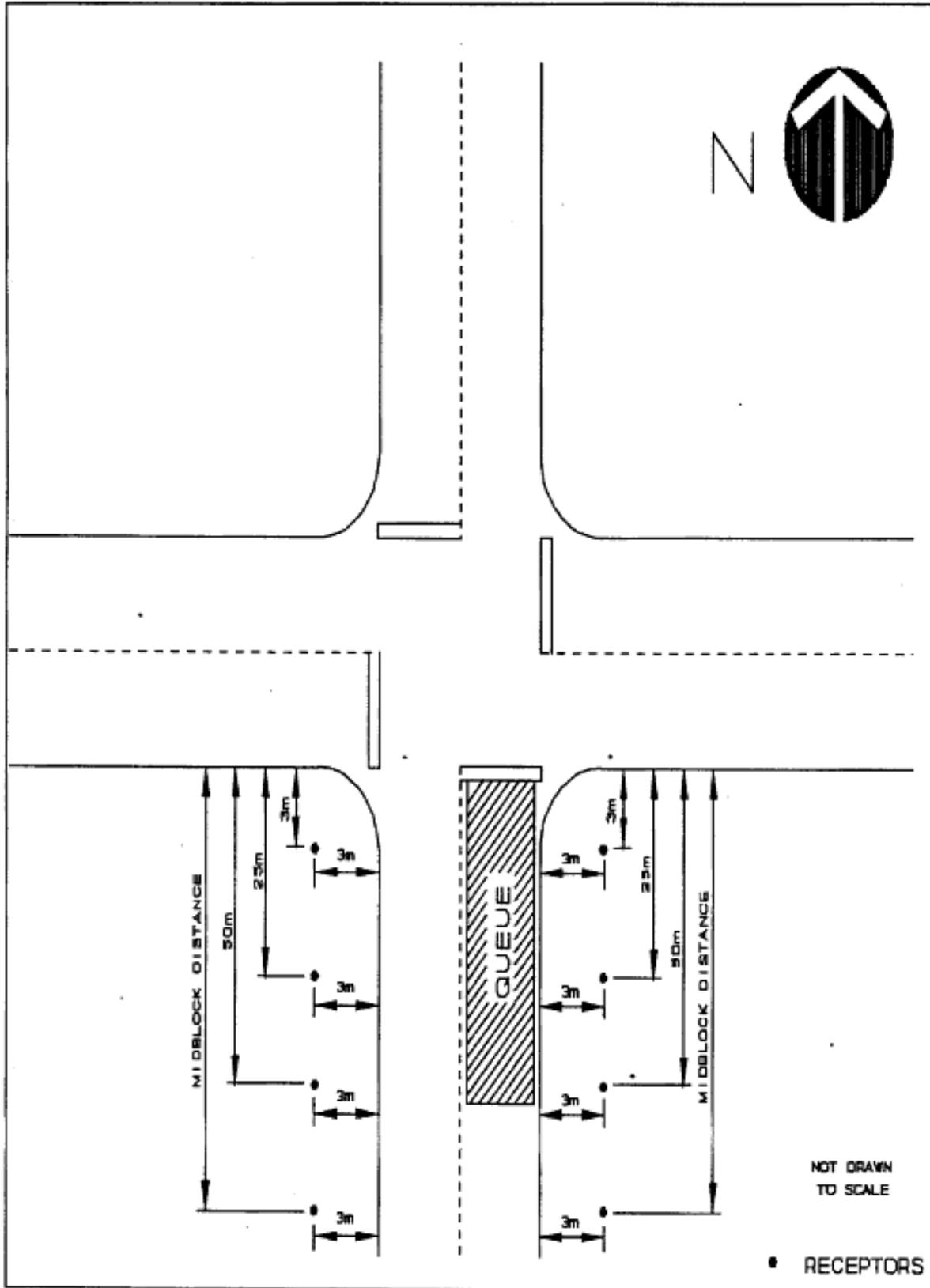


Figure 5 - Intersection configuration used for modeling with link placement

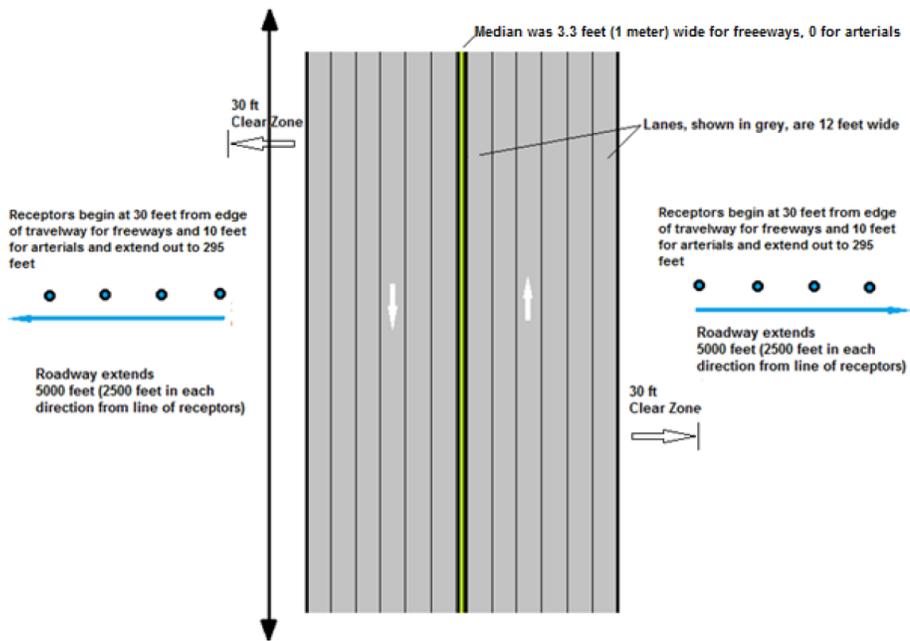
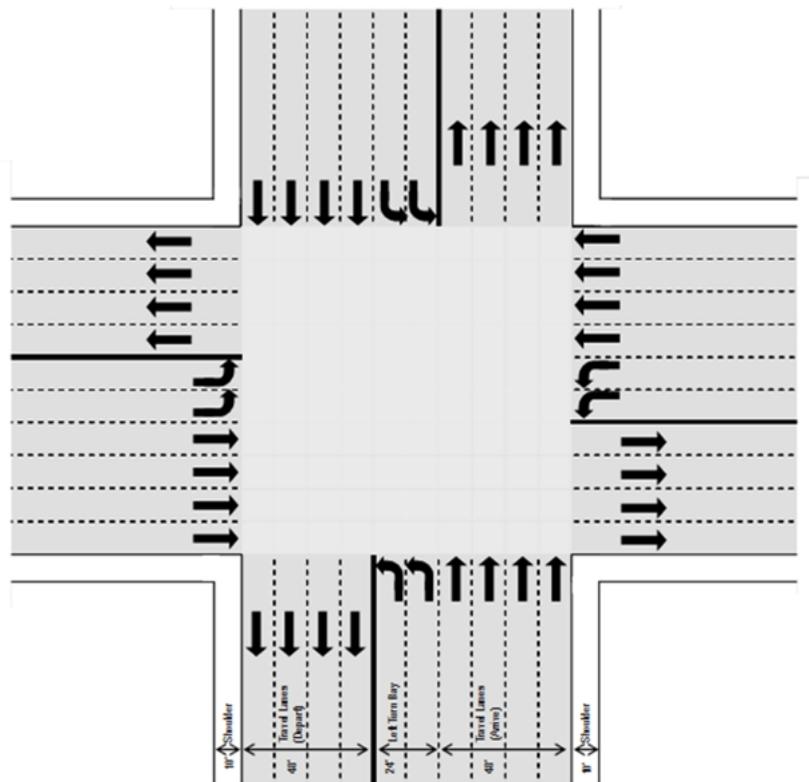


Figure 6 - Typical Modeling Layout for Freeways and Arterials



Note: Each oncoming direction has 4 approach and 2 left turn lanes as well as 4 departure lanes.

Figure 7 - Intersection Geometry Modeled

interchange for a 90-degree skew angle and with the intersection on the right side of the freeway. This modeling combines the impacts from the freeway and intersection modeling to determine the CO contribution for an interchange project for any given combination of the modeled number of freeway lanes and distances from the freeway to the interchange. That is, two separate modeling applications were conducted, and the results combined. Due to the skew angle, receptors for each cannot simply be added based on distance between the facility types. The results shown here represent a combination of the two facility types that considered receptor location, geometry (skew, left/right orientation, and distance between the facilities), road grade, setting (urban or rural) and wind directions in an R-based program that combined CAL3QHCR results with appropriate pairing and determined the overall peak concentrations from the combined facilities. Grade effects for the interchange were modeled for the non-freeway portion of the interchange from ± 0 to ± 7 percent grade. The total of the freeway contribution, intersection contribution, and background are to be directly compared to the CO NAAQS.

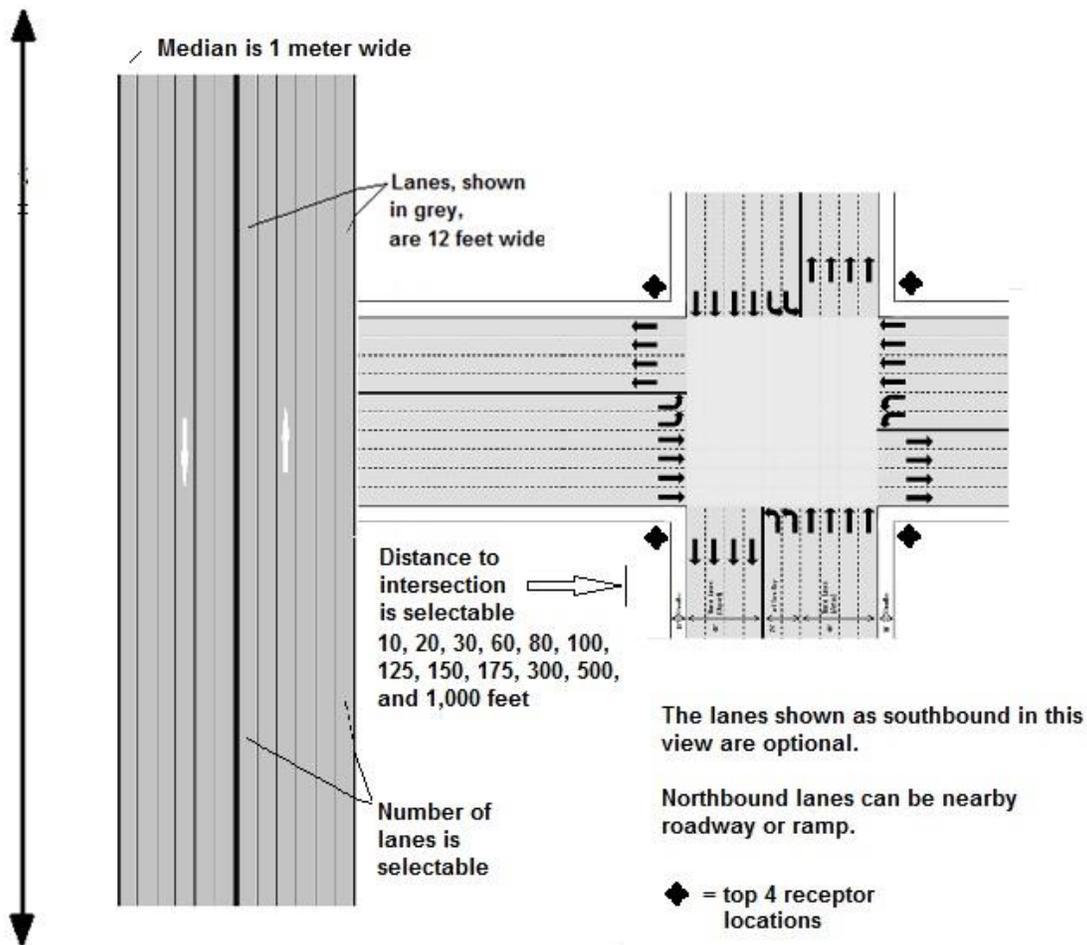


Figure 9 - Interchange Configuration with Nearby Freeway and Intersection/Ramp Layout

As the modeled concentrations may be considered conservatively high estimates for interchanges without adjacent intersections, given that intersection contributions to near-road concentrations are

included along with the interchange contributions in the modeling for this PA and TSD, the modeling may serve as a conservative means to screen such projects. Similarly, and given the substantial safety margin afforded by the use of multiple worst-case modeling assumptions as summarized below, the modeling may also serve as a conservative means to screen freeway-freeway (free-flow) interchanges.

4.2.3 Background Concentrations

To develop a realistic nationwide CO background concentration estimate, observed data for 8-hour and 1-hour average CO concentrations were extracted from EPA’s AirData for each of the three most recent years (2014-2016). AirData is a database of air monitoring data. Datasets representing the 1-hour average, 8-hour average, and annual summary statistics from all reporting sites are available.¹⁶

To determine a nationally representative background concentration, we chose a form consistent with the CO design value (the 2nd highest non-overlapping observed CO concentrations) and the form of the CO national ambient air quality standards (NAAQS) from each of the nation’s CO monitoring stations. We determined the range of reported DVs from all stations in AirData, excluding those in Mexico and Puerto Rico, from 2014-2016. **Table 8** shows the 90th, 95th, and 99th percentiles from the reported DVs from each station in the record meeting a 75% data completeness threshold. To accommodate the recent trend and be consistent with the form of the DV, Table 8 also shows the maximum from the three most recent years for each of those percentages.

Based on this review, it was determined that a reasonably conservative value, applicable to almost any location nationwide, is the highest 95th percentile CO concentration from the past three years (Table 8). Using this value, the representative 1-hour background concentration was determined to be 4.4 ppm and the representative 8-hour background concentration was determined to be 2.4 ppm.

Table 8 – Nationwide Network of CO Monitoring Stations Ranked Concentrations 2014-2016

Percentile	2011	2012	2013	Highest
2nd High Maximum 8-hour CO Concentrations (ppm)				
99th	3.4	2.9	3.7	3.7
95th	2.4	2.3	2.2	2.4
90th	2.0	2.0	1.8	2.0
2nd High Maximum 1-hour CO Concentrations (ppm)				
99th	6.5	5.7	7.2	7.2
95th	4.3	4.4	4.2	4.4
90th	3.2	3.1	2.9	3.2

Source: USEPA AIRData (2018)

¹⁶ This analysis was based on tabular pre-generated data files available at: https://aqs.epa.gov/aqsweb/airdata/download_files.html

FUTURE BACKGROUND

For future years mobile sources are expected to remain the primary source of CO emissions nationwide. EPA provides for the option to adjust for future CO concentrations as a result of emissions rate changes in the mobile source fleet. Continued fleet turnover at a national level to vehicles constructed to more stringent EPA emission standards may reasonably be expected to result in reduced emission rates in the future. However, to preserve the conservative, worst-case approach, no reductions in future emission rates and background levels were assumed for this study. Thus, the results presented in the following Section are representative of years 2020 and later.

4.2.4 Persistence Factor

In order to compare results to the 8-hour CO standard, the total CO concentration for a given scenario is obtained by multiplying the 1-hour modeled project contribution CO concentration by the persistence factor and then adding the 8-hour CO background concentration:

$$\text{Total 8-hour CO} = 1\text{-hour project contribution} \times \text{persistence factor} + 8\text{-hour background}$$

The persistence factor accounts for variability in traffic (i.e., less traffic during off peak hours) and meteorological conditions (i.e., changes in wind speed, wind direction, and temperature) between the 1-hour time frame and the 8-hour time frame. The persistence factor is the ratio between the maximum 1-hour concentration and the resulting maximum 8-hour concentration in the 8-hour time frame containing the maximum 1-hour concentration. The persistence factor recommended by EPA for a local area is derived from the average of the highest 10 non-overlapping 8-hour CO concentrations over the previous three years.

Where representative monitoring data are not available, EPA recommends the use of a persistence factor of 0.7, which was applied for this analysis¹⁷.

4.3 Summary of Worst-Case Modeling Inputs

All modeling inputs including all worst-case assumptions applied in this analysis were made consistent with all applicable EPA and FHWA requirements and guidance.

For emission modeling, worst-case modeling assumptions include:

1. *Usage of current year emission factors instead of (lower) future year values:* Emission factors for 2020 were used for all future years, despite that emission factors are projected to decline over time with continued fleet turnover (to vehicles built to meet more stringent EPA Tier 3 emission standards) along with more stringent fuel quality standards,
2. *Exclusion of emission inspection and maintenance program benefits* as applicable,
3. *Increased percentages of high-emitting vehicle types over low-emitting ones:* High percentages (link-source-type-hour fractions) were assumed for single unit gasoline

¹⁷ The governing programmatic agreement will provide guidance on adjusting the modeling results from this national-level analysis using Virginia-specific background concentrations and persistence factors. Background concentrations and persistence factors for Virginia are specified in the VDOT Resource Document, which, along with associated data repository (files and links), is available on the VDOT website: <http://www.virginiadot.org/programs/pr-environmental.asp>

trucks, which have relatively high CO emission factors compared to other vehicle types. At the same time, the percentages for short- and long-haul combination truck were set to zero, as these vehicles are largely diesel-powered and have relatively low CO emission factors. The combination significantly increased modeled fleet-average emission factors.

4. *Fleet-average emission factors not weighted for typical annual mileage accumulation rates (MARs)*: On average, newer vehicles have lower emission factors and higher annual MARs than older vehicles, so weighting fleet-average emission factors by annual MARs can substantially decrease modeled fleet-averages. Conversely, not doing so (as a worst-case assumption) results in higher modeled fleet-average emission factors than what would be expected to actually occur.
5. *High ambient temperature*, which results in higher air conditioner usage which significantly increases energy (fuel) usage and modeled emissions.
6. *Fuel Formulation*: As noted in the TSD, the FHWA CF found one specific fuel formulation (ID 3812) yielded higher CO emission rates than other relevant fuel formulations, so that formulation was assumed as a worst-case assumption for these screening procedures.
7. *Maximum emission factors for speed range*: Emission factors vary by speed so, as a worst-case modeling assumption, the maximum emission factors for the speed ranges tested for both freeways and arterial streets were selected.

For dispersion modeling, worst-case modeling assumptions include:

1. *Maximum capacity traffic volumes* for each road type.
2. *Nearest-possible receptor locations*: Receptor locations were located on the edge of the roadway right-of-way, i.e., at the closest point to the roadway. Modeled concentrations decrease with increasing distance from the roadway traffic, so placing receptors as close as possible to the roadway maximizes the modeled concentrations.
3. *Worst-case facility configurations*: Geometric assumptions for each project type that serve to concentrate traffic, emissions and concentrations to the greatest extent possible, including:
 - a. An angled “hillside” configuration for intersection modeling, so that the upgrade links are adjacent for one corner. Upgrade links have higher power demand and emission rates, which leads to higher concentrations. Modeled concentrations are therefore maximized for upgrade links that are adjacent, and even further increased for skewed intersections in which the upgrade links are closer together.
 - b. Zero vertical separation for the interchange and mainline roadway, and
 - c. Zero median widths for arterial streets and minimum distance for highways.

4. *Worst-case number of lanes for interchange ramps:* Interchange ramps were assumed to have more lanes of traffic (each with worst-case volumes) than would typically or reasonably be expected.
5. *EPA default meteorological data for screening:* EPA default screening values for wind speeds (1.0 m/s), surface roughness, and stability class were assumed, which results in higher modeled estimates of ambient concentrations than are expected to occur in practice.
6. *Background concentrations:* Current national-average and Virginia background concentrations are assumed to be the same in the future as they are today, whereas they are actually expected to continue to decline given ongoing fleet turnover nationally to vehicles constructed to more stringent EPA emission standards (including Tier 3).

In summary, the use of multiple worst-case modeling inputs significantly increases modeled emissions and concentrations of CO over what would reasonably be expected to occur in practice. The use of multiple worst-case modeling assumptions versus just one or a few has a cumulative or compounding effect that markedly increases modeled air concentrations over what might be realistic or expected. Despite the extensive set of worst-case assumptions, the NAAQS are still met in each case. The use of worst-case modeling inputs therefore provides a substantial safety margin for the modeling.

4.4 Comparison with the CO NAAQS

Each scenario (facility type, configuration, and number of lanes, road grade and traffic volume) was modeled, and the results compared with the current 1- and 8-hour CO NAAQS to determine if the scenario met or exceeded the standards. The comparison began with project scenarios that yielded the highest modeled concentrations and were iterated downward to determine which scenario first passes. The results from the comparison are a set of tables which identify those projects which pass a specific scenario. These results are the basis for the highway project types and conditions identified in the programmatic agreement.

As the respective margin between background concentrations and the NAAQS are much higher for the 1-hour NAAQS than the 8-hour, the latter (8-hour standard) tends to be controlling. As a result, projects are effectively screened based on compliance with the 8-hour NAAQS.

To compare results to the 8-hour CO standard, the total CO concentration for a given scenario is derived by multiplying the 1-hour modeled CO concentration by the persistence factor and then adding the 8-hour CO background concentration, as follows.

$$\text{Total 8 - hour CO} = 1 - \text{hour project contribution} \times \text{persistence factor} + 8 - \text{hour background}$$

5. Results

Modeling results for the project types and conditions discussed above are outlined below. Detailed tables of results presented in Appendix A show both scenarios in which the NAAQS are met and not met, based on modeling conducted using national-level (not Virginia-specific) conservative and worst-case assumptions. Concentrations for which the NAAQS are met using national-level modeling are shown in black text; concentrations for which the NAAQS are not met using national-level modeling are shown in red with the values crossed through.

To apply the tables for conditions in Virginia, the table entry (black text or red strikethrough) corresponding to the project (based on the facility type, setting, configuration etc.) must be calculated as specified above using a Virginia-specific background concentration and persistence factor specified in the VDOT Resource Document for the area in which the project is located. If the resulting adjusted concentration is below the CO NAAQS, then the project is covered by the screening procedures.

Note, although the modeling for these screening procedures specifically tested lanes widths of 12 feet or more for freeway and arterial project types and 11 feet or more for intersections, lane width has only a relatively minor effect on the modeled concentrations based on the sensitivity analysis conducted for the prior programmatic agreement¹⁸ and much less than the safety margin afforded by the conservative or worst-case modeling approach undertaken for these screening procedures. Therefore, given the limited sensitivity and the substantial safety margin, lane widths of 11 feet or more are covered for all project types addressed in these screening procedures.

5.1 Freeway and Arterials

Based on the MOVES2014a and CAL3QHC (version 04244) inputs and the national-level (not Virginia-specific) assumptions described above, the maximum 1-hour CO concentrations for urban and rural arterials and freeways were calculated for varying lane, urban or rural setting, and grade combinations. **Table A-1**, which presents 1-hour concentrations, shows the lane and grade combinations for arterials and freeways in urban and rural locations that do not produce emissions sufficient to result in an exceedance of either the 1 or 8-hour CO standards¹⁹. In all cases, the 8-hour CO standard is the limiting case.

5.2 Intersections

Table A-2 shows the maximum 1-hour CO concentrations based on national-level (not Virginia-specific) conservative and worst-case modeling for six approach lane (2 left turn lanes and 4 through lanes) urban and rural intersections that, with the applied, conservative 8-hour national CO background level of 2.4 ppm and EPA default persistence factor of 0.7, do not produce

¹⁸ As reported in Section 7.2.1 of the TSD from NCHRP 25-25/Task 78 (previously referenced), sensitivity testing showed that only slightly higher CO concentrations resulted from lane widths of 11 feet rather than the typical value of 12 feet. *Excerpt: "To assess the impact of lane width on modeled concentration, 10, 12, 14, 16, 18, 20 and 22-lane urban freeways were modeled using an 11 foot lane width. The 22-lane freeway showed the maximum response to this change in lane width, with a relative increase in concentration of 2%. ... Based on this minimal impact on CO levels between the 11 and 12 foot lanes, both widths are covered by the draft PA and TSD templates for freeway and arterial project types."*

¹⁹ The corresponding 8-hour concentration is based on an 8-hour CO background concentration of 2.4 ppm and a persistence factor of 0.7.

modeled CO concentrations that could result in exceedances of the 8-hour CO NAAQS. That is, intersection projects of this size or smaller, and with grade and skew angle less than or equal to the prescribed, would not result in an exceedance of the CO NAAQS.

Intersections with posted speeds under 15 mph and/or with five or more legs are not covered by the screening procedures, although they may be added in a future update.

5.3 Interchanges

Tables A-3 (a), (b), and (c) show the one-hour CO concentrations for interchange scenarios that, with national-level (not Virginia-specific) conservative and worst-case modeling assumptions including the assumed 8-hour CO background level and persistence factor, do not produce modeled concentrations that would cause or contribute to an exceedance of the 8-hour CO ambient air standard (NAAQS). Although intersections were considered on either side of the freeway, Tables A-3(a) to (c) only report the higher of these. The same speed limitations for freeways and arterials from above also apply here.

As the modeled concentrations may be considered conservatively high for interchanges *without* adjacent intersections, given that intersection contributions to near-road concentrations are included along with the interchange contributions in the modeling for this and TSD, the tables may serve as a conservative means to screen such projects. Similarly, and given the substantial safety margin afforded by the use of multiple worst-case modeling assumptions as summarized below, the tables may also serve as a conservative means to screen *freeway-freeway* (free-flow) interchanges.

The intersection geometry is the same as in the intersection case, with six lanes on each approach (4 approach, 2 left turn) and 4 departure lanes, with grades from 0 to 7 percent. This is a conservative approach for this type of project because freeway interchanges generally have a one- or two-lane ramp approaching or departing from the intersection. The freeway was modeled at a 0% grade. Both rural and urban locations were modeled.

The table columns represent varying distances from the edge of the nearest freeway travel lane to the edge of the nearest parallel roadway. For the 90-degree skew case, this is also the length of the interchange ramp. The table rows represent the setting (urban or rural), varying numbers of travel lanes on the freeway, and the skew angle of the interchange ramp.

Thus, a rural interchange with a 2-lane freeway and an adjacent intersection that is located not less than 20 feet from the nearest edge of the freeway lanes, connected with a 45-degree angled road segment, and has an intersection grade of 3 percent or less has a one-hour concentration listed of 8.1 ppm. Since a concentration is listed for this project configuration, it does not exceed the 8-hour CO standard.

6. Conclusions

This TSD provides background and technical information in support of an updated PA between the VDOT and FHWA Virginia Division for project level CO analysis. The updated PA eliminates the need for project-specific analyses and/or screening assessments of potential CO impacts for all projects undergoing environmental studies for purposes of NEPA. The updated PA is based on the weight-of-evidence presented in this TSD, which includes:

- Continued implementation of effective emission control technology, increasingly more stringent motor vehicle emission and fuel quality standards implemented over the past few decades by the Environmental Protection Agency (EPA) that have had the combined effect of substantially reducing CO emission rates nationwide, resulting in long-term downward trends in emissions and near-road ambient concentrations of CO despite increasing vehicle-miles-travelled (VMT);
- Extensive experience in project-specific modeling for CO for a wide variety of project types, configurations and operating conditions in which compliance with the national ambient air quality standards (NAAQS) established by EPA for CO is readily demonstrated given the substantially reduced CO emission rates, and despite the use of multiple worst-case assumptions for emission and dispersion modeling that have a compounding effect such that emissions and near-road ambient concentrations are substantially over-estimated;
- Extensive experience in programmatic agreements for project-level agreements for CO that establish ever-increasing thresholds for such analyses given the substantially reduced emission rates; and
- The results of worst-case modeling conducted for this PA for typical highway project types, configurations and operating conditions in which compliance with the NAAQS is again readily demonstrated, and by a substantial safety margin.

In sum, the weight-of-evidence supports a conclusion that the time and cost for project-specific modeling or assessments for CO are not warranted given the typical foregone conclusion that the NAAQS for CO will be met and usually by a substantial margin. Therefore, as a reasonable and prudent approach to streamlining environmental clearances consistent with federal and state streamlining initiatives, NEPA documentation will reference the PA for all projects going forward in lieu of project-specific CO modeling or assessments.

Notwithstanding the elimination of modeling analyses and screening assessments under the PA, VDOT retains the option to conduct at its discretion (and FHWA may request) project-specific CO modeling analyses and/or screening assessments for purposes of transparency, i.e., to show that there would be no significant CO impacts and that the project would reasonably be expected to meet the NAAQS.

For projects for which discretionary screening assessments are conducted, the screening criteria are based on conservative and worst-case modeling assumptions that establish the types of projects and project conditions that would meet the NAAQS for CO by a substantial safety margin. These project types and conditions would require only a general qualitative statement that references this agreement. The project types covered by worst-case modeling are freeways,

arterials, interchanges and intersections.

For context, FHWA guidance²⁰ for air quality analyses states that: *“A microscale CO analysis is unnecessary where such impacts (project CO contribution plus background) can be judged to be well below the 1- and 8-hour National Ambient Air Quality Standards (or other applicable State or local standards). This judgment may be based on (1) previous analyses for similar projects; (2) previous general analyses for various classes of projects; or (3) simplified graphical or “look-up” table evaluations. In these cases, a brief statement stating the basis for the judgment is sufficient.”*

In keeping with FHWA guidance, a weight-of-evidence assessment as provided above that references prior modeling assessments and programmatic agreements for which worst-case modeling was conducted for typical project types and configurations suffices for determining that CO analyses or assessments should not be routinely required in the future as it may reasonably be expected that the CO NAAQS would be met in all cases. Conducting project-specific modeling or even worst-case modeling for programmatic agreements going forward has diminishing utility and is not cost-effective, and therefore runs counter to state and federal streamlining efforts including the FHWA *Every Day Counts* initiative. Further, allowing for discretionary modeling analyses or screening assessments provides reasonable assurance that any “exceptional” cases would still be addressed appropriately. A programmatic agreement or policy to eliminate all CO analyses and assessments going forward, with appropriate allowance for discretionary analyses or assessments, is therefore reasonable, consistent with FHWA guidance, and supports implementation of state and federal streamlining initiatives.

²⁰ FHWA, “Guidance for Preparing and Processing Environmental and Section 4(F) Documents”, Technical Advisory T6640.8A, October 30, 1987, Section 8(b). See: https://www.environment.fhwa.dot.gov/legislation/nepa/guidance_preparing_env_documents.aspx

7. Project Documentation and Other Terms of Agreement

For the project's air quality report, VDOT (or local public agency for locally administered projects (LAPs)) will include a statement that the project under review meets the project types and conditions covered in the PA and will conclude with one of the following statements (or similar). For the NEPA document, an abbreviated version may be applied.

For projects for which this PA is to be referenced in lieu of project-specific assessments²¹:

"As the project is located in a region that is attainment of the CO NAAQS, EPA project-level ("hot-spot") transportation conformity requirements do not apply. As only NEPA applies, a project-specific analysis and/or assessment for carbon monoxide (CO) is not needed under the terms of the programmatic agreement between FHWA and VDOT for project-level air quality analyses for CO. As documented in that agreement, which is based on the analysis and information presented in the template programmatic agreement and Technical Support Document (TSD) developed in the National Cooperative Highway Research Program (NCHRP) 25-25 Task 104 study (2020), the weight-of-evidence shows that it may reasonably be concluded that the national ambient quality standard (NAAQS) for CO will be met for all projects given:

- Continued implementation of effective emission control technology, increasingly more stringent motor vehicle emission and fuel quality standards implemented over the past few decades by the Environmental Protection Agency (EPA) that have had the combined effect of substantially reducing CO emission rates nationwide, resulting in long-term downward trends in emissions and near-road ambient concentrations of CO despite increasing vehicle-miles-travelled (VMT);*
- Extensive experience in project-specific modeling for CO for a wide variety of project types, configurations and operating conditions in which compliance with the national ambient air quality standards (NAAQS) established by EPA for CO is readily demonstrated given the substantially reduced CO emission rates, and despite the use of multiple worst-case assumptions for emission and dispersion modeling that have a compounding effect such that emissions and near-road ambient concentrations are substantially over-estimated;*
- Extensive experience in programmatic agreements for project-level agreements for CO that establish ever-increasing thresholds for such analyses given the substantially reduced emission rates, and*
- The results of worst-case modeling conducted for this PA for typical highway project types, configurations and operating conditions in which compliance with the NAAQS is again readily demonstrated, and by a substantial safety margin."*

²¹ The text for the NEPA document may be limited to just the first paragraph, concluding with "...will be met." In other words, the summary of the weight of evidence given in the subsequent four bullet points would be excluded for the NEPA document, but would be included in a separate air quality report if one is prepared for the project.

For discretionary project-specific assessments using this PA:

“The project is consistent with (and does not exceed) the project types and conditions listed in the agreement between FHWA and VDOT for streamlining the project-level air quality analysis process for carbon monoxide. Modeling using “worst-case” parameters has been conducted for these project types and conditions. It has been determined that projects such as this one may reasonably be expected to not significantly impact air quality and cause or contribute to a new violation of the National Ambient Air Quality Standards for carbon monoxide.”

or

“An air quality analysis is not necessary as this project will not increase traffic volumes, reduce source-receptor distances, or change other existing conditions to such a degree as to jeopardize attainment of the National Ambient Air Quality Standard for carbon monoxide.”

It is recognized that, from time to time, new emission and/or dispersion models may be developed and approved and/or that underlying ambient or technical conditions may change. As necessary, this TSD can be updated to reflect any substantive changes.

Appendix A – Worst-Case Modeling Results

Table A-1: One-Hour CO Concentrations (ppm) for Freeways and Arterials^a in Urban and Rural Locations of Varying Lane and Grade Configuration (Not Including Background Concentrations)

Facility Type	Location	Number of Lanes	Grade (Percent)							
			0	1	2	3	4	5	6	7
Arterials	Rural	2	3	3	3.3	3.4	3.7	4	4.4	4.8
Arterials	Rural	4	6.5	6.9	7.3	7.7	8.4	9	9.9	10.5
Arterials	Rural	6	8.7	9.3	9.9	10.5	11.4	12.3	13.4	14.6
Arterials	Rural	8	10.7	11.3	12.1	12.8	14	15.1	16.5	17.9
Arterials	Rural	10	12.3	13.1	14.1	15	16.2	17.6	19.2	20.8
Arterials	Rural	12	13.6	14.6	15.8	16.7	18.2	19.7	21.6	23.4
Arterials	Urban	2	1.8	1.9	2.1	2.1	2.3	2.4	2.7	2.8
Arterials	Urban	4	4	4.3	4.6	4.9	5.2	5.7	6.2	6.7
Arterials	Urban	6	5.5	5.7	6.2	6.7	7.2	7.7	8.5	9.2
Arterials	Urban	8	6.6	7.1	7.6	8.1	8.8	9.6	10.5	11.4
Arterials	Urban	10	7.5	8.2	8.8	9.4	10.3	11.1	12.3	13.3
Arterials	Urban	12	8.4	9.1	9.8	10.5	11.5	12.5	13.8	15
Freeways	Rural	2	1.4	1.7	1.9	2.1	2.4	2.8	3	3.2
Freeways	Rural	4	3.7	4.2	5	5.7	6.6	7.5	8.2	8.6
Freeways	Rural	6	5.3	6.1	7.1	8.2	9.5	10.8	11.8	12.4
Freeways	Rural	8	6.6	7.6	9.2	10.6	12.2	13.9	15.2	16.1
Freeways	Rural	10	7.8	9.1	10.9	12.6	14.7	16.7	18.3	19.3
Freeways	Rural	12	8.9	10.4	12.5	14.6	16.9	19.3	21.1	22.4
Freeways	Rural	14	9.8	11.5	13.9	16.3	18.9	21.6	23.7	25
Freeways	Rural	16	10.7	12.6	15.2	17.8	20.7	23.6	25.9	27.4
Freeways	Rural	18	11.3	13.6	16.4	19.1	22.3	25.6	28	29.6
Freeways	Rural	20	12	14.3	17.5	20.4	23.7	27.2	29.8	31.6
Freeways	Rural	22	12.5	15.1	18.4	21.5	25.1	28.7	31.6	33.5
Freeways	Urban	2	0.9	1	1.1	1.3	1.5	1.7	1.9	1.9
Freeways	Urban	4	2.3	2.6	3.1	3.6	4.1	4.7	5.2	5.5
Freeways	Urban	6	3.2	3.7	4.5	5.2	6	6.9	7.6	8
Freeways	Urban	8	4	4.8	5.8	6.7	7.8	8.9	9.7	10.4
Freeways	Urban	10	4.8	5.7	6.8	8	9.3	10.7	11.8	12.4
Freeways	Urban	12	5.4	6.5	7.8	9.2	10.7	12.3	13.5	14.3
Freeways	Urban	14	5.9	7.2	8.8	10.3	11.9	13.8	15.1	16
Freeways	Urban	16	6.4	7.8	9.5	11.2	13.1	15	16.5	17.5
Freeways	Urban	18	6.9	8.4	10.3	12.1	14.1	16.2	17.8	18.9
Freeways	Urban	20	7.2	8.9	10.9	12.9	15	17.2	19	20.1
Freeways	Urban	22	7.5	9.3	11.5	13.5	15.8	18.2	20	21.2

Notes: Red strikethrough values indicated exceedances of the standard, based on national-level (not Virginia-specific) conservative and worst-case modeling assumptions. To apply the table above for a project located in Virginia, the value in the table (black text or red strikethrough) with the setting and configuration corresponding to the project must be adjusted using the appropriate Virginia-specific background concentration and persistence factor.

^a These findings apply to scenarios with average speed ranging from 15 to 56 mph for arterials and 19 to 75 mph for freeways, for which posted speeds in this range may be applied as a reasonable proxy.

Table A-2: One-Hour CO Concentrations (Not Including Background Concentrations) for Rural and Urban Intersections^b at Varying Skew Angles and Intersection Grades for a Six Approach Lane Intersection

Location	Skew Angle	Grade (Percent)							
		0	1	2	3	4	5	6	7
Rural	15	8.6	9.1	9.8	10.2	11.1	11.9	13	13.9
Rural	30	6.3	6.7	7.1	7.5	8.2	8.8	9.4	10.1
Rural	45	6.2	6.4	6.9	7.2	7.8	8.4	9	9.9
Rural	60	5.6	5.9	6.2	6.5	7	7.5	8	8.7
Rural	90	5.4	5.6	6	6.3	6.8	7.3	7.8	8.4
Urban	15	4.7	4.9	5.3	5.6	6.1	6.7	7.1	7.7
Urban	30	4.5	4.8	5	5.5	6.1	6.4	6.7	7.2
Urban	45	4.1	4.4	4.6	4.8	5.2	5.7	6.2	6.5
Urban	60	3.8	4.1	4.3	4.5	5	5.3	5.9	6.3
Urban	90	3.6	3.9	4.1	4.3	4.5	5	5.4	5.9

Notes: Red strikethrough values indicated exceedances of the standard, based on national-level (not Virginia-specific) conservative and worst-case modeling assumptions. To apply the table above for a project located in Virginia, the value in the table (black text or red strikethrough) with the setting and configuration corresponding to the project must be adjusted using the appropriate Virginia-specific background concentration and persistence factor.

^b These findings apply to scenarios with average speed ranging from 15 to 45 mph for intersections, for which posted speeds in this range may be applied as a reasonable proxy

Table A-3(a): One-Hour CO Concentrations at Varying Intersection-Freeway Distances, Intersection Grade, and Lane Configurations for 45° Skew Angle (Not Including Background Concentrations)^c

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)											
			20	30	60	80	100	125	150	175	300	500	1000	
Rural	2	0%	6.9	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.2
Rural	2	1%	7.3	6.7	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.5
Rural	2	2%	7.7	7.3	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
Rural	2	3%	8.1	7.6	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4	7.4
Rural	2	4%	8.5	8.1	8	8	8	8	8	8	8	8	8	7.9
Rural	2	5%	8.9	8.8	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Rural	2	6%	9.7	9.4	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2
Rural	2	7%	10.3	10.3	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
Rural	4	0%	9.4	7.9	7.1	7	6.9	6.8	6.8	6.8	6.6	6.6	6.6	6.4
Rural	4	1%	9.8	8.3	7.3	7.2	7.1	7	7	7	6.9	6.8	6.7	6.7
Rural	4	2%	10.2	8.7	7.7	7.7	7.7	7.6	7.5	7.5	7.5	7.3	7.3	7.3
Rural	4	3%	10.6	9.1	8	8	8	7.9	7.8	7.8	7.8	7.6	7.6	7.6
Rural	4	4%	11	9.5	8.5	8.5	8.5	8.4	8.4	8.4	8.3	8.2	8.1	8.1
Rural	4	5%	11.4	9.9	9.2	9.2	9.2	9.1	9	9	9	8.8	8.8	8.8
Rural	4	6%	12.2	10.7	9.8	9.8	9.8	9.7	9.6	9.6	9.6	9.4	9.4	9.4
Rural	4	7%	12.7	11.2	10.7	10.7	10.7	10.6	10.5	10.5	10.5	10.3	10.3	10.3
Rural	6	0%	10.5	8.7	7.7	7.6	7.5	7.3	7.2	7.2	6.9	6.8	6.6	6.6
Rural	6	1%	10.9	9.1	7.9	7.8	7.7	7.5	7.4	7.4	7.1	7	6.8	6.8
Rural	6	2%	11.3	9.5	8.3	8.2	8.1	7.9	7.9	7.9	7.7	7.5	7.3	7.3
Rural	6	3%	11.7	9.9	8.6	8.5	8.4	8.2	8.2	8.2	8	7.8	7.6	7.6
Rural	6	4%	12.1	10.3	9.1	9	8.9	8.8	8.8	8.8	8.5	8.4	8.2	8.2
Rural	6	5%	12.5	10.7	9.7	9.5	9.5	9.4	9.4	9.4	9.2	9	8.8	8.8
Rural	6	6%	13.3	11.5	10.3	10.1	10.1	10	10	10	9.8	9.6	9.4	9.4
Rural	6	7%	13.8	12	11.2	11	11	10.9	10.9	10.9	10.7	10.5	10.3	10.3
Rural	8	0%	11.4	9.4	8.3	8.1	8	7.8	7.6	7.4	7.3	7	6.8	6.8

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)										
			20	30	60	80	100	125	150	175	300	500	1000
Rural	8	1%	11.8	9.8	8.5	8.3	8.2	8	7.8	7.6	7.5	7.2	7
Rural	8	2%	12.2	10.2	8.9	8.7	8.6	8.4	8.2	8.1	8	7.8	7.5
Rural	8	3%	12.6	10.6	9.2	9	8.9	8.7	8.5	8.4	8.3	8.1	7.8
Rural	8	4%	13	11	9.7	9.5	9.4	9.2	9	9	8.9	8.6	8.4
Rural	8	5%	13.4	11.4	10.2	10	9.9	9.7	9.7	9.6	9.5	9.3	9
Rural	8	6%	14.2	12.2	10.8	10.6	10.5	10.3	10.3	10.2	10.1	9.9	9.6
Rural	8	7%	14.7	12.7	11.6	11.5	11.4	11.2	11.2	11.1	11	10.8	10.5
Rural	10	0%	12	9.9	8.8	8.6	8.4	8.1	7.9	7.7	7.4	7.2	7
Rural	10	1%	12.4	10.3	9	8.8	8.6	8.3	8.1	7.9	7.7	7.4	7.2
Rural	10	2%	12.8	10.7	9.4	9.2	9	8.7	8.6	8.4	8.3	7.9	7.7
Rural	10	3%	13.2	11.1	9.7	9.5	9.3	9	8.9	8.7	8.6	8.2	8
Rural	10	4%	13.6	11.5	10.2	10	9.8	9.5	9.4	9.2	9.1	8.8	8.6
Rural	10	5%	14	11.9	10.7	10.5	10.3	10.2	10.1	9.9	9.8	9.4	9.2
Rural	10	6%	14.8	12.7	11.3	11.1	10.9	10.8	10.7	10.5	10.4	10	9.8
Rural	10	7%	15.3	13.2	12	11.8	11.8	11.7	11.6	11.4	11.3	10.9	10.7
Rural	12	0%	12.6	11	9.3	9.1	8.8	8.5	8.2	8	7.6	7.5	7.1
Rural	12	1%	13	11.1	9.5	9.3	9	8.7	8.4	8.3	7.9	7.7	7.3
Rural	12	2%	13.4	11.1	9.9	9.7	9.4	9.1	8.9	8.9	8.5	8.2	7.9
Rural	12	3%	13.8	11.4	10.2	10	9.7	9.4	9.2	9.2	8.8	8.5	8.2
Rural	12	4%	14.2	11.8	10.7	10.5	10.2	9.9	9.7	9.7	9.3	9.1	8.7
Rural	12	5%	14.6	12.2	11.2	11	10.7	10.5	10.4	10.4	10	9.7	9.4
Rural	12	6%	15.4	13	11.8	11.6	11.3	11.1	11	11	10.6	10.3	10
Rural	12	7%	15.9	13.5	12.5	12.3	12.2	12	11.9	11.9	11.5	11.2	10.9
Urban	2	0%	4.6	4.4	4.3	4.3	4.3	4.3	4.3	4.3	4.2	4.1	4.1
Urban	2	1%	4.8	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.4	4.4
Urban	2	2%	5.1	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.6	4.6
Urban	2	3%	5.3	5.1	5	5	5	5	5	5	4.9	4.8	4.8

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)											
			20	30	60	80	100	125	150	175	300	500	1000	
Urban	2	4%	5.7	5.5	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.3	5.2	5.2
Urban	2	5%	6.2	6	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.8	5.7	5.7
Urban	2	6%	6.7	6.5	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.3	6.2	6.2
Urban	2	7%	7	6.8	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.5	6.5
Urban	4	0%	5.9	5.2	4.7	4.7	4.6	4.6	4.5	4.5	4.5	4.4	4.3	4.2
Urban	4	1%	6.2	5.5	5	5	5	5	4.9	4.8	4.8	4.8	4.6	4.6
Urban	4	2%	6.5	5.8	5.2	5.2	5.2	5.2	5.2	5.1	5	5	4.8	4.8
Urban	4	3%	6.7	6	5.4	5.4	5.3	5.3	5.2	5.2	5.1	5	4.9	4.9
Urban	4	4%	6.9	6.2	5.8	5.8	5.7	5.7	5.6	5.6	5.6	5.5	5.4	5.3
Urban	4	5%	7.3	6.6	6.3	6.3	6.2	6.2	6.1	6.1	6	6	5.9	5.8
Urban	4	6%	7.8	7.1	6.8	6.8	6.7	6.7	6.6	6.6	6.6	6.5	6.4	6.3
Urban	4	7%	8.2	7.5	7.1	7.1	7.1	7.1	7	6.9	6.9	6.9	6.7	6.7
Urban	6	0%	6.8	5.9	5	5	4.9	4.8	4.8	4.7	4.6	4.6	4.4	4.2
Urban	6	1%	7.1	6.2	5.3	5.3	5.2	5.2	5.2	5.1	5	5	4.8	4.6
Urban	6	2%	7.4	6.5	5.5	5.5	5.4	5.4	5.4	5.4	5.3	5.2	5	4.8
Urban	6	3%	7.6	6.7	5.7	5.7	5.6	5.5	5.5	5.5	5.5	5.3	5.1	4.9
Urban	6	4%	7.8	6.9	6.1	6.1	6	5.9	5.9	5.8	5.7	5.7	5.5	5.3
Urban	6	5%	8.2	7.3	6.6	6.6	6.5	6.4	6.4	6.4	6.3	6.2	6	5.8
Urban	6	6%	8.7	7.8	7.1	7.1	7	6.9	6.9	6.8	6.7	6.7	6.5	6.3
Urban	6	7%	9.1	8.2	7.4	7.4	7.3	7.3	7.3	7.2	7.1	7.1	6.9	6.7
Urban	8	0%	7.4	6.4	5.3	5.3	5.2	5.1	5	5	4.8	4.8	4.6	4.4
Urban	8	1%	7.7	6.7	5.7	5.7	5.5	5.5	5.4	5.4	5.4	5.2	5	4.8
Urban	8	2%	8	7	5.9	5.9	5.7	5.7	5.6	5.6	5.6	5.4	5.2	5
Urban	8	3%	8.2	7.2	6	6	5.9	5.8	5.8	5.7	5.7	5.5	5.3	5.1
Urban	8	4%	8.4	7.4	6.4	6.4	6.3	6.2	6.1	6.1	6.1	5.9	5.7	5.5
Urban	8	5%	8.8	7.8	6.9	6.9	6.8	6.7	6.6	6.6	6.6	6.4	6.2	6
Urban	8	6%	9.3	8.3	7.4	7.4	7.3	7.2	7.1	7.1	7.1	6.9	6.7	6.5

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)										
			20	30	60	80	100	125	150	175	300	500	1000
Urban	8	7%	9.7	8.7	7.8	7.8	7.6	7.6	7.5	7.5	7.3	7.1	6.9
Urban	10	0%	7.9	7.2	5.6	5.5	5.5	5.3	5.3	5.2	5	4.7	4.4
Urban	10	1%	8.2	7.4	6	5.9	5.9	5.7	5.7	5.6	5.4	5.1	4.8
Urban	10	2%	8.5	7.5	6.2	6.1	6.1	5.9	5.9	5.8	5.6	5.3	5
Urban	10	3%	8.7	7.7	6.4	6.3	6.2	6.1	6	6	5.7	5.4	5.1
Urban	10	4%	8.9	7.9	6.7	6.6	6.6	6.4	6.4	6.3	6.1	5.8	5.5
Urban	10	5%	9.3	8.2	7.2	7.1	7.1	6.9	6.9	6.8	6.6	6.3	6
Urban	10	6%	9.8	8.7	7.7	7.6	7.6	7.4	7.4	7.3	7.1	6.8	6.5
Urban	10	7%	10.2	9.1	8.1	8	8	7.8	7.8	7.7	7.5	7.2	6.9
Urban	12	0%	8.6	7.8	6	5.8	5.7	5.6	5.5	5.5	5.1	4.9	4.4
Urban	12	1%	8.8	8	6.4	6.2	6.1	6	5.9	5.9	5.5	5.3	4.8
Urban	12	2%	9	8.1	6.6	6.4	6.3	6.2	6.1	6.1	5.7	5.5	5
Urban	12	3%	9.2	8.3	6.7	6.6	6.5	6.4	6.3	6.2	5.8	5.6	5.1
Urban	12	4%	9.4	8.5	7.1	6.9	6.8	6.7	6.6	6.6	6.2	6	5.5
Urban	12	5%	9.8	8.8	7.6	7.4	7.3	7.2	7.1	7.1	6.7	6.5	6
Urban	12	6%	10.3	9.2	8.1	7.9	7.8	7.7	7.6	7.6	7.2	7	6.5
Urban	12	7%	10.7	9.6	8.5	8.3	8.2	8.1	8	8	7.6	7.4	6.9

Notes: Red strikethrough values indicated exceedances of the standard, based on national-level (not Virginia-specific) conservative and worst-case modeling assumptions. To apply the table above for a project located in Virginia, the value in the table (black text or red strikethrough) with the setting and configuration corresponding to the project must be adjusted using the appropriate Virginia-specific background concentration and persistence factor.

c. These findings apply to scenarios with the intersection average speed ranging from 15 to 45 mph and the freeway average speed ranging from 19 to 75 mph, for which posted speeds in these ranges may be applied as reasonable proxies

Table A-3(b): One-Hour CO Concentrations at Varying Intersection-Freeway Distances, Intersection Grade, and Lane Configurations for 60° Skew Angle (Not Including Background Concentrations)^d

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)											
			20	30	60	80	100	125	150	175	300	500	1000	
Rural	2	0%	6.7	6.2	6	6	6	6	6	6	5.9	5.8	5.6	5.6
Rural	2	1%	7	6.5	6.3	6.3	6.3	6.3	6.3	6.3	6.2	6.1	5.9	5.9
Rural	2	2%	7.4	6.8	6.6	6.6	6.6	6.6	6.6	6.6	6.5	6.4	6.2	6.2
Rural	2	3%	7.8	7.1	6.9	6.9	6.9	6.9	6.9	6.9	6.8	6.7	6.5	6.5
Rural	2	4%	8.2	7.6	7.4	7.4	7.4	7.4	7.4	7.4	7.3	7.2	7	7
Rural	2	5%	8.8	8.1	7.9	7.9	7.9	7.9	7.9	7.9	7.8	7.7	7.5	7.5
Rural	2	6%	9.4	8.7	8.4	8.4	8.4	8.4	8.4	8.4	8.3	8.2	8	8
Rural	2	7%	9.9	9.3	9.1	9.1	9.1	9.1	9.1	9.1	9	8.9	8.7	8.7
Rural	4	0%	9.1	7.6	6.9	6.8	6.7	6.6	6.5	6.4	6.4	6	5.8	5.6
Rural	4	1%	9.4	7.9	7.2	7.1	7	6.9	6.8	6.7	6.7	6.3	6.1	5.9
Rural	4	2%	9.8	8.3	7.5	7.4	7.3	7.2	7.1	7	7	6.6	6.4	6.2
Rural	4	3%	10.2	8.7	7.8	7.7	7.6	7.5	7.4	7.3	7.3	6.9	6.7	6.5
Rural	4	4%	10.6	9.1	8.3	8.2	8.1	8	7.9	7.8	7.8	7.4	7.2	7
Rural	4	5%	11.2	9.7	8.8	8.7	8.6	8.5	8.4	8.3	8.3	7.9	7.7	7.5
Rural	4	6%	11.8	10.3	9.3	9.2	9.1	9	8.9	8.8	8.8	8.4	8.2	8
Rural	4	7%	12.3	10.8	10	9.9	9.8	9.7	9.6	9.5	9.5	9.1	8.9	8.7
Rural	6	0%	10.3	8.5	7.5	7.4	7.3	7.3	7.1	6.9	6.7	6.3	6	5.8
Rural	6	1%	10.6	8.8	7.8	7.7	7.6	7.6	7.4	7.2	7	6.6	6.3	6.1
Rural	6	2%	11	9.2	8.1	8	7.9	7.9	7.7	7.5	7.3	6.9	6.6	6.4
Rural	6	3%	11.4	9.6	8.4	8.3	8.2	8	7.8	7.6	7.6	7.2	6.9	6.7
Rural	6	4%	11.8	10	8.9	8.8	8.7	8.5	8.3	8.1	8.1	7.7	7.4	7.2
Rural	6	5%	12.4	10.6	9.4	9.3	9.2	9	8.8	8.6	8.6	8.2	7.9	7.7
Rural	6	6%	13	11.2	9.9	9.8	9.7	9.5	9.3	9.1	9.1	8.7	8.4	8.2
Rural	6	7%	13.5	11.7	10.6	10.5	10.4	10.2	10	9.8	9.8	9.4	9.1	8.9
Rural	8	0%	11.1	9.2	8.1	7.9	7.8	7.6	7.4	7.2	7.2	6.5	6.2	6

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)										
			20	30	60	80	100	125	150	175	300	500	1000
Rural	8	1%	11.4	9.5	8.4	8.2	8.1	7.9	7.7	7.5	6.8	6.5	6.3
Rural	8	2%	11.8	9.9	8.7	8.5	8.4	8.2	8	7.8	7.1	6.8	6.6
Rural	8	3%	12.2	10.3	9	8.8	8.7	8.5	8.3	8.1	7.4	7.1	6.9
Rural	8	4%	12.6	10.7	9.5	9.3	9.2	9	8.8	8.6	7.9	7.6	7.4
Rural	8	5%	13.2	11.3	10	9.8	9.7	9.5	9.3	9.1	8.4	8.1	7.9
Rural	8	6%	13.8	11.9	10.5	10.3	10.2	10	9.8	9.6	8.9	8.6	8.4
Rural	8	7%	14.3	12.4	11.2	11	10.9	10.7	10.5	10.3	9.6	9.3	9.1
Rural	10	0%	11.8	9.7	8.6	8.4	8.1	7.9	7.7	7.5	6.6	6.4	6.2
Rural	10	1%	12.1	10	8.9	8.7	8.4	8.2	8	7.8	6.9	6.7	6.5
Rural	10	2%	12.5	10.4	9.2	9	8.7	8.5	8.3	8.1	7.2	7	6.8
Rural	10	3%	12.9	10.8	9.5	9.3	9	8.8	8.6	8.4	7.5	7.3	7.1
Rural	10	4%	13.3	11.2	10	9.8	9.5	9.3	9.1	8.9	8	7.8	7.6
Rural	10	5%	13.9	11.8	10.5	10.3	10	9.8	9.6	9.4	8.5	8.3	8.1
Rural	10	6%	14.5	12.4	11	10.8	10.5	10.3	10.1	9.9	9	8.8	8.6
Rural	10	7%	15	12.9	11.7	11.5	11.2	11	10.8	10.6	9.7	9.5	9.3
Rural	12	0%	12.3	10.7	9.1	8.9	8.6	8.2	8	7.8	6.8	6.7	6.4
Rural	12	1%	12.6	10.8	9.4	9.2	8.9	8.5	8.3	8.1	7.1	7	6.7
Rural	12	2%	13	10.9	9.7	9.5	9.2	8.8	8.6	8.4	7.4	7.3	7
Rural	12	3%	13.4	11.1	10	9.8	9.5	9.1	8.9	8.7	7.7	7.6	7.3
Rural	12	4%	13.8	11.5	10.5	10.3	10	9.6	9.4	9.2	8.2	8.1	7.8
Rural	12	5%	14.4	12.1	11	10.8	10.5	10.1	9.9	9.7	8.7	8.6	8.3
Rural	12	6%	15	12.7	11.5	11.3	11	10.6	10.4	10.2	9.2	9.1	8.8
Rural	12	7%	15.5	13.2	12.2	12	11.7	11.3	11.1	10.9	9.9	9.8	9.5
Urban	2	0%	4.4	4.1	4	4	4	4	4	4	3.8	3.8	3.8
Urban	2	1%	4.6	4.4	4.3	4.3	4.3	4.3	4.3	4.3	4.1	4.1	4.1
Urban	2	2%	4.8	4.6	4.5	4.5	4.5	4.5	4.5	4.5	4.3	4.3	4.3
Urban	2	3%	5.1	4.8	4.7	4.7	4.7	4.7	4.7	4.7	4.5	4.5	4.5

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)										
			20	30	60	80	100	125	150	175	300	500	1000
Urban	2	4%	5.5	5.3	5.2	5.2	5.2	5.2	5.2	5.2	5	5	5
Urban	2	5%	5.8	5.6	5.5	5.5	5.5	5.5	5.5	5.5	5.3	5.3	5.3
Urban	2	6%	6.4	6.2	6.1	6.1	6.1	6.1	6.1	6.1	5.9	5.9	5.9
Urban	2	7%	6.8	6.6	6.5	6.5	6.5	6.5	6.5	6.5	6.3	6.3	6.3
Urban	4	0%	5.8	5.1	4.4	4.4	4.3	4.2	4.2	4.2	4	4	3.8
Urban	4	1%	5.9	5.2	4.7	4.7	4.6	4.5	4.5	4.5	4.3	4.3	4.1
Urban	4	2%	6.2	5.5	4.9	4.9	4.8	4.7	4.7	4.7	4.5	4.5	4.3
Urban	4	3%	6.5	5.8	5.1	5.1	5	4.9	4.9	4.9	4.7	4.7	4.5
Urban	4	4%	6.8	6.1	5.6	5.6	5.5	5.4	5.4	5.4	5.2	5.2	5
Urban	4	5%	7.1	6.4	5.9	5.9	5.8	5.7	5.7	5.7	5.5	5.5	5.3
Urban	4	6%	7.6	6.9	6.5	6.5	6.4	6.3	6.3	6.3	6.1	6.1	5.9
Urban	4	7%	7.9	7.2	6.9	6.9	6.8	6.7	6.7	6.7	6.5	6.5	6.3
Urban	6	0%	6.7	5.8	4.8	4.7	4.6	4.5	4.4	4.4	4.2	4	3.8
Urban	6	1%	6.8	5.9	5	5	4.9	4.8	4.7	4.7	4.5	4.3	4.1
Urban	6	2%	7.1	6.2	5.2	5.2	5.1	5	4.9	4.9	4.7	4.5	4.3
Urban	6	3%	7.4	6.5	5.5	5.4	5.3	5.2	5.1	5.1	4.9	4.7	4.5
Urban	6	4%	7.7	6.8	5.9	5.9	5.8	5.7	5.6	5.6	5.4	5.2	5
Urban	6	5%	8	7.1	6.2	6.2	6.1	6	5.9	5.9	5.7	5.5	5.3
Urban	6	6%	8.5	7.6	6.8	6.8	6.7	6.6	6.5	6.5	6.3	6.1	5.9
Urban	6	7%	8.8	7.9	7.2	7.2	7.1	7	6.9	6.9	6.7	6.5	6.3
Urban	8	0%	7.3	6.4	5.1	4.9	4.9	4.7	4.7	4.6	4.4	4.2	4
Urban	8	1%	7.4	6.4	5.3	5.2	5.2	5	5	4.9	4.7	4.5	4.3
Urban	8	2%	7.7	6.7	5.5	5.4	5.4	5.2	5.2	5.1	4.9	4.7	4.5
Urban	8	3%	8	7	5.8	5.6	5.6	5.4	5.4	5.3	5.1	4.9	4.7
Urban	8	4%	8.3	7.3	6.2	6.1	6.1	5.9	5.9	5.7	5.5	5.4	5.2
Urban	8	5%	8.6	7.6	6.5	6.4	6.4	6.2	6.2	6	5.8	5.7	5.5
Urban	8	6%	9.1	8.1	7.1	7	7	6.8	6.8	6.6	6.4	6.3	6.1

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)										
			20	30	60	80	100	125	150	175	300	500	1000
Urban	8	7%	9.4	8.4	7.5	7.4	7.4	7.2	7.2	7	6.8	6.7	6.5
Urban	10	0%	7.9	7.2	5.6	5.2	5.1	5	4.9	4.9	4.5	4.3	4
Urban	10	1%	7.9	7.2	5.6	5.5	5.4	5.3	5.2	5.2	4.8	4.6	4.3
Urban	10	2%	8.2	7.5	5.9	5.7	5.6	5.5	5.4	5.4	5	4.8	4.5
Urban	10	3%	8.5	7.6	6.2	5.9	5.8	5.7	5.6	5.6	5.3	5	4.7
Urban	10	4%	8.8	7.9	6.5	6.4	6.2	6.1	6.1	5.9	5.7	5.4	5.2
Urban	10	5%	9.1	8	6.8	6.7	6.5	6.4	6.4	6.2	6	5.7	5.5
Urban	10	6%	9.6	8.5	7.3	7.3	7.1	7	7	6.8	6.6	6.3	6.1
Urban	10	7%	9.9	8.8	7.7	7.7	7.5	7.4	7.4	7.2	7	6.7	6.5
Urban	12	0%	8.6	7.8	6	5.6	5.4	5.3	5.2	5.1	4.7	4.4	4.2
Urban	12	1%	8.6	7.8	6	5.8	5.7	5.6	5.5	5.4	5	4.7	4.5
Urban	12	2%	8.9	8.1	6.3	6	5.9	5.8	5.7	5.6	5.2	4.9	4.7
Urban	12	3%	9	8.2	6.4	6.2	6.1	6	5.9	5.8	5.4	5.2	4.9
Urban	12	4%	9.3	8.5	6.7	6.6	6.4	6.4	6.2	6.1	5.8	5.6	5.4
Urban	12	5%	9.6	8.6	7	6.9	6.7	6.7	6.5	6.4	6.1	5.9	5.7
Urban	12	6%	10.1	9	7.6	7.5	7.3	7.3	7.1	7	6.7	6.5	6.3
Urban	12	7%	10.4	9.3	8	7.9	7.7	7.7	7.5	7.4	7.1	6.9	6.7

Notes: Red strikethrough values indicated exceedances of the standard, based on national-level (not Virginia-specific) conservative and worst-case modeling assumptions. To apply the table above for a project located in Virginia, the value in the table (black text or red strikethrough) with the setting and configuration corresponding to the project must be adjusted using the appropriate Virginia-specific background concentration and persistence factor.

^d These findings apply to scenarios with the intersection average speed ranging from 15 to 45 mph and the freeway average speed ranging from 19 to 75 mph, for which posted speeds in these ranges may be applied as reasonable proxies

Table A-3(c): One-hour CO Concentrations at Varying Intersection-Freeway Distances, Intersection Grade, and Lane Configurations for 90° Skew Angle (not including background concentrations)^e

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)										
			20	30	60	80	100	125	150	175	300	500	1000
Rural	2	0%	6.7	6	5.8	5.8	5.8	5.8	5.8	5.6	5.6	5.6	5.4
Rural	2	1%	7	6.3	6	6	6	6	6	5.8	5.8	5.7	5.6
Rural	2	2%	7.4	6.7	6.4	6.4	6.4	6.4	6.4	6.2	6.2	6.2	6
Rural	2	3%	7.8	7.1	6.7	6.7	6.7	6.7	6.7	6.5	6.5	6.3	6.3
Rural	2	4%	8.1	7.4	7.2	7.2	7.2	7.2	7.2	7	7	6.8	6.8
Rural	2	5%	8.8	8.1	7.7	7.7	7.7	7.7	7.7	7.5	7.5	7.3	7.3
Rural	2	6%	9.4	8.7	8.2	8.2	8.2	8.2	8.2	8	8	7.8	7.8
Rural	2	7%	9.9	9.2	8.8	8.8	8.8	8.8	8.8	8.6	8.6	8.4	8.4
Rural	4	0%	9	7.6	6.7	6.6	6.5	6.4	6.3	6.2	5.8	5.8	5.6
Rural	4	1%	9.3	7.9	6.9	6.8	6.7	6.6	6.5	6.4	6	5.9	5.7
Rural	4	2%	9.7	8.3	7.3	7.2	7.1	7	6.9	6.8	6.4	6.4	6.2
Rural	4	3%	10.1	8.7	7.6	7.5	7.4	7.3	7.2	7.1	6.7	6.5	6.3
Rural	4	4%	10.4	9	8.1	8	7.9	7.8	7.7	7.6	7.2	6.9	6.8
Rural	4	5%	11.1	9.7	8.6	8.5	8.4	8.3	8.2	8.1	7.7	7.4	7.3
Rural	4	6%	11.7	10.3	9.1	9	8.9	8.8	8.7	8.6	8.2	7.9	7.8
Rural	4	7%	12.2	10.8	9.7	9.6	9.5	9.4	9.3	9.2	8.8	8.5	8.4
Rural	6	0%	10.3	8.5	7.3	7.1	7	6.9	6.7	6.5	6	6	5.8
Rural	6	1%	10.6	8.8	7.5	7.3	7.2	7.1	6.9	6.7	6.2	6.1	5.9
Rural	6	2%	11	9.2	7.9	7.7	7.6	7.5	7.3	7.1	6.6	6.6	6.4
Rural	6	3%	11.4	9.6	8.2	8	7.9	7.8	7.6	7.4	6.9	6.7	6.5
Rural	6	4%	11.7	9.9	8.7	8.5	8.4	8.3	8.1	7.9	7.4	7.1	6.9
Rural	6	5%	12.4	10.6	9.2	9	8.9	8.8	8.6	8.4	7.9	7.5	7.3
Rural	6	6%	13	11.2	9.7	9.5	9.4	9.3	9.1	8.9	8.4	8	7.8
Rural	6	7%	13.5	11.7	10.3	10.1	10	9.9	9.7	9.5	9	8.6	8.4
Rural	8	0%	11.1	9	7.9	7.7	7.5	7.2	7.1	6.9	6.3	6.2	6

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)										
			20	30	60	80	100	125	150	175	300	500	1000
Rural	8	1%	11.4	9.3	8.1	7.9	7.7	7.4	7.3	7.1	6.4	6.3	6.1
Rural	8	2%	11.8	9.7	8.5	8.3	8.1	7.8	7.7	7.5	6.9	6.8	6.6
Rural	8	3%	12.2	10.1	8.8	8.6	8.4	8.1	8	7.8	7.1	6.9	6.7
Rural	8	4%	12.5	10.4	9.3	9.1	8.9	8.6	8.5	8.3	7.6	7.3	7.1
Rural	8	5%	13.2	11.1	9.8	9.6	9.4	9.1	9	8.8	8.1	7.7	7.5
Rural	8	6%	13.8	11.7	10.3	10.1	9.9	9.6	9.5	9.3	8.6	8.2	8
Rural	8	7%	14.3	12.2	10.9	10.7	10.5	10.2	10.1	9.9	9.2	8.8	8.6
Rural	10	0%	11.8	9.5	8.4	8.2	7.9	7.7	7.5	7.2	6.5	6.3	6
Rural	10	1%	12.1	9.8	8.6	8.4	8.1	7.9	7.7	7.4	6.6	6.4	6.1
Rural	10	2%	12.5	10.2	9	8.8	8.5	8.3	8.1	7.8	7.1	6.9	6.6
Rural	10	3%	12.9	10.6	9.3	9.1	8.8	8.6	8.4	8.1	7.3	7	6.7
Rural	10	4%	13.2	10.9	9.8	9.6	9.3	9.1	8.9	8.6	7.8	7.4	7.1
Rural	10	5%	13.9	11.6	10.3	10.1	9.8	9.6	9.4	9.1	8.3	7.8	7.5
Rural	10	6%	14.5	12.2	10.8	10.6	10.3	10.1	9.9	9.6	8.8	8.3	8
Rural	10	7%	15	12.7	11.4	11.2	10.9	10.7	10.5	10.2	9.4	8.9	8.6
Rural	12	0%	12.3	10.6	8.9	8.5	8.3	8	7.8	7.5	6.7	6.5	6.2
Rural	12	1%	12.6	10.7	9.1	8.7	8.5	8.2	8	7.7	6.8	6.6	6.3
Rural	12	2%	13	10.7	9.5	9.1	8.9	8.6	8.4	8.1	7.3	7.1	6.8
Rural	12	3%	13.4	11	9.8	9.4	9.2	8.9	8.7	8.4	7.4	7.2	6.9
Rural	12	4%	13.7	11.3	10.3	9.9	9.7	9.4	9.2	8.9	7.9	7.6	7.3
Rural	12	5%	14.4	12	10.8	10.4	10.2	9.9	9.7	9.4	8.4	8	7.7
Rural	12	6%	15	12.6	11.3	10.9	10.7	10.4	10.2	9.9	8.9	8.5	8.2
Rural	12	7%	15.5	13.1	11.9	11.5	11.3	11	10.8	10.5	9.5	9.1	8.8
Urban	2	0%	4.5	4.2	3.9	3.8	3.8	3.8	3.8	3.8	3.7	3.6	3.6
Urban	2	1%	4.6	4.3	4.1	4.1	4.1	4.1	4.1	4.1	3.9	3.9	3.9
Urban	2	2%	4.9	4.6	4.3	4.3	4.3	4.3	4.3	4.3	4.1	4.1	4.1
Urban	2	3%	5.2	4.9	4.6	4.5	4.5	4.5	4.5	4.5	4.3	4.3	4.3

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)										
			20	30	60	80	100	125	150	175	300	500	1000
Urban	2	4%	5.4	5.1	4.8	4.7	4.7	4.7	4.7	4.7	4.5	4.5	4.5
Urban	2	5%	5.8	5.5	5.2	5.2	5.2	5.2	5.2	5.2	5	5	5
Urban	2	6%	6.3	6	5.7	5.6	5.6	5.6	5.6	5.6	5.4	5.4	5.4
Urban	2	7%	6.7	6.4	6.1	6.1	6.1	6.1	6.1	6.1	5.9	5.9	5.9
Urban	4	0%	5.9	5.2	4.5	4.2	4.2	4	4	4	3.9	3.8	3.8
Urban	4	1%	6	5.3	4.6	4.5	4.4	4.3	4.3	4.3	4.1	4.1	4
Urban	4	2%	6.3	5.6	4.9	4.7	4.6	4.5	4.5	4.5	4.3	4.3	4.1
Urban	4	3%	6.6	5.9	5.2	4.9	4.9	4.7	4.7	4.7	4.5	4.5	4.3
Urban	4	4%	6.8	6.1	5.4	5.1	5.1	4.9	4.9	4.9	4.7	4.7	4.5
Urban	4	5%	7.2	6.5	5.8	5.6	5.5	5.4	5.4	5.4	5.2	5.2	5
Urban	4	6%	7.7	7	6.3	6	6	5.8	5.8	5.8	5.6	5.6	5.4
Urban	4	7%	8.1	7.4	6.7	6.5	6.4	6.3	6.3	6.3	6.1	6.1	5.9
Urban	6	0%	6.8	5.9	4.9	4.6	4.4	4.3	4.2	4.2	4	4	3.8
Urban	6	1%	6.9	6	5	4.8	4.7	4.6	4.5	4.5	4.3	4.2	4
Urban	6	2%	7.2	6.3	5.3	5	4.9	4.8	4.7	4.7	4.5	4.3	4.1
Urban	6	3%	7.5	6.6	5.6	5.3	5.1	5	4.9	4.9	4.7	4.5	4.3
Urban	6	4%	7.7	6.8	5.8	5.5	5.3	5.2	5.1	5.1	4.9	4.7	4.5
Urban	6	5%	8.1	7.2	6.2	5.9	5.8	5.7	5.6	5.6	5.4	5.2	5
Urban	6	6%	8.6	7.7	6.7	6.4	6.2	6.1	6	6	5.8	5.6	5.4
Urban	6	7%	9	8.1	7.1	6.8	6.7	6.6	6.5	6.5	6.3	6.1	5.9
Urban	8	0%	7.4	6.4	5.2	4.9	4.7	4.5	4.5	4.4	4.2	4.1	4
Urban	8	1%	7.5	6.5	5.3	5	5	4.8	4.8	4.6	4.4	4.3	4.2
Urban	8	2%	7.8	6.8	5.6	5.3	5.2	5	5	4.8	4.6	4.4	4.3
Urban	8	3%	8.1	7.1	5.9	5.6	5.4	5.2	5.2	5	4.8	4.6	4.5
Urban	8	4%	8.3	7.3	6.1	5.8	5.6	5.4	5.4	5.2	5	4.8	4.7
Urban	8	5%	8.7	7.7	6.5	6.2	6.1	5.9	5.9	5.7	5.5	5.3	5.2
Urban	8	6%	9.2	8.2	7	6.7	6.5	6.3	6.3	6.1	5.9	5.7	5.6

Location	Number of Lanes	Intersection Grade (Percent)	Distance between Freeway and Intersection (ft)										
			20	30	60	80	100	125	150	175	300	500	1000
Urban	8	7%	9.6	8.6	7.4	7.1	7	6.8	6.8	6.6	6.4	6.2	6.1
Urban	10	0%	7.9	7.1	5.6	5.2	4.9	4.7	4.7	4.6	4.4	4.2	4
Urban	10	1%	8	7.2	5.7	5.3	5.1	5	4.9	4.8	4.6	4.4	4.2
Urban	10	2%	8.3	7.5	6	5.6	5.3	5.2	5.1	5	4.7	4.5	4.3
Urban	10	3%	8.6	7.6	6.3	5.9	5.6	5.4	5.3	5.2	4.9	4.7	4.5
Urban	10	4%	8.8	7.8	6.5	6.1	5.8	5.6	5.5	5.4	5.1	4.9	4.7
Urban	10	5%	9.2	8.1	6.9	6.5	6.2	6.1	6	5.9	5.6	5.4	5.2
Urban	10	6%	9.7	8.6	7.4	7	6.7	6.5	6.4	6.3	6	5.8	5.6
Urban	10	7%	10.1	9	7.8	7.4	7.1	7	6.9	6.8	6.5	6.3	6.1
Urban	12	0%	8.5	7.7	5.9	5.4	5.1	5	4.9	4.8	4.6	4.4	4.2
Urban	12	1%	8.6	7.8	6	5.5	5.3	5.3	5.1	5	4.8	4.6	4.4
Urban	12	2%	8.9	8.1	6.3	5.8	5.5	5.5	5.3	5.2	4.9	4.7	4.5
Urban	12	3%	9.1	8.2	6.5	6	5.7	5.7	5.5	5.4	5.1	4.9	4.7
Urban	12	4%	9.3	8.4	6.7	6.2	5.9	5.9	5.7	5.6	5.3	5.1	4.9
Urban	12	5%	9.7	8.7	7.1	6.6	6.4	6.4	6.2	6.1	5.8	5.6	5.4
Urban	12	6%	10.2	9.1	7.6	7.1	6.8	6.8	6.6	6.5	6.2	6	5.8
Urban	12	7%	10.6	9.5	8	7.5	7.3	7.3	7.1	7	6.7	6.5	6.3

Notes: Red strikethrough values indicated exceedances of the standard, based on national-level (not Virginia-specific) conservative and worst-case modeling assumptions. To apply the table above for a project located in Virginia, the value in the table (black text or red strikethrough) with the setting and configuration corresponding to the project must be adjusted using the appropriate Virginia-specific background concentration and persistence factor.

^e These findings apply to scenarios with the intersection average speed ranging from 15 to 45 mph and the freeway average speed ranging from 19 to 75 mph, for which posted speeds in these ranges may be applied as reasonable proxies

Appendix B - MOVES Emission Factors Used in TSD

Table B-1: CO Idle Emission Rates Used in the Modeling, in Grams Per Vehicle-Hour, 2020

Road Type	Speed	Grams Per Vehicle Hour
Urban Unrestricted	0	13.67
Rural Unrestricted	0	13.82
Urban Restricted	0	13.60
Rural Restricted	0	13.71

This page was intentionally left blank.

Table B-2: CO Running Emission Rates Used in the Modeling for Upgrade and Downgrade Conditions, Respectively, in Grams Per Vehicle-Mile, 2020, by Speed and Grade

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	1	0	63.70	63.70	Urban Unrestricted	1	7	70.01	30.00	Rural Restricted	1	4	68.70	40.00
Rural Unrestricted	2	0	31.93	31.93	Urban Unrestricted	2	7	35.88	15.20	Rural Restricted	2	4	34.94	20.26
Rural Unrestricted	3	0	22.10	22.10	Urban Unrestricted	3	7	28.02	11.01	Rural Restricted	3	4	25.79	14.43
Rural Unrestricted	4	0	17.61	17.61	Urban Unrestricted	4	7	25.31	9.14	Rural Restricted	4	4	21.81	11.67
Rural Unrestricted	5	0	15.05	15.05	Urban Unrestricted	5	7	23.76	7.96	Rural Restricted	5	4	19.49	9.97
Rural Unrestricted	6	0	13.52	13.52	Urban Unrestricted	6	7	22.81	7.08	Rural Restricted	6	4	18.03	8.81
Rural Unrestricted	7	0	12.43	12.43	Urban Unrestricted	7	7	22.13	6.46	Rural Restricted	7	4	16.99	7.97
Rural Unrestricted	8	0	11.61	11.61	Urban Unrestricted	8	7	21.62	5.99	Rural Restricted	8	4	16.20	7.35
Rural Unrestricted	9	0	10.97	10.97	Urban Unrestricted	9	7	21.23	5.63	Rural Restricted	9	4	15.53	6.88
Rural Unrestricted	10	0	10.46	10.46	Urban Unrestricted	10	7	20.91	5.33	Rural Restricted	10	4	14.84	6.56
Rural Unrestricted	11	0	10.06	10.06	Urban Unrestricted	11	7	20.73	5.09	Rural Restricted	11	4	14.32	6.27
Rural Unrestricted	12	0	9.77	9.77	Urban Unrestricted	12	7	20.75	4.87	Rural Restricted	12	4	14.00	5.98
Rural Unrestricted	13	0	9.52	9.52	Urban Unrestricted	13	7	20.77	4.68	Rural Restricted	13	4	13.72	5.73
Rural Unrestricted	14	0	9.31	9.31	Urban Unrestricted	14	7	20.79	4.53	Rural Restricted	14	4	13.49	5.52
Rural Unrestricted	15	0	9.13	9.13	Urban Unrestricted	15	7	20.80	4.39	Rural Restricted	15	4	13.28	5.33
Rural Unrestricted	16	0	8.98	8.98	Urban Unrestricted	16	7	20.81	4.26	Rural Restricted	16	4	13.17	5.13
Rural Unrestricted	17	0	8.87	8.87	Urban Unrestricted	17	7	20.80	4.14	Rural Restricted	17	4	13.26	4.87
Rural Unrestricted	18	0	8.77	8.77	Urban Unrestricted	18	7	20.79	4.03	Rural Restricted	18	4	13.34	4.63
Rural Unrestricted	19	0	8.62	8.62	Urban Unrestricted	19	7	20.85	3.87	Rural Restricted	19	4	13.41	4.42
Rural Unrestricted	20	0	8.41	8.41	Urban Unrestricted	20	7	20.97	3.64	Rural Restricted	20	4	13.47	4.23
Rural Unrestricted	21	0	8.20	8.20	Urban Unrestricted	21	7	21.08	3.43	Rural Restricted	21	4	13.50	4.06
Rural Unrestricted	22	0	7.95	7.95	Urban Unrestricted	22	7	21.14	3.20	Rural Restricted	22	4	13.52	3.89
Rural Unrestricted	23	0	7.73	7.73	Urban Unrestricted	23	7	21.19	2.99	Rural Restricted	23	4	13.54	3.74
Rural Unrestricted	24	0	7.52	7.52	Urban Unrestricted	24	7	21.24	2.79	Rural Restricted	24	4	13.56	3.60
Rural Unrestricted	25	0	7.37	7.37	Urban Unrestricted	25	7	21.25	2.66	Rural Restricted	25	4	13.51	3.54
Rural Unrestricted	26	0	7.31	7.31	Urban Unrestricted	26	7	21.15	2.60	Rural Restricted	26	4	13.40	3.55
Rural Unrestricted	27	0	7.29	7.29	Urban Unrestricted	27	7	21.01	2.56	Rural Restricted	27	4	13.30	3.56
Rural Unrestricted	28	0	7.26	7.26	Urban Unrestricted	28	7	20.87	2.52	Rural Restricted	28	4	13.21	3.56
Rural Unrestricted	29	0	7.24	7.24	Urban Unrestricted	29	7	20.75	2.48	Rural Restricted	29	4	13.12	3.57
Rural Unrestricted	30	0	7.22	7.22	Urban Unrestricted	30	7	20.63	2.45	Rural Restricted	30	4	13.04	3.58
Rural Unrestricted	31	0	7.20	7.20	Urban Unrestricted	31	7	20.52	2.42	Rural Restricted	31	4	13.04	3.58
Rural Unrestricted	32	0	7.02	7.02	Urban Unrestricted	32	7	20.48	2.31	Rural Restricted	32	4	12.95	3.50
Rural Unrestricted	33	0	6.71	6.71	Urban Unrestricted	33	7	20.27	2.13	Rural Restricted	33	4	12.71	3.34
Rural Unrestricted	34	0	6.42	6.42	Urban Unrestricted	34	7	20.07	1.97	Rural Restricted	34	4	12.49	3.19
Rural Unrestricted	35	0	6.24	6.24	Urban Unrestricted	35	7	20.04	1.87	Rural Restricted	35	4	12.42	3.11
Rural Unrestricted	36	0	6.13	6.13	Urban Unrestricted	36	7	20.10	1.81	Rural Restricted	36	4	12.46	3.08
Rural Unrestricted	37	0	6.03	6.03	Urban Unrestricted	37	7	20.16	1.76	Rural Restricted	37	4	12.50	3.05
Rural Unrestricted	38	0	5.93	5.93	Urban Unrestricted	38	7	20.22	1.71	Rural Restricted	38	4	12.53	3.02
Rural Unrestricted	39	0	5.84	5.84	Urban Unrestricted	39	7	20.28	1.66	Rural Restricted	39	4	12.57	2.99
Rural Unrestricted	40	0	5.75	5.75	Urban Unrestricted	40	7	20.33	1.61	Rural Restricted	40	4	12.60	2.96

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	41	0	5.67	5.67	Urban Unrestricted	41	7	20.38	1.57	Rural Restricted	41	4	12.63	2.93
Rural Unrestricted	42	0	5.59	5.59	Urban Unrestricted	42	7	20.43	1.53	Rural Restricted	42	4	12.66	2.91
Rural Unrestricted	43	0	5.51	5.51	Urban Unrestricted	43	7	20.47	1.49	Rural Restricted	43	4	12.68	2.89
Rural Unrestricted	44	0	5.44	5.44	Urban Unrestricted	44	7	20.52	1.45	Rural Restricted	44	4	12.71	2.86
Rural Unrestricted	45	0	5.37	5.37	Urban Unrestricted	45	7	20.54	1.42	Rural Restricted	45	4	12.71	2.84
Rural Unrestricted	46	0	5.29	5.29	Urban Unrestricted	46	7	20.52	1.39	Rural Restricted	46	4	12.69	2.83
Rural Unrestricted	47	0	5.22	5.22	Urban Unrestricted	47	7	20.51	1.35	Rural Restricted	47	4	12.68	2.80
Rural Unrestricted	48	0	5.15	5.15	Urban Unrestricted	48	7	20.50	1.32	Rural Restricted	48	4	12.68	2.77
Rural Unrestricted	49	0	5.09	5.09	Urban Unrestricted	49	7	20.49	1.29	Rural Restricted	49	4	12.68	2.75
Rural Unrestricted	50	0	5.07	5.07	Urban Unrestricted	50	7	20.47	1.26	Rural Restricted	50	4	12.67	2.72
Rural Unrestricted	51	0	5.06	5.06	Urban Unrestricted	51	7	20.46	1.23	Rural Restricted	51	4	12.67	2.70
Rural Unrestricted	52	0	5.04	5.04	Urban Unrestricted	52	7	20.45	1.21	Rural Restricted	52	4	12.67	2.68
Rural Unrestricted	53	0	5.03	5.03	Urban Unrestricted	53	7	20.46	1.18	Rural Restricted	53	4	12.66	2.65
Rural Unrestricted	54	0	5.01	5.01	Urban Unrestricted	54	7	20.54	1.16	Rural Restricted	54	4	12.66	2.63
Rural Unrestricted	55	0	5.00	5.00	Urban Unrestricted	55	7	20.63	1.13	Rural Restricted	55	4	12.66	2.61
Rural Unrestricted	56	0	4.97	4.97	Urban Unrestricted	56	7	20.72	1.11	Rural Restricted	56	4	12.66	2.59
Rural Unrestricted	57	0	4.94	4.94	Urban Unrestricted	57	7	20.83	1.08	Rural Restricted	57	4	12.68	2.56
Rural Unrestricted	58	0	4.91	4.91	Urban Unrestricted	58	7	20.93	1.05	Rural Restricted	58	4	12.69	2.54
Rural Unrestricted	59	0	4.88	4.88	Urban Unrestricted	59	7	21.03	1.02	Rural Restricted	59	4	12.72	2.52
Rural Unrestricted	60	0	4.85	4.85	Urban Unrestricted	60	7	21.12	1.00	Rural Restricted	60	4	12.84	2.51
Rural Unrestricted	61	0	4.85	4.85	Urban Unrestricted	61	7	21.27	0.97	Rural Restricted	61	4	12.97	2.49
Rural Unrestricted	62	0	4.89	4.89	Urban Unrestricted	62	7	21.44	0.96	Rural Restricted	62	4	13.12	2.46
Rural Unrestricted	63	0	4.92	4.92	Urban Unrestricted	63	7	21.61	0.94	Rural Restricted	63	4	13.27	2.43
Rural Unrestricted	64	0	4.98	4.98	Urban Unrestricted	64	7	21.77	0.92	Rural Restricted	64	4	13.41	2.41
Rural Unrestricted	65	0	5.11	5.11	Urban Unrestricted	65	7	21.93	0.90	Rural Restricted	65	4	13.72	2.40
Rural Unrestricted	66	0	5.22	5.22	Urban Unrestricted	66	7	22.09	0.88	Rural Restricted	66	4	14.12	2.41
Rural Unrestricted	67	0	5.33	5.33	Urban Unrestricted	67	7	22.24	0.86	Rural Restricted	67	4	14.47	2.40
Rural Unrestricted	68	0	5.44	5.44	Urban Unrestricted	68	7	22.38	0.85	Rural Restricted	68	4	14.78	2.38
Rural Unrestricted	69	0	5.55	5.55	Urban Unrestricted	69	7	22.52	0.83	Rural Restricted	69	4	15.07	2.36
Rural Unrestricted	70	0	5.65	5.65	Urban Unrestricted	70	7	22.66	0.81	Rural Restricted	70	4	15.37	2.34
Rural Unrestricted	71	0	5.76	5.76	Urban Unrestricted	71	7	22.79	0.80	Rural Restricted	71	4	15.65	2.32
Rural Unrestricted	72	0	5.85	5.85	Urban Unrestricted	72	7	22.92	0.78	Rural Restricted	72	4	15.92	2.30
Rural Unrestricted	73	0	5.96	5.96	Urban Unrestricted	73	7	23.05	0.76	Rural Restricted	73	4	16.20	2.28
Rural Unrestricted	74	0	6.20	6.20	Urban Unrestricted	74	7	23.08	0.77	Rural Restricted	74	4	16.52	2.31
Rural Unrestricted	75	0	6.87	6.87	Urban Unrestricted	75	7	22.78	0.85	Rural Restricted	75	4	16.83	2.47
Urban Unrestricted	1	0	63.50	63.50	Rural Unrestricted	1	8	70.48	29.13	Urban Restricted	1	4	68.56	39.87
Urban Unrestricted	2	0	31.83	31.83	Rural Unrestricted	2	8	36.19	14.74	Urban Restricted	2	4	34.87	20.19
Urban Unrestricted	3	0	22.03	22.03	Rural Unrestricted	3	8	28.71	10.59	Urban Restricted	3	4	25.73	14.39
Urban Unrestricted	4	0	17.56	17.56	Rural Unrestricted	4	8	26.38	8.69	Urban Restricted	4	4	21.76	11.63
Urban Unrestricted	5	0	15.01	15.01	Rural Unrestricted	5	8	25.07	7.49	Urban Restricted	5	4	19.45	9.94
Urban Unrestricted	6	0	13.49	13.49	Rural Unrestricted	6	8	24.29	6.60	Urban Restricted	6	4	17.99	8.78
Urban Unrestricted	7	0	12.40	12.40	Rural Unrestricted	7	8	23.73	5.96	Urban Restricted	7	4	16.95	7.95

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	8	0	11.58	11.58	Rural Unrestricted	8	8	23.31	5.48	Urban Restricted	8	4	16.18	7.33
Urban Unrestricted	9	0	10.94	10.94	Rural Unrestricted	9	8	22.98	5.11	Urban Restricted	9	4	15.50	6.86
Urban Unrestricted	10	0	10.44	10.44	Rural Unrestricted	10	8	22.71	4.82	Urban Restricted	10	4	14.81	6.54
Urban Unrestricted	11	0	10.04	10.04	Rural Unrestricted	11	8	22.59	4.57	Urban Restricted	11	4	14.30	6.25
Urban Unrestricted	12	0	9.75	9.75	Rural Unrestricted	12	8	22.70	4.37	Urban Restricted	12	4	13.97	5.96
Urban Unrestricted	13	0	9.50	9.50	Rural Unrestricted	13	8	22.79	4.19	Urban Restricted	13	4	13.69	5.72
Urban Unrestricted	14	0	9.30	9.30	Rural Unrestricted	14	8	22.86	4.04	Urban Restricted	14	4	13.46	5.50
Urban Unrestricted	15	0	9.11	9.11	Rural Unrestricted	15	8	22.93	3.91	Urban Restricted	15	4	13.25	5.32
Urban Unrestricted	16	0	8.97	8.97	Rural Unrestricted	16	8	22.97	3.80	Urban Restricted	16	4	13.14	5.12
Urban Unrestricted	17	0	8.86	8.86	Rural Unrestricted	17	8	22.97	3.68	Urban Restricted	17	4	13.23	4.86
Urban Unrestricted	18	0	8.76	8.76	Rural Unrestricted	18	8	22.97	3.58	Urban Restricted	18	4	13.31	4.62
Urban Unrestricted	19	0	8.61	8.61	Rural Unrestricted	19	8	23.14	3.44	Urban Restricted	19	4	13.39	4.41
Urban Unrestricted	20	0	8.40	8.40	Rural Unrestricted	20	8	23.52	3.26	Urban Restricted	20	4	13.45	4.22
Urban Unrestricted	21	0	8.19	8.19	Rural Unrestricted	21	8	23.85	3.08	Urban Restricted	21	4	13.48	4.05
Urban Unrestricted	22	0	7.94	7.94	Rural Unrestricted	22	8	24.11	2.89	Urban Restricted	22	4	13.50	3.88
Urban Unrestricted	23	0	7.71	7.71	Rural Unrestricted	23	8	24.36	2.72	Urban Restricted	23	4	13.52	3.73
Urban Unrestricted	24	0	7.50	7.50	Rural Unrestricted	24	8	24.58	2.56	Urban Restricted	24	4	13.54	3.59
Urban Unrestricted	25	0	7.35	7.35	Rural Unrestricted	25	8	24.76	2.44	Urban Restricted	25	4	13.49	3.53
Urban Unrestricted	26	0	7.29	7.29	Rural Unrestricted	26	8	24.62	2.37	Urban Restricted	26	4	13.38	3.54
Urban Unrestricted	27	0	7.27	7.27	Rural Unrestricted	27	8	24.31	2.31	Urban Restricted	27	4	13.28	3.55
Urban Unrestricted	28	0	7.25	7.25	Rural Unrestricted	28	8	24.02	2.25	Urban Restricted	28	4	13.19	3.55
Urban Unrestricted	29	0	7.23	7.23	Rural Unrestricted	29	8	23.75	2.20	Urban Restricted	29	4	13.10	3.56
Urban Unrestricted	30	0	7.21	7.21	Rural Unrestricted	30	8	23.50	2.15	Urban Restricted	30	4	13.02	3.57
Urban Unrestricted	31	0	7.19	7.19	Rural Unrestricted	31	8	23.27	2.10	Urban Restricted	31	4	13.02	3.57
Urban Unrestricted	32	0	7.00	7.00	Rural Unrestricted	32	8	23.32	2.01	Urban Restricted	32	4	12.94	3.49
Urban Unrestricted	33	0	6.69	6.69	Rural Unrestricted	33	8	23.21	1.88	Urban Restricted	33	4	12.70	3.33
Urban Unrestricted	34	0	6.39	6.39	Rural Unrestricted	34	8	23.10	1.76	Urban Restricted	34	4	12.47	3.18
Urban Unrestricted	35	0	6.21	6.21	Rural Unrestricted	35	8	23.14	1.68	Urban Restricted	35	4	12.41	3.10
Urban Unrestricted	36	0	6.10	6.10	Rural Unrestricted	36	8	23.27	1.62	Urban Restricted	36	4	12.45	3.07
Urban Unrestricted	37	0	5.99	5.99	Rural Unrestricted	37	8	23.39	1.57	Urban Restricted	37	4	12.49	3.04
Urban Unrestricted	38	0	5.89	5.89	Rural Unrestricted	38	8	23.51	1.52	Urban Restricted	38	4	12.53	3.01
Urban Unrestricted	39	0	5.80	5.80	Rural Unrestricted	39	8	23.62	1.47	Urban Restricted	39	4	12.56	2.98
Urban Unrestricted	40	0	5.71	5.71	Rural Unrestricted	40	8	23.72	1.42	Urban Restricted	40	4	12.59	2.95
Urban Unrestricted	41	0	5.62	5.62	Rural Unrestricted	41	8	23.82	1.38	Urban Restricted	41	4	12.62	2.92
Urban Unrestricted	42	0	5.54	5.54	Rural Unrestricted	42	8	23.91	1.34	Urban Restricted	42	4	12.65	2.90
Urban Unrestricted	43	0	5.46	5.46	Rural Unrestricted	43	8	24.00	1.30	Urban Restricted	43	4	12.68	2.87
Urban Unrestricted	44	0	5.40	5.40	Rural Unrestricted	44	8	24.09	1.26	Urban Restricted	44	4	12.71	2.85
Urban Unrestricted	45	0	5.35	5.35	Rural Unrestricted	45	8	24.14	1.22	Urban Restricted	45	4	12.71	2.83
Urban Unrestricted	46	0	5.29	5.29	Rural Unrestricted	46	8	24.16	1.18	Urban Restricted	46	4	12.69	2.82
Urban Unrestricted	47	0	5.24	5.24	Rural Unrestricted	47	8	24.19	1.15	Urban Restricted	47	4	12.69	2.79
Urban Unrestricted	48	0	5.19	5.19	Rural Unrestricted	48	8	24.21	1.11	Urban Restricted	48	4	12.68	2.76
Urban Unrestricted	49	0	5.14	5.14	Rural Unrestricted	49	8	24.23	1.08	Urban Restricted	49	4	12.68	2.74

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	50	0	5.09	5.09	Rural Unrestricted	50	8	24.16	1.05	Urban Restricted	50	4	12.68	2.71
Urban Unrestricted	51	0	5.04	5.04	Rural Unrestricted	51	8	24.09	1.02	Urban Restricted	51	4	12.67	2.69
Urban Unrestricted	52	0	5.00	5.00	Rural Unrestricted	52	8	24.03	0.99	Urban Restricted	52	4	12.67	2.67
Urban Unrestricted	53	0	4.96	4.96	Rural Unrestricted	53	8	23.96	0.97	Urban Restricted	53	4	12.67	2.64
Urban Unrestricted	54	0	4.95	4.95	Rural Unrestricted	54	8	23.90	0.94	Urban Restricted	54	4	12.67	2.62
Urban Unrestricted	55	0	4.94	4.94	Rural Unrestricted	55	8	23.84	0.92	Urban Restricted	55	4	12.67	2.60
Urban Unrestricted	56	0	4.92	4.92	Rural Unrestricted	56	8	23.81	0.90	Urban Restricted	56	4	12.67	2.58
Urban Unrestricted	57	0	4.89	4.89	Rural Unrestricted	57	8	23.79	0.88	Urban Restricted	57	4	12.69	2.55
Urban Unrestricted	58	0	4.87	4.87	Rural Unrestricted	58	8	23.78	0.86	Urban Restricted	58	4	12.70	2.53
Urban Unrestricted	59	0	4.84	4.84	Rural Unrestricted	59	8	23.76	0.84	Urban Restricted	59	4	12.74	2.51
Urban Unrestricted	60	0	4.81	4.81	Rural Unrestricted	60	8	23.74	0.83	Urban Restricted	60	4	12.85	2.50
Urban Unrestricted	61	0	4.83	4.83	Rural Unrestricted	61	8	23.77	0.81	Urban Restricted	61	4	12.99	2.47
Urban Unrestricted	62	0	4.86	4.86	Rural Unrestricted	62	8	23.82	0.80	Urban Restricted	62	4	13.14	2.45
Urban Unrestricted	63	0	4.90	4.90	Rural Unrestricted	63	8	23.86	0.78	Urban Restricted	63	4	13.29	2.42
Urban Unrestricted	64	0	4.97	4.97	Rural Unrestricted	64	8	23.90	0.76	Urban Restricted	64	4	13.43	2.40
Urban Unrestricted	65	0	5.09	5.09	Rural Unrestricted	65	8	23.93	0.74	Urban Restricted	65	4	13.74	2.39
Urban Unrestricted	66	0	5.20	5.20	Rural Unrestricted	66	8	23.95	0.72	Urban Restricted	66	4	14.14	2.40
Urban Unrestricted	67	0	5.32	5.32	Rural Unrestricted	67	8	23.98	0.71	Urban Restricted	67	4	14.49	2.38
Urban Unrestricted	68	0	5.43	5.43	Rural Unrestricted	68	8	24.00	0.69	Urban Restricted	68	4	14.80	2.36
Urban Unrestricted	69	0	5.53	5.53	Rural Unrestricted	69	8	24.02	0.67	Urban Restricted	69	4	15.10	2.35
Urban Unrestricted	70	0	5.64	5.64	Rural Unrestricted	70	8	24.04	0.65	Urban Restricted	70	4	15.40	2.33
Urban Unrestricted	71	0	5.74	5.74	Rural Unrestricted	71	8	24.06	0.63	Urban Restricted	71	4	15.68	2.31
Urban Unrestricted	72	0	5.84	5.84	Rural Unrestricted	72	8	24.08	0.62	Urban Restricted	72	4	15.96	2.29
Urban Unrestricted	73	0	5.94	5.94	Rural Unrestricted	73	8	24.11	0.60	Urban Restricted	73	4	16.24	2.27
Urban Unrestricted	74	0	6.19	6.19	Rural Unrestricted	74	8	24.11	0.60	Urban Restricted	74	4	16.56	2.29
Urban Unrestricted	75	0	6.86	6.86	Rural Unrestricted	75	8	23.94	0.64	Urban Restricted	75	4	16.87	2.46
Rural Unrestricted	1	1	65.92	48.31	Urban Unrestricted	1	8	70.27	28.94	Rural Restricted	1	5	69.46	32.28
Rural Unrestricted	2	1	33.15	24.67	Urban Unrestricted	2	8	36.08	14.65	Rural Restricted	2	5	35.43	16.43
Rural Unrestricted	3	1	23.27	18.42	Urban Unrestricted	3	8	28.64	10.52	Rural Restricted	3	5	26.58	12.02
Rural Unrestricted	4	1	18.80	15.66	Urban Unrestricted	4	8	26.33	8.64	Rural Restricted	4	5	22.88	10.00
Rural Unrestricted	5	1	16.23	13.83	Urban Unrestricted	5	8	25.02	7.45	Rural Restricted	5	5	20.73	8.73
Rural Unrestricted	6	1	14.65	12.38	Urban Unrestricted	6	8	24.25	6.56	Rural Restricted	6	5	19.37	7.79
Rural Unrestricted	7	1	13.52	11.34	Urban Unrestricted	7	8	23.69	5.93	Rural Restricted	7	5	18.40	7.12
Rural Unrestricted	8	1	12.67	10.56	Urban Unrestricted	8	8	23.28	5.46	Rural Restricted	8	5	17.67	6.62
Rural Unrestricted	9	1	12.01	9.95	Urban Unrestricted	9	8	22.95	5.09	Rural Restricted	9	5	17.01	6.23
Rural Unrestricted	10	1	11.48	9.47	Urban Unrestricted	10	8	22.69	4.80	Rural Restricted	10	5	16.26	5.93
Rural Unrestricted	11	1	11.11	9.07	Urban Unrestricted	11	8	22.57	4.55	Rural Restricted	11	5	15.73	5.66
Rural Unrestricted	12	1	10.93	8.75	Urban Unrestricted	12	8	22.68	4.35	Rural Restricted	12	5	15.43	5.38
Rural Unrestricted	13	1	10.78	8.48	Urban Unrestricted	13	8	22.77	4.18	Rural Restricted	13	5	15.18	5.15
Rural Unrestricted	14	1	10.66	8.25	Urban Unrestricted	14	8	22.85	4.03	Rural Restricted	14	5	14.97	4.94
Rural Unrestricted	15	1	10.54	8.05	Urban Unrestricted	15	8	22.91	3.90	Rural Restricted	15	5	14.78	4.77
Rural Unrestricted	16	1	10.43	7.88	Urban Unrestricted	16	8	22.95	3.78	Rural Restricted	16	5	14.70	4.58

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	17	1	10.31	7.74	Urban Unrestricted	17	8	22.95	3.67	Rural Restricted	17	5	14.87	4.32
Rural Unrestricted	18	1	10.20	7.61	Urban Unrestricted	18	8	22.95	3.57	Rural Restricted	18	5	15.01	4.09
Rural Unrestricted	19	1	10.06	7.43	Urban Unrestricted	19	8	23.12	3.43	Rural Restricted	19	5	15.14	3.88
Rural Unrestricted	20	1	9.87	7.19	Urban Unrestricted	20	8	23.50	3.25	Rural Restricted	20	5	15.26	3.70
Rural Unrestricted	21	1	9.68	6.96	Urban Unrestricted	21	8	23.84	3.07	Rural Restricted	21	5	15.33	3.54
Rural Unrestricted	22	1	9.44	6.76	Urban Unrestricted	22	8	24.11	2.88	Rural Restricted	22	5	15.37	3.38
Rural Unrestricted	23	1	9.23	6.58	Urban Unrestricted	23	8	24.35	2.71	Rural Restricted	23	5	15.41	3.24
Rural Unrestricted	24	1	9.03	6.41	Urban Unrestricted	24	8	24.57	2.55	Rural Restricted	24	5	15.45	3.11
Rural Unrestricted	25	1	8.88	6.28	Urban Unrestricted	25	8	24.76	2.43	Rural Restricted	25	5	15.42	3.05
Rural Unrestricted	26	1	8.80	6.21	Urban Unrestricted	26	8	24.61	2.36	Rural Restricted	26	5	15.33	3.05
Rural Unrestricted	27	1	8.73	6.18	Urban Unrestricted	27	8	24.30	2.30	Rural Restricted	27	5	15.25	3.05
Rural Unrestricted	28	1	8.67	6.15	Urban Unrestricted	28	8	24.02	2.24	Rural Restricted	28	5	15.18	3.05
Rural Unrestricted	29	1	8.62	6.12	Urban Unrestricted	29	8	23.75	2.19	Rural Restricted	29	5	15.11	3.05
Rural Unrestricted	30	1	8.56	6.09	Urban Unrestricted	30	8	23.50	2.14	Rural Restricted	30	5	15.05	3.05
Rural Unrestricted	31	1	8.52	6.07	Urban Unrestricted	31	8	23.26	2.09	Rural Restricted	31	5	15.08	3.05
Rural Unrestricted	32	1	8.30	5.89	Urban Unrestricted	32	8	23.24	2.00	Rural Restricted	32	5	15.04	2.96
Rural Unrestricted	33	1	7.93	5.60	Urban Unrestricted	33	8	23.05	1.86	Rural Restricted	33	5	14.87	2.79
Rural Unrestricted	34	1	7.59	5.32	Urban Unrestricted	34	8	22.88	1.73	Rural Restricted	34	5	14.70	2.62
Rural Unrestricted	35	1	7.40	5.16	Urban Unrestricted	35	8	22.85	1.65	Rural Restricted	35	5	14.68	2.55
Rural Unrestricted	36	1	7.32	5.08	Urban Unrestricted	36	8	22.92	1.59	Rural Restricted	36	5	14.75	2.52
Rural Unrestricted	37	1	7.24	4.99	Urban Unrestricted	37	8	22.99	1.53	Rural Restricted	37	5	14.81	2.50
Rural Unrestricted	38	1	7.16	4.92	Urban Unrestricted	38	8	23.05	1.48	Rural Restricted	38	5	14.86	2.48
Rural Unrestricted	39	1	7.09	4.84	Urban Unrestricted	39	8	23.10	1.43	Rural Restricted	39	5	14.92	2.46
Rural Unrestricted	40	1	7.02	4.77	Urban Unrestricted	40	8	23.16	1.38	Rural Restricted	40	5	14.97	2.45
Rural Unrestricted	41	1	6.95	4.70	Urban Unrestricted	41	8	23.21	1.33	Rural Restricted	41	5	15.02	2.43
Rural Unrestricted	42	1	6.89	4.64	Urban Unrestricted	42	8	23.26	1.29	Rural Restricted	42	5	15.07	2.41
Rural Unrestricted	43	1	6.83	4.58	Urban Unrestricted	43	8	23.30	1.24	Rural Restricted	43	5	15.11	2.40
Rural Unrestricted	44	1	6.78	4.52	Urban Unrestricted	44	8	23.36	1.21	Rural Restricted	44	5	15.16	2.38
Rural Unrestricted	45	1	6.71	4.46	Urban Unrestricted	45	8	23.40	1.17	Rural Restricted	45	5	15.17	2.37
Rural Unrestricted	46	1	6.63	4.41	Urban Unrestricted	46	8	23.40	1.13	Rural Restricted	46	5	15.16	2.35
Rural Unrestricted	47	1	6.56	4.35	Urban Unrestricted	47	8	23.41	1.10	Rural Restricted	47	5	15.15	2.32
Rural Unrestricted	48	1	6.48	4.30	Urban Unrestricted	48	8	23.41	1.06	Rural Restricted	48	5	15.15	2.28
Rural Unrestricted	49	1	6.42	4.25	Urban Unrestricted	49	8	23.42	1.03	Rural Restricted	49	5	15.15	2.25
Rural Unrestricted	50	1	6.39	4.23	Urban Unrestricted	50	8	23.42	1.00	Rural Restricted	50	5	15.14	2.22
Rural Unrestricted	51	1	6.37	4.21	Urban Unrestricted	51	8	23.43	0.97	Rural Restricted	51	5	15.14	2.19
Rural Unrestricted	52	1	6.35	4.19	Urban Unrestricted	52	8	23.43	0.94	Rural Restricted	52	5	15.13	2.16
Rural Unrestricted	53	1	6.33	4.17	Urban Unrestricted	53	8	23.44	0.91	Rural Restricted	53	5	15.13	2.13
Rural Unrestricted	54	1	6.31	4.15	Urban Unrestricted	54	8	23.43	0.89	Rural Restricted	54	5	15.13	2.11
Rural Unrestricted	55	1	6.29	4.13	Urban Unrestricted	55	8	23.43	0.87	Rural Restricted	55	5	15.12	2.08
Rural Unrestricted	56	1	6.26	4.10	Urban Unrestricted	56	8	23.45	0.86	Rural Restricted	56	5	15.12	2.05
Rural Unrestricted	57	1	6.23	4.08	Urban Unrestricted	57	8	23.49	0.85	Rural Restricted	57	5	15.11	2.01
Rural Unrestricted	58	1	6.20	4.05	Urban Unrestricted	58	8	23.53	0.83	Rural Restricted	58	5	15.10	1.98

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	59	1	6.17	4.02	Urban Unrestricted	59	8	23.56	0.82	Rural Restricted	59	5	15.13	1.95
Rural Unrestricted	60	1	6.14	4.00	Urban Unrestricted	60	8	23.59	0.81	Rural Restricted	60	5	15.32	1.93
Rural Unrestricted	61	1	6.18	3.99	Urban Unrestricted	61	8	23.66	0.80	Rural Restricted	61	5	15.56	1.91
Rural Unrestricted	62	1	6.27	3.99	Urban Unrestricted	62	8	23.76	0.78	Rural Restricted	62	5	15.83	1.88
Rural Unrestricted	63	1	6.35	3.98	Urban Unrestricted	63	8	23.85	0.77	Rural Restricted	63	5	16.10	1.86
Rural Unrestricted	64	1	6.49	4.00	Urban Unrestricted	64	8	23.92	0.76	Rural Restricted	64	5	16.36	1.84
Rural Unrestricted	65	1	6.72	4.05	Urban Unrestricted	65	8	23.94	0.74	Rural Restricted	65	5	16.65	1.83
Rural Unrestricted	66	1	6.94	4.10	Urban Unrestricted	66	8	23.97	0.72	Rural Restricted	66	5	16.95	1.83
Rural Unrestricted	67	1	7.16	4.15	Urban Unrestricted	67	8	23.99	0.70	Rural Restricted	67	5	17.28	1.82
Rural Unrestricted	68	1	7.37	4.20	Urban Unrestricted	68	8	24.02	0.68	Rural Restricted	68	5	17.60	1.80
Rural Unrestricted	69	1	7.57	4.24	Urban Unrestricted	69	8	24.04	0.66	Rural Restricted	69	5	17.92	1.78
Rural Unrestricted	70	1	7.77	4.29	Urban Unrestricted	70	8	24.06	0.65	Rural Restricted	70	5	18.23	1.76
Rural Unrestricted	71	1	7.96	4.33	Urban Unrestricted	71	8	24.08	0.63	Rural Restricted	71	5	18.53	1.74
Rural Unrestricted	72	1	8.15	4.37	Urban Unrestricted	72	8	24.10	0.61	Rural Restricted	72	5	18.82	1.72
Rural Unrestricted	73	1	8.34	4.42	Urban Unrestricted	73	8	24.13	0.60	Rural Restricted	73	5	19.11	1.70
Rural Unrestricted	74	1	8.65	4.55	Urban Unrestricted	74	8	24.13	0.59	Rural Restricted	74	5	19.34	1.70
Rural Unrestricted	75	1	9.31	4.98	Urban Unrestricted	75	8	23.96	0.63	Rural Restricted	75	5	19.27	1.79
Urban Unrestricted	1	1	65.72	48.13	Rural Unrestricted	1	9	71.10	27.05	Urban Restricted	1	5	69.32	32.16
Urban Unrestricted	2	1	33.05	24.58	Rural Unrestricted	2	9	36.58	13.70	Urban Restricted	2	5	35.35	16.37
Urban Unrestricted	3	1	23.20	18.35	Rural Unrestricted	3	9	29.46	9.88	Urban Restricted	3	5	26.52	11.98
Urban Unrestricted	4	1	18.75	15.62	Rural Unrestricted	4	9	27.49	8.16	Urban Restricted	4	5	22.84	9.97
Urban Unrestricted	5	1	16.18	13.79	Rural Unrestricted	5	9	26.43	7.04	Urban Restricted	5	5	20.69	8.69
Urban Unrestricted	6	1	14.61	12.34	Rural Unrestricted	6	9	25.85	6.20	Urban Restricted	6	5	19.33	7.76
Urban Unrestricted	7	1	13.48	11.31	Rural Unrestricted	7	9	25.44	5.60	Urban Restricted	7	5	18.36	7.10
Urban Unrestricted	8	1	12.64	10.53	Rural Unrestricted	8	9	25.13	5.14	Urban Restricted	8	5	17.64	6.60
Urban Unrestricted	9	1	11.98	9.93	Rural Unrestricted	9	9	24.88	4.79	Urban Restricted	9	5	16.98	6.21
Urban Unrestricted	10	1	11.45	9.44	Rural Unrestricted	10	9	24.69	4.51	Urban Restricted	10	5	16.23	5.92
Urban Unrestricted	11	1	11.08	9.05	Rural Unrestricted	11	9	24.62	4.28	Urban Restricted	11	5	15.70	5.65
Urban Unrestricted	12	1	10.91	8.73	Rural Unrestricted	12	9	24.79	4.08	Urban Restricted	12	5	15.40	5.37
Urban Unrestricted	13	1	10.76	8.46	Rural Unrestricted	13	9	24.93	3.92	Urban Restricted	13	5	15.15	5.13
Urban Unrestricted	14	1	10.64	8.23	Rural Unrestricted	14	9	25.05	3.78	Urban Restricted	14	5	14.94	4.93
Urban Unrestricted	15	1	10.53	8.03	Rural Unrestricted	15	9	25.15	3.66	Urban Restricted	15	5	14.75	4.76
Urban Unrestricted	16	1	10.41	7.87	Rural Unrestricted	16	9	25.20	3.54	Urban Restricted	16	5	14.67	4.57
Urban Unrestricted	17	1	10.29	7.72	Rural Unrestricted	17	9	25.19	3.44	Urban Restricted	17	5	14.84	4.31
Urban Unrestricted	18	1	10.18	7.60	Rural Unrestricted	18	9	25.18	3.35	Urban Restricted	18	5	14.98	4.08
Urban Unrestricted	19	1	10.04	7.42	Rural Unrestricted	19	9	25.46	3.22	Urban Restricted	19	5	15.12	3.87
Urban Unrestricted	20	1	9.85	7.17	Rural Unrestricted	20	9	26.07	3.03	Urban Restricted	20	5	15.24	3.69
Urban Unrestricted	21	1	9.66	6.95	Rural Unrestricted	21	9	26.63	2.86	Urban Restricted	21	5	15.31	3.53
Urban Unrestricted	22	1	9.43	6.75	Rural Unrestricted	22	9	27.12	2.67	Urban Restricted	22	5	15.35	3.37
Urban Unrestricted	23	1	9.21	6.56	Rural Unrestricted	23	9	27.57	2.50	Urban Restricted	23	5	15.39	3.23
Urban Unrestricted	24	1	9.01	6.40	Rural Unrestricted	24	9	27.98	2.35	Urban Restricted	24	5	15.42	3.11
Urban Unrestricted	25	1	8.86	6.26	Rural Unrestricted	25	9	28.32	2.23	Urban Restricted	25	5	15.40	3.04

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	26	1	8.78	6.20	Rural Unrestricted	26	9	28.16	2.14	Urban Restricted	26	5	15.31	3.04
Urban Unrestricted	27	1	8.71	6.16	Rural Unrestricted	27	9	27.73	2.07	Urban Restricted	27	5	15.23	3.04
Urban Unrestricted	28	1	8.65	6.13	Rural Unrestricted	28	9	27.34	2.00	Urban Restricted	28	5	15.16	3.04
Urban Unrestricted	29	1	8.60	6.10	Rural Unrestricted	29	9	26.97	1.94	Urban Restricted	29	5	15.09	3.04
Urban Unrestricted	30	1	8.55	6.08	Rural Unrestricted	30	9	26.63	1.88	Urban Restricted	30	5	15.03	3.04
Urban Unrestricted	31	1	8.50	6.05	Rural Unrestricted	31	9	26.31	1.83	Urban Restricted	31	5	15.06	3.04
Urban Unrestricted	32	1	8.29	5.87	Rural Unrestricted	32	9	26.30	1.75	Urban Restricted	32	5	15.03	2.95
Urban Unrestricted	33	1	7.92	5.58	Rural Unrestricted	33	9	26.14	1.65	Urban Restricted	33	5	14.86	2.78
Urban Unrestricted	34	1	7.58	5.30	Rural Unrestricted	34	9	26.00	1.56	Urban Restricted	34	5	14.70	2.62
Urban Unrestricted	35	1	7.39	5.14	Rural Unrestricted	35	9	25.99	1.49	Urban Restricted	35	5	14.68	2.54
Urban Unrestricted	36	1	7.31	5.05	Rural Unrestricted	36	9	26.07	1.43	Urban Restricted	36	5	14.74	2.52
Urban Unrestricted	37	1	7.23	4.96	Rural Unrestricted	37	9	26.15	1.38	Urban Restricted	37	5	14.80	2.50
Urban Unrestricted	38	1	7.15	4.88	Rural Unrestricted	38	9	26.22	1.34	Urban Restricted	38	5	14.86	2.48
Urban Unrestricted	39	1	7.08	4.81	Rural Unrestricted	39	9	26.28	1.29	Urban Restricted	39	5	14.92	2.46
Urban Unrestricted	40	1	7.01	4.73	Rural Unrestricted	40	9	26.35	1.25	Urban Restricted	40	5	14.97	2.44
Urban Unrestricted	41	1	6.95	4.66	Rural Unrestricted	41	9	26.41	1.21	Urban Restricted	41	5	15.02	2.42
Urban Unrestricted	42	1	6.89	4.60	Rural Unrestricted	42	9	26.47	1.17	Urban Restricted	42	5	15.07	2.40
Urban Unrestricted	43	1	6.83	4.54	Rural Unrestricted	43	9	26.52	1.13	Urban Restricted	43	5	15.12	2.39
Urban Unrestricted	44	1	6.77	4.48	Rural Unrestricted	44	9	26.57	1.10	Urban Restricted	44	5	15.16	2.37
Urban Unrestricted	45	1	6.69	4.42	Rural Unrestricted	45	9	26.60	1.06	Urban Restricted	45	5	15.18	2.36
Urban Unrestricted	46	1	6.61	4.37	Rural Unrestricted	46	9	26.59	1.03	Urban Restricted	46	5	15.17	2.34
Urban Unrestricted	47	1	6.53	4.32	Rural Unrestricted	47	9	26.58	1.00	Urban Restricted	47	5	15.16	2.31
Urban Unrestricted	48	1	6.45	4.27	Rural Unrestricted	48	9	26.58	0.97	Urban Restricted	48	5	15.16	2.27
Urban Unrestricted	49	1	6.38	4.22	Rural Unrestricted	49	9	26.57	0.94	Urban Restricted	49	5	15.16	2.24
Urban Unrestricted	50	1	6.31	4.17	Rural Unrestricted	50	9	26.48	0.91	Urban Restricted	50	5	15.16	2.21
Urban Unrestricted	51	1	6.24	4.13	Rural Unrestricted	51	9	26.39	0.89	Urban Restricted	51	5	15.15	2.18
Urban Unrestricted	52	1	6.17	4.09	Rural Unrestricted	52	9	26.30	0.86	Urban Restricted	52	5	15.15	2.15
Urban Unrestricted	53	1	6.12	4.05	Rural Unrestricted	53	9	26.22	0.84	Urban Restricted	53	5	15.15	2.12
Urban Unrestricted	54	1	6.12	4.04	Rural Unrestricted	54	9	26.14	0.82	Urban Restricted	54	5	15.15	2.10
Urban Unrestricted	55	1	6.12	4.03	Rural Unrestricted	55	9	26.06	0.80	Urban Restricted	55	5	15.14	2.07
Urban Unrestricted	56	1	6.12	4.02	Rural Unrestricted	56	9	26.00	0.78	Urban Restricted	56	5	15.14	2.04
Urban Unrestricted	57	1	6.10	4.00	Rural Unrestricted	57	9	25.95	0.76	Urban Restricted	57	5	15.13	2.00
Urban Unrestricted	58	1	6.09	3.99	Rural Unrestricted	58	9	25.90	0.75	Urban Restricted	58	5	15.12	1.97
Urban Unrestricted	59	1	6.07	3.97	Rural Unrestricted	59	9	25.85	0.73	Urban Restricted	59	5	15.16	1.94
Urban Unrestricted	60	1	6.06	3.95	Rural Unrestricted	60	9	25.80	0.72	Urban Restricted	60	5	15.34	1.92
Urban Unrestricted	61	1	6.12	3.95	Rural Unrestricted	61	9	25.80	0.70	Urban Restricted	61	5	15.58	1.90
Urban Unrestricted	62	1	6.22	3.95	Rural Unrestricted	62	9	25.83	0.69	Urban Restricted	62	5	15.86	1.87
Urban Unrestricted	63	1	6.32	3.96	Rural Unrestricted	63	9	25.86	0.67	Urban Restricted	63	5	16.13	1.85
Urban Unrestricted	64	1	6.47	3.98	Rural Unrestricted	64	9	25.86	0.66	Urban Restricted	64	5	16.39	1.83
Urban Unrestricted	65	1	6.70	4.03	Rural Unrestricted	65	9	25.78	0.64	Urban Restricted	65	5	16.68	1.82
Urban Unrestricted	66	1	6.92	4.08	Rural Unrestricted	66	9	25.70	0.63	Urban Restricted	66	5	16.99	1.82
Urban Unrestricted	67	1	7.14	4.13	Rural Unrestricted	67	9	25.62	0.61	Urban Restricted	67	5	17.31	1.81

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	68	1	7.35	4.18	Rural Unrestricted	68	9	25.55	0.60	Urban Restricted	68	5	17.64	1.79
Urban Unrestricted	69	1	7.55	4.22	Rural Unrestricted	69	9	25.48	0.58	Urban Restricted	69	5	17.96	1.77
Urban Unrestricted	70	1	7.75	4.27	Rural Unrestricted	70	9	25.41	0.57	Urban Restricted	70	5	18.27	1.75
Urban Unrestricted	71	1	7.95	4.31	Rural Unrestricted	71	9	25.34	0.55	Urban Restricted	71	5	18.57	1.73
Urban Unrestricted	72	1	8.13	4.35	Rural Unrestricted	72	9	25.27	0.54	Urban Restricted	72	5	18.87	1.71
Urban Unrestricted	73	1	8.33	4.40	Rural Unrestricted	73	9	25.21	0.53	Urban Restricted	73	5	19.16	1.69
Urban Unrestricted	74	1	8.64	4.53	Rural Unrestricted	74	9	25.14	0.52	Urban Restricted	74	5	19.39	1.69
Urban Unrestricted	75	1	9.30	4.96	Rural Unrestricted	75	9	24.95	0.53	Urban Restricted	75	5	19.32	1.78
Rural Unrestricted	1	2	67.31	42.80	Urban Unrestricted	1	9	70.88	26.86	Rural Restricted	1	6	69.91	31.04
Rural Unrestricted	2	2	33.95	21.86	Urban Unrestricted	2	9	36.47	13.61	Rural Restricted	2	6	35.73	15.75
Rural Unrestricted	3	2	24.20	16.36	Urban Unrestricted	3	9	29.38	9.82	Rural Restricted	3	6	27.13	11.36
Rural Unrestricted	4	2	19.88	13.97	Urban Unrestricted	4	9	27.44	8.11	Rural Restricted	4	6	23.66	9.33
Rural Unrestricted	5	2	17.40	12.36	Urban Unrestricted	5	9	26.38	7.00	Rural Restricted	5	6	21.66	8.08
Rural Unrestricted	6	2	15.91	11.08	Urban Unrestricted	6	9	25.81	6.17	Rural Restricted	6	6	20.42	7.19
Rural Unrestricted	7	2	14.84	10.17	Urban Unrestricted	7	9	25.40	5.57	Rural Restricted	7	6	19.53	6.55
Rural Unrestricted	8	2	14.03	9.48	Urban Unrestricted	8	9	25.10	5.12	Rural Restricted	8	6	18.86	6.07
Rural Unrestricted	9	2	13.41	8.95	Urban Unrestricted	9	9	24.86	4.77	Rural Restricted	9	6	18.24	5.70
Rural Unrestricted	10	2	12.91	8.52	Urban Unrestricted	10	9	24.66	4.49	Rural Restricted	10	6	17.51	5.41
Rural Unrestricted	11	2	12.55	8.18	Urban Unrestricted	11	9	24.60	4.26	Rural Restricted	11	6	16.99	5.16
Rural Unrestricted	12	2	12.38	7.89	Urban Unrestricted	12	9	24.77	4.07	Rural Restricted	12	6	16.73	4.90
Rural Unrestricted	13	2	12.24	7.65	Urban Unrestricted	13	9	24.91	3.90	Rural Restricted	13	6	16.51	4.69
Rural Unrestricted	14	2	12.11	7.44	Urban Unrestricted	14	9	25.03	3.76	Rural Restricted	14	6	16.32	4.50
Rural Unrestricted	15	2	12.00	7.26	Urban Unrestricted	15	9	25.14	3.64	Rural Restricted	15	6	16.16	4.34
Rural Unrestricted	16	2	11.90	7.10	Urban Unrestricted	16	9	25.19	3.53	Rural Restricted	16	6	16.16	4.16
Rural Unrestricted	17	2	11.80	6.95	Urban Unrestricted	17	9	25.18	3.43	Rural Restricted	17	6	16.53	3.91
Rural Unrestricted	18	2	11.71	6.82	Urban Unrestricted	18	9	25.17	3.34	Rural Restricted	18	6	16.86	3.68
Rural Unrestricted	19	2	11.57	6.63	Urban Unrestricted	19	9	25.45	3.21	Rural Restricted	19	6	17.15	3.48
Rural Unrestricted	20	2	11.39	6.36	Urban Unrestricted	20	9	26.06	3.02	Rural Restricted	20	6	17.42	3.30
Rural Unrestricted	21	2	11.22	6.12	Urban Unrestricted	21	9	26.62	2.85	Rural Restricted	21	6	17.56	3.14
Rural Unrestricted	22	2	11.03	5.90	Urban Unrestricted	22	9	27.11	2.66	Rural Restricted	22	6	17.54	3.00
Rural Unrestricted	23	2	10.85	5.69	Urban Unrestricted	23	9	27.57	2.49	Rural Restricted	23	6	17.53	2.88
Rural Unrestricted	24	2	10.69	5.51	Urban Unrestricted	24	9	27.98	2.34	Rural Restricted	24	6	17.51	2.76
Rural Unrestricted	25	2	10.54	5.37	Urban Unrestricted	25	9	28.32	2.22	Rural Restricted	25	6	17.45	2.70
Rural Unrestricted	26	2	10.44	5.31	Urban Unrestricted	26	9	28.16	2.13	Rural Restricted	26	6	17.36	2.69
Rural Unrestricted	27	2	10.38	5.28	Urban Unrestricted	27	9	27.73	2.06	Rural Restricted	27	6	17.28	2.67
Rural Unrestricted	28	2	10.32	5.26	Urban Unrestricted	28	9	27.34	2.00	Rural Restricted	28	6	17.20	2.66
Rural Unrestricted	29	2	10.27	5.23	Urban Unrestricted	29	9	26.97	1.93	Rural Restricted	29	6	17.12	2.65
Rural Unrestricted	30	2	10.22	5.21	Urban Unrestricted	30	9	26.63	1.87	Rural Restricted	30	6	17.06	2.64
Rural Unrestricted	31	2	10.17	5.19	Urban Unrestricted	31	9	26.31	1.82	Rural Restricted	31	6	17.11	2.63
Rural Unrestricted	32	2	10.00	5.02	Urban Unrestricted	32	9	26.24	1.74	Rural Restricted	32	6	17.11	2.53
Rural Unrestricted	33	2	9.71	4.75	Urban Unrestricted	33	9	26.03	1.63	Rural Restricted	33	6	16.95	2.36
Rural Unrestricted	34	2	9.43	4.49	Urban Unrestricted	34	9	25.83	1.54	Rural Restricted	34	6	16.80	2.20

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	35	2	9.27	4.34	Urban Unrestricted	35	9	25.77	1.46	Rural Restricted	35	6	16.80	2.11
Rural Unrestricted	36	2	9.18	4.28	Urban Unrestricted	36	9	25.80	1.41	Rural Restricted	36	6	16.89	2.07
Rural Unrestricted	37	2	9.10	4.21	Urban Unrestricted	37	9	25.83	1.35	Rural Restricted	37	6	16.98	2.03
Rural Unrestricted	38	2	9.02	4.15	Urban Unrestricted	38	9	25.86	1.30	Rural Restricted	38	6	17.06	1.99
Rural Unrestricted	39	2	8.94	4.10	Urban Unrestricted	39	9	25.89	1.26	Rural Restricted	39	6	17.14	1.96
Rural Unrestricted	40	2	8.87	4.04	Urban Unrestricted	40	9	25.91	1.21	Rural Restricted	40	6	17.21	1.93
Rural Unrestricted	41	2	8.80	3.99	Urban Unrestricted	41	9	25.94	1.17	Rural Restricted	41	6	17.29	1.89
Rural Unrestricted	42	2	8.73	3.94	Urban Unrestricted	42	9	25.96	1.13	Rural Restricted	42	6	17.35	1.86
Rural Unrestricted	43	2	8.67	3.89	Urban Unrestricted	43	9	25.98	1.09	Rural Restricted	43	6	17.42	1.84
Rural Unrestricted	44	2	8.61	3.85	Urban Unrestricted	44	9	26.04	1.05	Rural Restricted	44	6	17.48	1.81
Rural Unrestricted	45	2	8.53	3.81	Urban Unrestricted	45	9	26.09	1.01	Rural Restricted	45	6	17.51	1.78
Rural Unrestricted	46	2	8.45	3.77	Urban Unrestricted	46	9	26.10	0.98	Rural Restricted	46	6	17.50	1.75
Rural Unrestricted	47	2	8.36	3.73	Urban Unrestricted	47	9	26.12	0.95	Rural Restricted	47	6	17.54	1.71
Rural Unrestricted	48	2	8.28	3.69	Urban Unrestricted	48	9	26.13	0.92	Rural Restricted	48	6	17.59	1.67
Rural Unrestricted	49	2	8.20	3.66	Urban Unrestricted	49	9	26.14	0.89	Rural Restricted	49	6	17.63	1.63
Rural Unrestricted	50	2	8.17	3.64	Urban Unrestricted	50	9	26.15	0.86	Rural Restricted	50	6	17.67	1.59
Rural Unrestricted	51	2	8.15	3.62	Urban Unrestricted	51	9	26.17	0.83	Rural Restricted	51	6	17.71	1.56
Rural Unrestricted	52	2	8.13	3.61	Urban Unrestricted	52	9	26.18	0.80	Rural Restricted	52	6	17.74	1.53
Rural Unrestricted	53	2	8.10	3.60	Urban Unrestricted	53	9	26.17	0.78	Rural Restricted	53	6	17.78	1.49
Rural Unrestricted	54	2	8.08	3.58	Urban Unrestricted	54	9	26.10	0.76	Rural Restricted	54	6	17.81	1.46
Rural Unrestricted	55	2	8.06	3.57	Urban Unrestricted	55	9	26.03	0.75	Rural Restricted	55	6	17.85	1.43
Rural Unrestricted	56	2	8.05	3.55	Urban Unrestricted	56	9	25.97	0.74	Rural Restricted	56	6	17.88	1.40
Rural Unrestricted	57	2	8.06	3.53	Urban Unrestricted	57	9	25.93	0.72	Rural Restricted	57	6	17.92	1.37
Rural Unrestricted	58	2	8.06	3.50	Urban Unrestricted	58	9	25.88	0.71	Rural Restricted	58	6	17.96	1.34
Rural Unrestricted	59	2	8.06	3.48	Urban Unrestricted	59	9	25.84	0.70	Rural Restricted	59	6	18.02	1.31
Rural Unrestricted	60	2	8.07	3.46	Urban Unrestricted	60	9	25.80	0.69	Rural Restricted	60	6	18.16	1.30
Rural Unrestricted	61	2	8.14	3.44	Urban Unrestricted	61	9	25.81	0.68	Rural Restricted	61	6	18.37	1.28
Rural Unrestricted	62	2	8.25	3.42	Urban Unrestricted	62	9	25.84	0.67	Rural Restricted	62	6	18.61	1.26
Rural Unrestricted	63	2	8.36	3.40	Urban Unrestricted	63	9	25.88	0.67	Rural Restricted	63	6	18.85	1.25
Rural Unrestricted	64	2	8.55	3.39	Urban Unrestricted	64	9	25.87	0.65	Rural Restricted	64	6	19.09	1.24
Rural Unrestricted	65	2	8.87	3.40	Urban Unrestricted	65	9	25.79	0.64	Rural Restricted	65	6	19.36	1.22
Rural Unrestricted	66	2	9.18	3.42	Urban Unrestricted	66	9	25.71	0.62	Rural Restricted	66	6	19.67	1.22
Rural Unrestricted	67	2	9.49	3.43	Urban Unrestricted	67	9	25.64	0.61	Rural Restricted	67	6	19.95	1.20
Rural Unrestricted	68	2	9.78	3.44	Urban Unrestricted	68	9	25.56	0.59	Rural Restricted	68	6	20.21	1.18
Rural Unrestricted	69	2	10.07	3.45	Urban Unrestricted	69	9	25.49	0.58	Rural Restricted	69	6	20.47	1.17
Rural Unrestricted	70	2	10.35	3.46	Urban Unrestricted	70	9	25.42	0.56	Rural Restricted	70	6	20.72	1.15
Rural Unrestricted	71	2	10.62	3.46	Urban Unrestricted	71	9	25.35	0.55	Rural Restricted	71	6	20.97	1.13
Rural Unrestricted	72	2	10.88	3.47	Urban Unrestricted	72	9	25.29	0.54	Rural Restricted	72	6	21.20	1.11
Rural Unrestricted	73	2	11.13	3.48	Urban Unrestricted	73	9	25.23	0.52	Rural Restricted	73	6	21.43	1.10
Rural Unrestricted	74	2	11.37	3.56	Urban Unrestricted	74	9	25.16	0.52	Rural Restricted	74	6	21.54	1.10
Rural Unrestricted	75	2	11.74	3.87	Urban Unrestricted	75	9	24.97	0.53	Rural Restricted	75	6	21.19	1.19
Urban Unrestricted	1	2	67.11	42.61	Rural Unrestricted	1	10	71.55	25.53	Urban Restricted	1	6	69.77	30.93

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	2	2	33.85	21.76	Rural Unrestricted	2	10	36.89	12.92	Urban Restricted	2	6	35.65	15.69
Urban Unrestricted	3	2	24.14	16.29	Rural Unrestricted	3	10	30.24	9.26	Urban Restricted	3	6	27.07	11.31
Urban Unrestricted	4	2	19.82	13.92	Rural Unrestricted	4	10	28.78	7.58	Urban Restricted	4	6	23.62	9.30
Urban Unrestricted	5	2	17.36	12.32	Rural Unrestricted	5	10	28.09	6.50	Urban Restricted	5	6	21.62	8.05
Urban Unrestricted	6	2	15.87	11.05	Rural Unrestricted	6	10	27.86	5.69	Urban Restricted	6	6	20.38	7.16
Urban Unrestricted	7	2	14.80	10.14	Rural Unrestricted	7	10	27.70	5.11	Urban Restricted	7	6	19.49	6.53
Urban Unrestricted	8	2	14.00	9.46	Rural Unrestricted	8	10	27.58	4.68	Urban Restricted	8	6	18.83	6.05
Urban Unrestricted	9	2	13.38	8.93	Rural Unrestricted	9	10	27.49	4.34	Urban Restricted	9	6	18.21	5.69
Urban Unrestricted	10	2	12.88	8.50	Rural Unrestricted	10	10	27.40	4.07	Urban Restricted	10	6	17.48	5.40
Urban Unrestricted	11	2	12.53	8.15	Rural Unrestricted	11	10	27.39	3.85	Urban Restricted	11	6	16.96	5.14
Urban Unrestricted	12	2	12.36	7.87	Rural Unrestricted	12	10	27.50	3.67	Urban Restricted	12	6	16.70	4.89
Urban Unrestricted	13	2	12.21	7.63	Rural Unrestricted	13	10	27.59	3.52	Urban Restricted	13	6	16.48	4.68
Urban Unrestricted	14	2	12.09	7.42	Rural Unrestricted	14	10	27.66	3.39	Urban Restricted	14	6	16.29	4.49
Urban Unrestricted	15	2	11.98	7.24	Rural Unrestricted	15	10	27.73	3.28	Urban Restricted	15	6	16.13	4.33
Urban Unrestricted	16	2	11.88	7.08	Rural Unrestricted	16	10	27.78	3.17	Urban Restricted	16	6	16.12	4.15
Urban Unrestricted	17	2	11.78	6.93	Rural Unrestricted	17	10	27.82	3.07	Urban Restricted	17	6	16.50	3.90
Urban Unrestricted	18	2	11.69	6.80	Rural Unrestricted	18	10	27.85	2.98	Urban Restricted	18	6	16.83	3.67
Urban Unrestricted	19	2	11.56	6.61	Rural Unrestricted	19	10	28.24	2.86	Urban Restricted	19	6	17.13	3.47
Urban Unrestricted	20	2	11.37	6.35	Rural Unrestricted	20	10	29.06	2.70	Urban Restricted	20	6	17.40	3.29
Urban Unrestricted	21	2	11.20	6.11	Rural Unrestricted	21	10	29.80	2.55	Urban Restricted	21	6	17.54	3.13
Urban Unrestricted	22	2	11.01	5.88	Rural Unrestricted	22	10	30.43	2.39	Urban Restricted	22	6	17.52	3.00
Urban Unrestricted	23	2	10.83	5.68	Rural Unrestricted	23	10	31.01	2.24	Urban Restricted	23	6	17.51	2.87
Urban Unrestricted	24	2	10.67	5.49	Rural Unrestricted	24	10	31.55	2.10	Urban Restricted	24	6	17.49	2.75
Urban Unrestricted	25	2	10.52	5.35	Rural Unrestricted	25	10	32.01	2.00	Urban Restricted	25	6	17.44	2.69
Urban Unrestricted	26	2	10.42	5.30	Rural Unrestricted	26	10	31.87	1.93	Urban Restricted	26	6	17.34	2.68
Urban Unrestricted	27	2	10.36	5.27	Rural Unrestricted	27	10	31.42	1.87	Urban Restricted	27	6	17.26	2.67
Urban Unrestricted	28	2	10.30	5.24	Rural Unrestricted	28	10	31.00	1.81	Urban Restricted	28	6	17.18	2.65
Urban Unrestricted	29	2	10.25	5.22	Rural Unrestricted	29	10	30.62	1.75	Urban Restricted	29	6	17.11	2.64
Urban Unrestricted	30	2	10.20	5.20	Rural Unrestricted	30	10	30.25	1.70	Urban Restricted	30	6	17.04	2.63
Urban Unrestricted	31	2	10.16	5.18	Rural Unrestricted	31	10	29.92	1.65	Urban Restricted	31	6	17.09	2.62
Urban Unrestricted	32	2	9.97	5.00	Rural Unrestricted	32	10	29.81	1.58	Urban Restricted	32	6	17.10	2.52
Urban Unrestricted	33	2	9.67	4.72	Rural Unrestricted	33	10	29.57	1.48	Urban Restricted	33	6	16.94	2.35
Urban Unrestricted	34	2	9.39	4.46	Rural Unrestricted	34	10	29.34	1.39	Urban Restricted	34	6	16.80	2.19
Urban Unrestricted	35	2	9.22	4.31	Rural Unrestricted	35	10	29.25	1.32	Urban Restricted	35	6	16.80	2.10
Urban Unrestricted	36	2	9.12	4.24	Rural Unrestricted	36	10	29.25	1.28	Urban Restricted	36	6	16.90	2.06
Urban Unrestricted	37	2	9.03	4.17	Rural Unrestricted	37	10	29.25	1.24	Urban Restricted	37	6	16.98	2.02
Urban Unrestricted	38	2	8.94	4.11	Rural Unrestricted	38	10	29.25	1.20	Urban Restricted	38	6	17.07	1.99
Urban Unrestricted	39	2	8.86	4.05	Rural Unrestricted	39	10	29.25	1.16	Urban Restricted	39	6	17.15	1.95
Urban Unrestricted	40	2	8.78	3.99	Rural Unrestricted	40	10	29.25	1.12	Urban Restricted	40	6	17.22	1.92
Urban Unrestricted	41	2	8.70	3.94	Rural Unrestricted	41	10	29.25	1.09	Urban Restricted	41	6	17.30	1.89
Urban Unrestricted	42	2	8.63	3.88	Rural Unrestricted	42	10	29.25	1.05	Urban Restricted	42	6	17.36	1.86
Urban Unrestricted	43	2	8.56	3.83	Rural Unrestricted	43	10	29.25	1.02	Urban Restricted	43	6	17.43	1.83

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	44	2	8.50	3.79	Rural Unrestricted	44	10	29.25	0.99	Urban Restricted	44	6	17.49	1.80
Urban Unrestricted	45	2	8.43	3.75	Rural Unrestricted	45	10	29.21	0.96	Urban Restricted	45	6	17.52	1.77
Urban Unrestricted	46	2	8.35	3.72	Rural Unrestricted	46	10	29.14	0.93	Urban Restricted	46	6	17.52	1.74
Urban Unrestricted	47	2	8.27	3.68	Rural Unrestricted	47	10	29.08	0.90	Urban Restricted	47	6	17.56	1.70
Urban Unrestricted	48	2	8.19	3.65	Rural Unrestricted	48	10	29.01	0.88	Urban Restricted	48	6	17.61	1.66
Urban Unrestricted	49	2	8.12	3.61	Rural Unrestricted	49	10	28.95	0.85	Urban Restricted	49	6	17.65	1.62
Urban Unrestricted	50	2	8.04	3.58	Rural Unrestricted	50	10	28.79	0.83	Urban Restricted	50	6	17.69	1.59
Urban Unrestricted	51	2	7.98	3.55	Rural Unrestricted	51	10	28.62	0.81	Urban Restricted	51	6	17.73	1.55
Urban Unrestricted	52	2	7.91	3.53	Rural Unrestricted	52	10	28.46	0.79	Urban Restricted	52	6	17.77	1.52
Urban Unrestricted	53	2	7.86	3.50	Rural Unrestricted	53	10	28.30	0.77	Urban Restricted	53	6	17.81	1.49
Urban Unrestricted	54	2	7.86	3.50	Rural Unrestricted	54	10	28.16	0.75	Urban Restricted	54	6	17.84	1.46
Urban Unrestricted	55	2	7.86	3.49	Rural Unrestricted	55	10	28.01	0.73	Urban Restricted	55	6	17.88	1.43
Urban Unrestricted	56	2	7.88	3.48	Rural Unrestricted	56	10	27.89	0.71	Urban Restricted	56	6	17.92	1.40
Urban Unrestricted	57	2	7.91	3.46	Rural Unrestricted	57	10	27.77	0.69	Urban Restricted	57	6	17.96	1.37
Urban Unrestricted	58	2	7.93	3.45	Rural Unrestricted	58	10	27.66	0.68	Urban Restricted	58	6	18.00	1.34
Urban Unrestricted	59	2	7.96	3.43	Rural Unrestricted	59	10	27.56	0.66	Urban Restricted	59	6	18.06	1.31
Urban Unrestricted	60	2	7.98	3.42	Rural Unrestricted	60	10	27.45	0.64	Urban Restricted	60	6	18.20	1.29
Urban Unrestricted	61	2	8.07	3.41	Rural Unrestricted	61	10	27.41	0.63	Urban Restricted	61	6	18.41	1.27
Urban Unrestricted	62	2	8.21	3.39	Rural Unrestricted	62	10	27.40	0.62	Urban Restricted	62	6	18.65	1.26
Urban Unrestricted	63	2	8.34	3.38	Rural Unrestricted	63	10	27.40	0.60	Urban Restricted	63	6	18.90	1.24
Urban Unrestricted	64	2	8.53	3.37	Rural Unrestricted	64	10	27.34	0.59	Urban Restricted	64	6	19.13	1.23
Urban Unrestricted	65	2	8.86	3.39	Rural Unrestricted	65	10	27.19	0.58	Urban Restricted	65	6	19.41	1.22
Urban Unrestricted	66	2	9.17	3.40	Rural Unrestricted	66	10	27.05	0.57	Urban Restricted	66	6	19.71	1.21
Urban Unrestricted	67	2	9.48	3.41	Rural Unrestricted	67	10	26.91	0.55	Urban Restricted	67	6	20.00	1.20
Urban Unrestricted	68	2	9.77	3.42	Rural Unrestricted	68	10	26.77	0.54	Urban Restricted	68	6	20.27	1.18
Urban Unrestricted	69	2	10.06	3.43	Rural Unrestricted	69	10	26.64	0.53	Urban Restricted	69	6	20.53	1.16
Urban Unrestricted	70	2	10.34	3.44	Rural Unrestricted	70	10	26.51	0.52	Urban Restricted	70	6	20.78	1.14
Urban Unrestricted	71	2	10.61	3.45	Rural Unrestricted	71	10	26.38	0.51	Urban Restricted	71	6	21.02	1.12
Urban Unrestricted	72	2	10.87	3.46	Rural Unrestricted	72	10	26.26	0.50	Urban Restricted	72	6	21.26	1.11
Urban Unrestricted	73	2	11.12	3.47	Rural Unrestricted	73	10	26.15	0.49	Urban Restricted	73	6	21.49	1.09
Urban Unrestricted	74	2	11.37	3.54	Rural Unrestricted	74	10	26.04	0.48	Urban Restricted	74	6	21.60	1.10
Urban Unrestricted	75	2	11.74	3.85	Rural Unrestricted	75	10	25.84	0.49	Urban Restricted	75	6	21.25	1.18
Rural Unrestricted	1	3	68.25	41.78	Urban Unrestricted	1	10	71.33	25.35	Rural Restricted	1	7	70.06	30.02
Rural Unrestricted	2	3	34.61	21.25	Urban Unrestricted	2	10	36.77	12.83	Rural Restricted	2	7	35.91	15.22
Rural Unrestricted	3	3	25.26	15.63	Urban Unrestricted	3	10	30.16	9.19	Rural Restricted	3	7	27.76	10.93
Rural Unrestricted	4	3	21.20	13.14	Urban Unrestricted	4	10	28.72	7.53	Rural Restricted	4	7	24.66	8.94
Rural Unrestricted	5	3	18.81	11.54	Urban Unrestricted	5	10	28.04	6.46	Rural Restricted	5	7	22.87	7.68
Rural Unrestricted	6	3	17.28	10.33	Urban Unrestricted	6	10	27.82	5.66	Rural Restricted	6	7	21.77	6.76
Rural Unrestricted	7	3	16.18	9.47	Urban Unrestricted	7	10	27.67	5.08	Rural Restricted	7	7	20.98	6.10
Rural Unrestricted	8	3	15.35	8.82	Urban Unrestricted	8	10	27.55	4.65	Rural Restricted	8	7	20.39	5.60
Rural Unrestricted	9	3	14.71	8.32	Urban Unrestricted	9	10	27.46	4.32	Rural Restricted	9	7	19.79	5.21
Rural Unrestricted	10	3	14.19	7.91	Urban Unrestricted	10	10	27.38	4.05	Rural Restricted	10	7	18.99	4.91

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	11	3	13.83	7.57	Urban Unrestricted	11	10	27.37	3.83	Rural Restricted	11	7	18.41	4.65
Rural Unrestricted	12	3	13.67	7.24	Urban Unrestricted	12	10	27.48	3.65	Rural Restricted	12	7	18.11	4.42
Rural Unrestricted	13	3	13.53	6.97	Urban Unrestricted	13	10	27.57	3.50	Rural Restricted	13	7	17.85	4.22
Rural Unrestricted	14	3	13.41	6.73	Urban Unrestricted	14	10	27.65	3.37	Rural Restricted	14	7	17.63	4.05
Rural Unrestricted	15	3	13.30	6.53	Urban Unrestricted	15	10	27.72	3.26	Rural Restricted	15	7	17.44	3.91
Rural Unrestricted	16	3	13.22	6.36	Urban Unrestricted	16	10	27.77	3.16	Rural Restricted	16	7	17.48	3.74
Rural Unrestricted	17	3	13.14	6.21	Urban Unrestricted	17	10	27.81	3.06	Rural Restricted	17	7	18.09	3.50
Rural Unrestricted	18	3	13.08	6.09	Urban Unrestricted	18	10	27.84	2.97	Rural Restricted	18	7	18.63	3.28
Rural Unrestricted	19	3	12.97	5.91	Urban Unrestricted	19	10	28.24	2.85	Rural Restricted	19	7	19.12	3.09
Rural Unrestricted	20	3	12.83	5.66	Urban Unrestricted	20	10	29.06	2.69	Rural Restricted	20	7	19.55	2.91
Rural Unrestricted	21	3	12.69	5.42	Urban Unrestricted	21	10	29.80	2.54	Rural Restricted	21	7	19.79	2.77
Rural Unrestricted	22	3	12.53	5.17	Urban Unrestricted	22	10	30.44	2.38	Rural Restricted	22	7	19.76	2.63
Rural Unrestricted	23	3	12.38	4.93	Urban Unrestricted	23	10	31.02	2.23	Rural Restricted	23	7	19.73	2.50
Rural Unrestricted	24	3	12.25	4.72	Urban Unrestricted	24	10	31.55	2.09	Rural Restricted	24	7	19.71	2.39
Rural Unrestricted	25	3	12.11	4.59	Urban Unrestricted	25	10	32.02	1.99	Rural Restricted	25	7	19.66	2.32
Rural Unrestricted	26	3	12.02	4.55	Urban Unrestricted	26	10	31.88	1.92	Rural Restricted	26	7	19.58	2.31
Rural Unrestricted	27	3	11.97	4.53	Urban Unrestricted	27	10	31.43	1.86	Rural Restricted	27	7	19.51	2.29
Rural Unrestricted	28	3	11.92	4.52	Urban Unrestricted	28	10	31.01	1.80	Rural Restricted	28	7	19.45	2.28
Rural Unrestricted	29	3	11.88	4.50	Urban Unrestricted	29	10	30.62	1.74	Rural Restricted	29	7	19.39	2.27
Rural Unrestricted	30	3	11.84	4.48	Urban Unrestricted	30	10	30.26	1.69	Rural Restricted	30	7	19.34	2.26
Rural Unrestricted	31	3	11.80	4.47	Urban Unrestricted	31	10	29.92	1.65	Rural Restricted	31	7	19.43	2.24
Rural Unrestricted	32	3	11.65	4.33	Urban Unrestricted	32	10	29.75	1.57	Rural Restricted	32	7	19.47	2.14
Rural Unrestricted	33	3	11.35	4.10	Urban Unrestricted	33	10	29.44	1.46	Rural Restricted	33	7	19.35	1.99
Rural Unrestricted	34	3	11.06	3.88	Urban Unrestricted	34	10	29.15	1.36	Rural Restricted	34	7	19.23	1.84
Rural Unrestricted	35	3	10.93	3.75	Urban Unrestricted	35	10	29.00	1.30	Rural Restricted	35	7	19.26	1.75
Rural Unrestricted	36	3	10.89	3.69	Urban Unrestricted	36	10	28.95	1.25	Rural Restricted	36	7	19.40	1.71
Rural Unrestricted	37	3	10.85	3.63	Urban Unrestricted	37	10	28.90	1.20	Rural Restricted	37	7	19.52	1.67
Rural Unrestricted	38	3	10.82	3.57	Urban Unrestricted	38	10	28.85	1.15	Rural Restricted	38	7	19.65	1.63
Rural Unrestricted	39	3	10.78	3.51	Urban Unrestricted	39	10	28.81	1.11	Rural Restricted	39	7	19.76	1.59
Rural Unrestricted	40	3	10.75	3.46	Urban Unrestricted	40	10	28.76	1.07	Rural Restricted	40	7	19.87	1.55
Rural Unrestricted	41	3	10.72	3.41	Urban Unrestricted	41	10	28.72	1.03	Rural Restricted	41	7	19.97	1.52
Rural Unrestricted	42	3	10.69	3.37	Urban Unrestricted	42	10	28.68	1.00	Rural Restricted	42	7	20.07	1.49
Rural Unrestricted	43	3	10.66	3.32	Urban Unrestricted	43	10	28.64	0.96	Rural Restricted	43	7	20.16	1.46
Rural Unrestricted	44	3	10.63	3.28	Urban Unrestricted	44	10	28.66	0.93	Rural Restricted	44	7	20.25	1.43
Rural Unrestricted	45	3	10.59	3.24	Urban Unrestricted	45	10	28.66	0.91	Rural Restricted	45	7	20.31	1.40
Rural Unrestricted	46	3	10.53	3.21	Urban Unrestricted	46	10	28.63	0.88	Rural Restricted	46	7	20.33	1.37
Rural Unrestricted	47	3	10.48	3.19	Urban Unrestricted	47	10	28.59	0.85	Rural Restricted	47	7	20.38	1.33
Rural Unrestricted	48	3	10.42	3.16	Urban Unrestricted	48	10	28.56	0.83	Rural Restricted	48	7	20.44	1.30
Rural Unrestricted	49	3	10.37	3.13	Urban Unrestricted	49	10	28.53	0.81	Rural Restricted	49	7	20.49	1.27
Rural Unrestricted	50	3	10.38	3.13	Urban Unrestricted	50	10	28.50	0.78	Rural Restricted	50	7	20.55	1.24
Rural Unrestricted	51	3	10.39	3.12	Urban Unrestricted	51	10	28.47	0.76	Rural Restricted	51	7	20.60	1.21
Rural Unrestricted	52	3	10.40	3.11	Urban Unrestricted	52	10	28.44	0.74	Rural Restricted	52	7	20.65	1.18

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	53	3	10.41	3.11	Urban Unrestricted	53	10	28.39	0.72	Rural Restricted	53	7	20.69	1.15
Rural Unrestricted	54	3	10.42	3.10	Urban Unrestricted	54	10	28.24	0.71	Rural Restricted	54	7	20.74	1.13
Rural Unrestricted	55	3	10.43	3.10	Urban Unrestricted	55	10	28.09	0.69	Rural Restricted	55	7	20.78	1.10
Rural Unrestricted	56	3	10.46	3.08	Urban Unrestricted	56	10	27.95	0.68	Rural Restricted	56	7	20.84	1.07
Rural Unrestricted	57	3	10.52	3.06	Urban Unrestricted	57	10	27.83	0.67	Rural Restricted	57	7	20.91	1.04
Rural Unrestricted	58	3	10.57	3.04	Urban Unrestricted	58	10	27.72	0.65	Rural Restricted	58	7	20.98	1.01
Rural Unrestricted	59	3	10.62	3.02	Urban Unrestricted	59	10	27.60	0.64	Rural Restricted	59	7	21.04	0.98
Rural Unrestricted	60	3	10.67	3.00	Urban Unrestricted	60	10	27.49	0.63	Rural Restricted	60	7	21.08	0.96
Rural Unrestricted	61	3	10.74	2.98	Urban Unrestricted	61	10	27.44	0.62	Rural Restricted	61	7	21.17	0.94
Rural Unrestricted	62	3	10.82	2.96	Urban Unrestricted	62	10	27.43	0.61	Rural Restricted	62	7	21.30	0.93
Rural Unrestricted	63	3	10.89	2.94	Urban Unrestricted	63	10	27.42	0.60	Rural Restricted	63	7	21.42	0.91
Rural Unrestricted	64	3	11.05	2.92	Urban Unrestricted	64	10	27.36	0.59	Rural Restricted	64	7	21.54	0.90
Rural Unrestricted	65	3	11.36	2.91	Urban Unrestricted	65	10	27.21	0.57	Rural Restricted	65	7	21.70	0.88
Rural Unrestricted	66	3	11.67	2.89	Urban Unrestricted	66	10	27.07	0.56	Rural Restricted	66	7	21.89	0.87
Rural Unrestricted	67	3	11.97	2.88	Urban Unrestricted	67	10	26.93	0.55	Rural Restricted	67	7	22.06	0.86
Rural Unrestricted	68	3	12.26	2.87	Urban Unrestricted	68	10	26.79	0.54	Rural Restricted	68	7	22.22	0.84
Rural Unrestricted	69	3	12.54	2.86	Urban Unrestricted	69	10	26.66	0.53	Rural Restricted	69	7	22.38	0.82
Rural Unrestricted	70	3	12.81	2.85	Urban Unrestricted	70	10	26.53	0.51	Rural Restricted	70	7	22.53	0.81
Rural Unrestricted	71	3	13.07	2.84	Urban Unrestricted	71	10	26.40	0.50	Rural Restricted	71	7	22.68	0.79
Rural Unrestricted	72	3	13.33	2.83	Urban Unrestricted	72	10	26.28	0.49	Rural Restricted	72	7	22.82	0.78
Rural Unrestricted	73	3	13.58	2.82	Urban Unrestricted	73	10	26.17	0.48	Rural Restricted	73	7	22.96	0.76
Rural Unrestricted	74	3	13.85	2.86	Urban Unrestricted	74	10	26.06	0.48	Rural Restricted	74	7	23.00	0.77
Rural Unrestricted	75	3	14.18	3.13	Urban Unrestricted	75	10	25.86	0.48	Rural Restricted	75	7	22.70	0.85
Urban Unrestricted	1	3	68.05	41.58	Rural Restricted	1	0	63.57	63.57	Urban Restricted	1	7	69.92	29.90
Urban Unrestricted	2	3	34.51	21.16	Rural Restricted	2	0	31.88	31.88	Urban Restricted	2	7	35.84	15.16
Urban Unrestricted	3	3	25.19	15.56	Rural Restricted	3	0	21.86	21.86	Urban Restricted	3	7	27.70	10.89
Urban Unrestricted	4	3	21.15	13.09	Rural Restricted	4	0	17.11	17.11	Urban Restricted	4	7	24.61	8.90
Urban Unrestricted	5	3	18.77	11.50	Rural Restricted	5	0	14.40	14.40	Urban Restricted	5	7	22.83	7.65
Urban Unrestricted	6	3	17.24	10.29	Rural Restricted	6	0	12.76	12.76	Urban Restricted	6	7	21.73	6.73
Urban Unrestricted	7	3	16.14	9.44	Rural Restricted	7	0	11.59	11.59	Urban Restricted	7	7	20.95	6.07
Urban Unrestricted	8	3	15.32	8.79	Rural Restricted	8	0	10.72	10.72	Urban Restricted	8	7	20.36	5.58
Urban Unrestricted	9	3	14.68	8.29	Rural Restricted	9	0	10.05	10.05	Urban Restricted	9	7	19.76	5.20
Urban Unrestricted	10	3	14.17	7.89	Rural Restricted	10	0	9.53	9.53	Urban Restricted	10	7	18.96	4.89
Urban Unrestricted	11	3	13.81	7.55	Rural Restricted	11	0	9.12	9.12	Urban Restricted	11	7	18.38	4.63
Urban Unrestricted	12	3	13.65	7.22	Rural Restricted	12	0	8.82	8.82	Urban Restricted	12	7	18.07	4.40
Urban Unrestricted	13	3	13.51	6.95	Rural Restricted	13	0	8.57	8.57	Urban Restricted	13	7	17.81	4.21
Urban Unrestricted	14	3	13.39	6.72	Rural Restricted	14	0	8.36	8.36	Urban Restricted	14	7	17.59	4.04
Urban Unrestricted	15	3	13.28	6.51	Rural Restricted	15	0	8.17	8.17	Urban Restricted	15	7	17.40	3.90
Urban Unrestricted	16	3	13.20	6.34	Rural Restricted	16	0	8.02	8.02	Urban Restricted	16	7	17.45	3.73
Urban Unrestricted	17	3	13.12	6.20	Rural Restricted	17	0	7.90	7.90	Urban Restricted	17	7	18.06	3.49
Urban Unrestricted	18	3	13.06	6.07	Rural Restricted	18	0	7.79	7.79	Urban Restricted	18	7	18.61	3.27
Urban Unrestricted	19	3	12.96	5.89	Rural Restricted	19	0	7.69	7.69	Urban Restricted	19	7	19.10	3.08

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	20	3	12.81	5.64	Rural Restricted	20	0	7.61	7.61	Urban Restricted	20	7	19.54	2.90
Urban Unrestricted	21	3	12.67	5.41	Rural Restricted	21	0	7.51	7.51	Urban Restricted	21	7	19.78	2.76
Urban Unrestricted	22	3	12.51	5.15	Rural Restricted	22	0	7.35	7.35	Urban Restricted	22	7	19.75	2.62
Urban Unrestricted	23	3	12.36	4.92	Rural Restricted	23	0	7.20	7.20	Urban Restricted	23	7	19.72	2.49
Urban Unrestricted	24	3	12.23	4.71	Rural Restricted	24	0	7.07	7.07	Urban Restricted	24	7	19.70	2.38
Urban Unrestricted	25	3	12.09	4.57	Rural Restricted	25	0	6.99	6.99	Urban Restricted	25	7	19.65	2.32
Urban Unrestricted	26	3	12.00	4.54	Rural Restricted	26	0	6.96	6.96	Urban Restricted	26	7	19.57	2.30
Urban Unrestricted	27	3	11.95	4.52	Rural Restricted	27	0	6.93	6.93	Urban Restricted	27	7	19.50	2.29
Urban Unrestricted	28	3	11.90	4.50	Rural Restricted	28	0	6.90	6.90	Urban Restricted	28	7	19.44	2.27
Urban Unrestricted	29	3	11.86	4.49	Rural Restricted	29	0	6.87	6.87	Urban Restricted	29	7	19.38	2.26
Urban Unrestricted	30	3	11.82	4.47	Rural Restricted	30	0	6.85	6.85	Urban Restricted	30	7	19.33	2.25
Urban Unrestricted	31	3	11.79	4.46	Rural Restricted	31	0	6.83	6.83	Urban Restricted	31	7	19.42	2.23
Urban Unrestricted	32	3	11.61	4.32	Rural Restricted	32	0	6.67	6.67	Urban Restricted	32	7	19.47	2.14
Urban Unrestricted	33	3	11.30	4.08	Rural Restricted	33	0	6.39	6.39	Urban Restricted	33	7	19.35	1.98
Urban Unrestricted	34	3	11.01	3.86	Rural Restricted	34	0	6.13	6.13	Urban Restricted	34	7	19.23	1.83
Urban Unrestricted	35	3	10.86	3.74	Rural Restricted	35	0	5.97	5.97	Urban Restricted	35	7	19.27	1.75
Urban Unrestricted	36	3	10.81	3.67	Rural Restricted	36	0	5.89	5.89	Urban Restricted	36	7	19.41	1.70
Urban Unrestricted	37	3	10.76	3.61	Rural Restricted	37	0	5.81	5.81	Urban Restricted	37	7	19.54	1.66
Urban Unrestricted	38	3	10.71	3.55	Rural Restricted	38	0	5.74	5.74	Urban Restricted	38	7	19.66	1.62
Urban Unrestricted	39	3	10.67	3.49	Rural Restricted	39	0	5.67	5.67	Urban Restricted	39	7	19.77	1.58
Urban Unrestricted	40	3	10.63	3.44	Rural Restricted	40	0	5.60	5.60	Urban Restricted	40	7	19.89	1.55
Urban Unrestricted	41	3	10.59	3.39	Rural Restricted	41	0	5.54	5.54	Urban Restricted	41	7	19.99	1.52
Urban Unrestricted	42	3	10.55	3.34	Rural Restricted	42	0	5.47	5.47	Urban Restricted	42	7	20.09	1.48
Urban Unrestricted	43	3	10.52	3.30	Rural Restricted	43	0	5.42	5.42	Urban Restricted	43	7	20.19	1.45
Urban Unrestricted	44	3	10.51	3.26	Rural Restricted	44	0	5.36	5.36	Urban Restricted	44	7	20.28	1.42
Urban Unrestricted	45	3	10.49	3.22	Rural Restricted	45	0	5.30	5.30	Urban Restricted	45	7	20.33	1.39
Urban Unrestricted	46	3	10.45	3.20	Rural Restricted	46	0	5.25	5.25	Urban Restricted	46	7	20.36	1.36
Urban Unrestricted	47	3	10.42	3.18	Rural Restricted	47	0	5.19	5.19	Urban Restricted	47	7	20.41	1.33
Urban Unrestricted	48	3	10.38	3.15	Rural Restricted	48	0	5.15	5.15	Urban Restricted	48	7	20.47	1.29
Urban Unrestricted	49	3	10.35	3.13	Rural Restricted	49	0	5.10	5.10	Urban Restricted	49	7	20.53	1.26
Urban Unrestricted	50	3	10.32	3.11	Rural Restricted	50	0	5.06	5.06	Urban Restricted	50	7	20.58	1.23
Urban Unrestricted	51	3	10.30	3.09	Rural Restricted	51	0	5.01	5.01	Urban Restricted	51	7	20.63	1.20
Urban Unrestricted	52	3	10.27	3.07	Rural Restricted	52	0	4.97	4.97	Urban Restricted	52	7	20.68	1.17
Urban Unrestricted	53	3	10.25	3.06	Rural Restricted	53	0	4.93	4.93	Urban Restricted	53	7	20.73	1.15
Urban Unrestricted	54	3	10.28	3.06	Rural Restricted	54	0	4.89	4.89	Urban Restricted	54	7	20.78	1.12
Urban Unrestricted	55	3	10.30	3.05	Rural Restricted	55	0	4.86	4.86	Urban Restricted	55	7	20.82	1.10
Urban Unrestricted	56	3	10.35	3.04	Rural Restricted	56	0	4.81	4.81	Urban Restricted	56	7	20.88	1.07
Urban Unrestricted	57	3	10.42	3.03	Rural Restricted	57	0	4.75	4.75	Urban Restricted	57	7	20.96	1.04
Urban Unrestricted	58	3	10.49	3.01	Rural Restricted	58	0	4.70	4.70	Urban Restricted	58	7	21.03	1.01
Urban Unrestricted	59	3	10.55	2.99	Rural Restricted	59	0	4.65	4.65	Urban Restricted	59	7	21.09	0.98
Urban Unrestricted	60	3	10.62	2.97	Rural Restricted	60	0	4.63	4.63	Urban Restricted	60	7	21.13	0.96
Urban Unrestricted	61	3	10.70	2.96	Rural Restricted	61	0	4.65	4.65	Urban Restricted	61	7	21.22	0.94

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	62	3	10.78	2.94	Rural Restricted	62	0	4.70	4.70	Urban Restricted	62	7	21.35	0.92
Urban Unrestricted	63	3	10.87	2.92	Rural Restricted	63	0	4.74	4.74	Urban Restricted	63	7	21.47	0.91
Urban Unrestricted	64	3	11.04	2.90	Rural Restricted	64	0	4.78	4.78	Urban Restricted	64	7	21.59	0.89
Urban Unrestricted	65	3	11.35	2.89	Rural Restricted	65	0	4.91	4.91	Urban Restricted	65	7	21.75	0.88
Urban Unrestricted	66	3	11.66	2.87	Rural Restricted	66	0	5.09	5.09	Urban Restricted	66	7	21.94	0.87
Urban Unrestricted	67	3	11.96	2.86	Rural Restricted	67	0	5.23	5.23	Urban Restricted	67	7	22.11	0.85
Urban Unrestricted	68	3	12.25	2.85	Rural Restricted	68	0	5.35	5.35	Urban Restricted	68	7	22.28	0.84
Urban Unrestricted	69	3	12.53	2.84	Rural Restricted	69	0	5.47	5.47	Urban Restricted	69	7	22.43	0.82
Urban Unrestricted	70	3	12.80	2.83	Rural Restricted	70	0	5.59	5.59	Urban Restricted	70	7	22.59	0.80
Urban Unrestricted	71	3	13.07	2.82	Rural Restricted	71	0	5.70	5.70	Urban Restricted	71	7	22.74	0.79
Urban Unrestricted	72	3	13.33	2.81	Rural Restricted	72	0	5.81	5.81	Urban Restricted	72	7	22.88	0.77
Urban Unrestricted	73	3	13.58	2.80	Rural Restricted	73	0	5.92	5.92	Urban Restricted	73	7	23.02	0.76
Urban Unrestricted	74	3	13.85	2.85	Rural Restricted	74	0	6.17	6.17	Urban Restricted	74	7	23.07	0.77
Urban Unrestricted	75	3	14.18	3.12	Rural Restricted	75	0	6.85	6.85	Urban Restricted	75	7	22.76	0.85
Rural Unrestricted	1	4	68.84	40.14	Urban Restricted	1	0	63.42	63.42	Rural Restricted	1	8	70.31	28.98
Rural Unrestricted	2	4	35.01	20.33	Urban Restricted	2	0	31.80	31.80	Rural Restricted	2	8	36.12	14.67
Rural Unrestricted	3	4	25.98	14.67	Urban Restricted	3	0	21.80	21.80	Rural Restricted	3	8	28.32	10.47
Rural Unrestricted	4	4	22.19	12.15	Urban Restricted	4	0	17.06	17.06	Rural Restricted	4	8	25.54	8.51
Rural Unrestricted	5	4	19.99	10.60	Urban Restricted	5	0	14.36	14.36	Rural Restricted	5	8	23.96	7.26
Rural Unrestricted	6	4	18.62	9.53	Urban Restricted	6	0	12.73	12.73	Rural Restricted	6	8	22.99	6.34
Rural Unrestricted	7	4	17.63	8.76	Urban Restricted	7	0	11.57	11.57	Rural Restricted	7	8	22.31	5.68
Rural Unrestricted	8	4	16.89	8.19	Urban Restricted	8	0	10.69	10.69	Rural Restricted	8	8	21.79	5.19
Rural Unrestricted	9	4	16.32	7.74	Urban Restricted	9	0	10.02	10.02	Rural Restricted	9	8	21.24	4.81
Rural Unrestricted	10	4	15.85	7.38	Urban Restricted	10	0	9.50	9.50	Rural Restricted	10	8	20.42	4.51
Rural Unrestricted	11	4	15.52	7.07	Urban Restricted	11	0	9.10	9.10	Rural Restricted	11	8	19.85	4.26
Rural Unrestricted	12	4	15.35	6.75	Urban Restricted	12	0	8.80	8.80	Rural Restricted	12	8	19.59	4.05
Rural Unrestricted	13	4	15.21	6.48	Urban Restricted	13	0	8.55	8.55	Rural Restricted	13	8	19.36	3.87
Rural Unrestricted	14	4	15.08	6.26	Urban Restricted	14	0	8.34	8.34	Rural Restricted	14	8	19.17	3.72
Rural Unrestricted	15	4	14.97	6.06	Urban Restricted	15	0	8.15	8.15	Rural Restricted	15	8	19.00	3.59
Rural Unrestricted	16	4	14.87	5.88	Urban Restricted	16	0	8.00	8.00	Rural Restricted	16	8	19.10	3.43
Rural Unrestricted	17	4	14.78	5.71	Urban Restricted	17	0	7.88	7.88	Rural Restricted	17	8	19.85	3.20
Rural Unrestricted	18	4	14.70	5.56	Urban Restricted	18	0	7.77	7.77	Rural Restricted	18	8	20.52	2.99
Rural Unrestricted	19	4	14.59	5.35	Urban Restricted	19	0	7.68	7.68	Rural Restricted	19	8	21.12	2.81
Rural Unrestricted	20	4	14.44	5.07	Urban Restricted	20	0	7.59	7.59	Rural Restricted	20	8	21.66	2.64
Rural Unrestricted	21	4	14.33	4.81	Urban Restricted	21	0	7.49	7.49	Rural Restricted	21	8	21.99	2.50
Rural Unrestricted	22	4	14.28	4.53	Urban Restricted	22	0	7.33	7.33	Rural Restricted	22	8	22.03	2.38
Rural Unrestricted	23	4	14.24	4.28	Urban Restricted	23	0	7.19	7.19	Rural Restricted	23	8	22.06	2.26
Rural Unrestricted	24	4	14.20	4.05	Urban Restricted	24	0	7.06	7.06	Rural Restricted	24	8	22.10	2.16
Rural Unrestricted	25	4	14.10	3.91	Urban Restricted	25	0	6.98	6.98	Rural Restricted	25	8	22.11	2.09
Rural Unrestricted	26	4	13.98	3.87	Urban Restricted	26	0	6.94	6.94	Rural Restricted	26	8	22.10	2.06
Rural Unrestricted	27	4	13.88	3.85	Urban Restricted	27	0	6.91	6.91	Rural Restricted	27	8	22.09	2.03
Rural Unrestricted	28	4	13.78	3.84	Urban Restricted	28	0	6.89	6.89	Rural Restricted	28	8	22.09	2.00

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	29	4	13.69	3.83	Urban Restricted	29	0	6.86	6.86	Rural Restricted	29	8	22.08	1.97
Rural Unrestricted	30	4	13.61	3.82	Urban Restricted	30	0	6.83	6.83	Rural Restricted	30	8	22.07	1.95
Rural Unrestricted	31	4	13.54	3.80	Urban Restricted	31	0	6.81	6.81	Rural Restricted	31	8	22.21	1.92
Rural Unrestricted	32	4	13.42	3.70	Urban Restricted	32	0	6.65	6.65	Rural Restricted	32	8	22.29	1.84
Rural Unrestricted	33	4	13.15	3.52	Urban Restricted	33	0	6.38	6.38	Rural Restricted	33	8	22.21	1.72
Rural Unrestricted	34	4	12.90	3.35	Urban Restricted	34	0	6.12	6.12	Rural Restricted	34	8	22.13	1.61
Rural Unrestricted	35	4	12.81	3.25	Urban Restricted	35	0	5.96	5.96	Rural Restricted	35	8	22.19	1.54
Rural Unrestricted	36	4	12.83	3.19	Urban Restricted	36	0	5.88	5.88	Rural Restricted	36	8	22.34	1.49
Rural Unrestricted	37	4	12.85	3.14	Urban Restricted	37	0	5.80	5.80	Rural Restricted	37	8	22.49	1.45
Rural Unrestricted	38	4	12.86	3.09	Urban Restricted	38	0	5.73	5.73	Rural Restricted	38	8	22.62	1.41
Rural Unrestricted	39	4	12.88	3.05	Urban Restricted	39	0	5.65	5.65	Rural Restricted	39	8	22.75	1.37
Rural Unrestricted	40	4	12.89	3.00	Urban Restricted	40	0	5.59	5.59	Rural Restricted	40	8	22.87	1.33
Rural Unrestricted	41	4	12.90	2.96	Urban Restricted	41	0	5.52	5.52	Rural Restricted	41	8	22.99	1.30
Rural Unrestricted	42	4	12.92	2.92	Urban Restricted	42	0	5.46	5.46	Rural Restricted	42	8	23.10	1.26
Rural Unrestricted	43	4	12.93	2.88	Urban Restricted	43	0	5.40	5.40	Rural Restricted	43	8	23.20	1.23
Rural Unrestricted	44	4	12.94	2.85	Urban Restricted	44	0	5.35	5.35	Rural Restricted	44	8	23.30	1.20
Rural Unrestricted	45	4	12.93	2.82	Urban Restricted	45	0	5.29	5.29	Rural Restricted	45	8	23.37	1.17
Rural Unrestricted	46	4	12.89	2.79	Urban Restricted	46	0	5.23	5.23	Rural Restricted	46	8	23.41	1.14
Rural Unrestricted	47	4	12.86	2.76	Urban Restricted	47	0	5.18	5.18	Rural Restricted	47	8	23.42	1.10
Rural Unrestricted	48	4	12.83	2.74	Urban Restricted	48	0	5.14	5.14	Rural Restricted	48	8	23.43	1.07
Rural Unrestricted	49	4	12.81	2.71	Urban Restricted	49	0	5.09	5.09	Rural Restricted	49	8	23.44	1.04
Rural Unrestricted	50	4	12.82	2.70	Urban Restricted	50	0	5.05	5.05	Rural Restricted	50	8	23.45	1.01
Rural Unrestricted	51	4	12.83	2.69	Urban Restricted	51	0	5.00	5.00	Rural Restricted	51	8	23.46	0.98
Rural Unrestricted	52	4	12.85	2.68	Urban Restricted	52	0	4.96	4.96	Rural Restricted	52	8	23.47	0.95
Rural Unrestricted	53	4	12.87	2.67	Urban Restricted	53	0	4.92	4.92	Rural Restricted	53	8	23.48	0.92
Rural Unrestricted	54	4	12.88	2.66	Urban Restricted	54	0	4.89	4.89	Rural Restricted	54	8	23.49	0.90
Rural Unrestricted	55	4	12.89	2.66	Urban Restricted	55	0	4.85	4.85	Rural Restricted	55	8	23.50	0.87
Rural Unrestricted	56	4	12.92	2.64	Urban Restricted	56	0	4.80	4.80	Rural Restricted	56	8	23.53	0.85
Rural Unrestricted	57	4	12.94	2.63	Urban Restricted	57	0	4.75	4.75	Rural Restricted	57	8	23.57	0.83
Rural Unrestricted	58	4	12.97	2.62	Urban Restricted	58	0	4.69	4.69	Rural Restricted	58	8	23.62	0.81
Rural Unrestricted	59	4	13.00	2.61	Urban Restricted	59	0	4.65	4.65	Rural Restricted	59	8	23.64	0.79
Rural Unrestricted	60	4	13.02	2.59	Urban Restricted	60	0	4.63	4.63	Rural Restricted	60	8	23.60	0.78
Rural Unrestricted	61	4	13.08	2.57	Urban Restricted	61	0	4.65	4.65	Rural Restricted	61	8	23.59	0.77
Rural Unrestricted	62	4	13.15	2.55	Urban Restricted	62	0	4.69	4.69	Rural Restricted	62	8	23.61	0.75
Rural Unrestricted	63	4	13.22	2.52	Urban Restricted	63	0	4.73	4.73	Rural Restricted	63	8	23.63	0.74
Rural Unrestricted	64	4	13.39	2.50	Urban Restricted	64	0	4.77	4.77	Rural Restricted	64	8	23.65	0.73
Rural Unrestricted	65	4	13.74	2.48	Urban Restricted	65	0	4.90	4.90	Rural Restricted	65	8	23.73	0.71
Rural Unrestricted	66	4	14.08	2.45	Urban Restricted	66	0	5.08	5.08	Rural Restricted	66	8	23.86	0.70
Rural Unrestricted	67	4	14.42	2.43	Urban Restricted	67	0	5.23	5.23	Rural Restricted	67	8	23.92	0.68
Rural Unrestricted	68	4	14.74	2.40	Urban Restricted	68	0	5.35	5.35	Rural Restricted	68	8	23.94	0.67
Rural Unrestricted	69	4	15.06	2.38	Urban Restricted	69	0	5.47	5.47	Rural Restricted	69	8	23.96	0.65
Rural Unrestricted	70	4	15.36	2.36	Urban Restricted	70	0	5.58	5.58	Rural Restricted	70	8	23.98	0.64

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	71	4	15.66	2.34	Urban Restricted	71	0	5.70	5.70	Rural Restricted	71	8	24.00	0.62
Rural Unrestricted	72	4	15.95	2.32	Urban Restricted	72	0	5.81	5.81	Rural Restricted	72	8	24.02	0.61
Rural Unrestricted	73	4	16.24	2.30	Urban Restricted	73	0	5.92	5.92	Rural Restricted	73	8	24.05	0.60
Rural Unrestricted	74	4	16.57	2.32	Urban Restricted	74	0	6.17	6.17	Rural Restricted	74	8	24.05	0.59
Rural Unrestricted	75	4	16.88	2.49	Urban Restricted	75	0	6.85	6.85	Rural Restricted	75	8	23.88	0.63
Urban Unrestricted	1	4	68.64	39.95	Rural Restricted	1	1	65.80	48.14	Urban Restricted	1	8	70.18	28.85
Urban Unrestricted	2	4	34.91	20.23	Rural Restricted	2	1	33.09	24.59	Urban Restricted	2	8	36.04	14.60
Urban Unrestricted	3	4	25.91	14.61	Rural Restricted	3	1	23.01	18.12	Urban Restricted	3	8	28.25	10.42
Urban Unrestricted	4	4	22.14	12.10	Rural Restricted	4	1	18.26	15.06	Urban Restricted	4	8	25.49	8.47
Urban Unrestricted	5	4	19.95	10.56	Rural Restricted	5	1	15.52	13.04	Urban Restricted	5	8	23.91	7.23
Urban Unrestricted	6	4	18.58	9.49	Rural Restricted	6	1	13.82	11.47	Urban Restricted	6	8	22.96	6.32
Urban Unrestricted	7	4	17.60	8.73	Rural Restricted	7	1	12.61	10.34	Urban Restricted	7	8	22.28	5.66
Urban Unrestricted	8	4	16.86	8.16	Rural Restricted	8	1	11.70	9.49	Urban Restricted	8	8	21.77	5.17
Urban Unrestricted	9	4	16.29	7.72	Rural Restricted	9	1	11.01	8.86	Urban Restricted	9	8	21.21	4.79
Urban Unrestricted	10	4	15.83	7.36	Rural Restricted	10	1	10.48	8.43	Urban Restricted	10	8	20.39	4.49
Urban Unrestricted	11	4	15.50	7.05	Rural Restricted	11	1	10.12	8.07	Urban Restricted	11	8	19.82	4.25
Urban Unrestricted	12	4	15.33	6.73	Rural Restricted	12	1	9.94	7.79	Urban Restricted	12	8	19.55	4.04
Urban Unrestricted	13	4	15.18	6.47	Rural Restricted	13	1	9.80	7.55	Urban Restricted	13	8	19.33	3.86
Urban Unrestricted	14	4	15.06	6.24	Rural Restricted	14	1	9.67	7.34	Urban Restricted	14	8	19.13	3.71
Urban Unrestricted	15	4	14.95	6.04	Rural Restricted	15	1	9.56	7.17	Urban Restricted	15	8	18.96	3.58
Urban Unrestricted	16	4	14.86	5.86	Rural Restricted	16	1	9.45	7.00	Urban Restricted	16	8	19.06	3.42
Urban Unrestricted	17	4	14.76	5.70	Rural Restricted	17	1	9.32	6.82	Urban Restricted	17	8	19.82	3.19
Urban Unrestricted	18	4	14.68	5.55	Rural Restricted	18	1	9.21	6.66	Urban Restricted	18	8	20.50	2.98
Urban Unrestricted	19	4	14.57	5.34	Rural Restricted	19	1	9.11	6.52	Urban Restricted	19	8	21.10	2.80
Urban Unrestricted	20	4	14.42	5.06	Rural Restricted	20	1	9.02	6.39	Urban Restricted	20	8	21.65	2.63
Urban Unrestricted	21	4	14.31	4.79	Rural Restricted	21	1	8.92	6.27	Urban Restricted	21	8	21.98	2.49
Urban Unrestricted	22	4	14.26	4.52	Rural Restricted	22	1	8.75	6.15	Urban Restricted	22	8	22.02	2.37
Urban Unrestricted	23	4	14.22	4.27	Rural Restricted	23	1	8.59	6.05	Urban Restricted	23	8	22.06	2.25
Urban Unrestricted	24	4	14.18	4.04	Rural Restricted	24	1	8.45	5.95	Urban Restricted	24	8	22.09	2.15
Urban Unrestricted	25	4	14.08	3.89	Rural Restricted	25	1	8.35	5.89	Urban Restricted	25	8	22.11	2.08
Urban Unrestricted	26	4	13.96	3.86	Rural Restricted	26	1	8.30	5.84	Urban Restricted	26	8	22.10	2.05
Urban Unrestricted	27	4	13.86	3.84	Rural Restricted	27	1	8.24	5.80	Urban Restricted	27	8	22.09	2.02
Urban Unrestricted	28	4	13.76	3.83	Rural Restricted	28	1	8.19	5.77	Urban Restricted	28	8	22.09	1.99
Urban Unrestricted	29	4	13.68	3.82	Rural Restricted	29	1	8.15	5.73	Urban Restricted	29	8	22.08	1.96
Urban Unrestricted	30	4	13.60	3.80	Rural Restricted	30	1	8.11	5.70	Urban Restricted	30	8	22.07	1.94
Urban Unrestricted	31	4	13.52	3.79	Rural Restricted	31	1	8.08	5.67	Urban Restricted	31	8	22.21	1.91
Urban Unrestricted	32	4	13.40	3.68	Rural Restricted	32	1	7.91	5.52	Urban Restricted	32	8	22.30	1.83
Urban Unrestricted	33	4	13.13	3.50	Rural Restricted	33	1	7.58	5.26	Urban Restricted	33	8	22.22	1.71
Urban Unrestricted	34	4	12.88	3.32	Rural Restricted	34	1	7.26	5.01	Urban Restricted	34	8	22.14	1.60
Urban Unrestricted	35	4	12.80	3.22	Rural Restricted	35	1	7.11	4.88	Urban Restricted	35	8	22.21	1.53
Urban Unrestricted	36	4	12.81	3.16	Rural Restricted	36	1	7.05	4.82	Urban Restricted	36	8	22.36	1.49
Urban Unrestricted	37	4	12.83	3.11	Rural Restricted	37	1	7.00	4.76	Urban Restricted	37	8	22.51	1.44

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	38	4	12.84	3.06	Rural Restricted	38	1	6.95	4.70	Urban Restricted	38	8	22.65	1.40
Urban Unrestricted	39	4	12.86	3.01	Rural Restricted	39	1	6.91	4.65	Urban Restricted	39	8	22.78	1.36
Urban Unrestricted	40	4	12.87	2.96	Rural Restricted	40	1	6.86	4.60	Urban Restricted	40	8	22.90	1.33
Urban Unrestricted	41	4	12.88	2.92	Rural Restricted	41	1	6.82	4.55	Urban Restricted	41	8	23.02	1.29
Urban Unrestricted	42	4	12.89	2.88	Rural Restricted	42	1	6.78	4.50	Urban Restricted	42	8	23.13	1.26
Urban Unrestricted	43	4	12.90	2.84	Rural Restricted	43	1	6.74	4.46	Urban Restricted	43	8	23.24	1.23
Urban Unrestricted	44	4	12.91	2.80	Rural Restricted	44	1	6.70	4.42	Urban Restricted	44	8	23.34	1.20
Urban Unrestricted	45	4	12.88	2.78	Rural Restricted	45	1	6.66	4.38	Urban Restricted	45	8	23.41	1.17
Urban Unrestricted	46	4	12.84	2.75	Rural Restricted	46	1	6.60	4.33	Urban Restricted	46	8	23.45	1.13
Urban Unrestricted	47	4	12.79	2.73	Rural Restricted	47	1	6.54	4.29	Urban Restricted	47	8	23.46	1.10
Urban Unrestricted	48	4	12.75	2.71	Rural Restricted	48	1	6.48	4.25	Urban Restricted	48	8	23.48	1.07
Urban Unrestricted	49	4	12.71	2.68	Rural Restricted	49	1	6.42	4.20	Urban Restricted	49	8	23.49	1.03
Urban Unrestricted	50	4	12.67	2.66	Rural Restricted	50	1	6.37	4.16	Urban Restricted	50	8	23.50	1.00
Urban Unrestricted	51	4	12.64	2.65	Rural Restricted	51	1	6.31	4.12	Urban Restricted	51	8	23.51	0.97
Urban Unrestricted	52	4	12.60	2.63	Rural Restricted	52	1	6.26	4.09	Urban Restricted	52	8	23.52	0.94
Urban Unrestricted	53	4	12.58	2.61	Rural Restricted	53	1	6.21	4.05	Urban Restricted	53	8	23.53	0.92
Urban Unrestricted	54	4	12.63	2.61	Rural Restricted	54	1	6.17	4.01	Urban Restricted	54	8	23.54	0.89
Urban Unrestricted	55	4	12.67	2.60	Rural Restricted	55	1	6.12	3.98	Urban Restricted	55	8	23.55	0.87
Urban Unrestricted	56	4	12.72	2.60	Rural Restricted	56	1	6.07	3.94	Urban Restricted	56	8	23.58	0.84
Urban Unrestricted	57	4	12.78	2.59	Rural Restricted	57	1	6.01	3.90	Urban Restricted	57	8	23.63	0.82
Urban Unrestricted	58	4	12.83	2.58	Rural Restricted	58	1	5.96	3.86	Urban Restricted	58	8	23.67	0.81
Urban Unrestricted	59	4	12.88	2.57	Rural Restricted	59	1	5.92	3.83	Urban Restricted	59	8	23.70	0.79
Urban Unrestricted	60	4	12.93	2.57	Rural Restricted	60	1	5.95	3.82	Urban Restricted	60	8	23.65	0.77
Urban Unrestricted	61	4	13.01	2.55	Rural Restricted	61	1	6.05	3.82	Urban Restricted	61	8	23.65	0.76
Urban Unrestricted	62	4	13.11	2.53	Rural Restricted	62	1	6.19	3.83	Urban Restricted	62	8	23.67	0.75
Urban Unrestricted	63	4	13.20	2.51	Rural Restricted	63	1	6.33	3.84	Urban Restricted	63	8	23.69	0.74
Urban Unrestricted	64	4	13.38	2.49	Rural Restricted	64	1	6.46	3.85	Urban Restricted	64	8	23.71	0.72
Urban Unrestricted	65	4	13.73	2.46	Rural Restricted	65	1	6.63	3.90	Urban Restricted	65	8	23.79	0.71
Urban Unrestricted	66	4	14.08	2.44	Rural Restricted	66	1	6.82	3.98	Urban Restricted	66	8	23.92	0.69
Urban Unrestricted	67	4	14.41	2.41	Rural Restricted	67	1	7.04	4.04	Urban Restricted	67	8	23.98	0.68
Urban Unrestricted	68	4	14.74	2.39	Rural Restricted	68	1	7.26	4.10	Urban Restricted	68	8	24.00	0.66
Urban Unrestricted	69	4	15.05	2.37	Rural Restricted	69	1	7.48	4.16	Urban Restricted	69	8	24.02	0.65
Urban Unrestricted	70	4	15.36	2.35	Rural Restricted	70	1	7.69	4.22	Urban Restricted	70	8	24.05	0.63
Urban Unrestricted	71	4	15.66	2.32	Rural Restricted	71	1	7.90	4.27	Urban Restricted	71	8	24.07	0.62
Urban Unrestricted	72	4	15.95	2.30	Rural Restricted	72	1	8.10	4.33	Urban Restricted	72	8	24.09	0.61
Urban Unrestricted	73	4	16.24	2.28	Rural Restricted	73	1	8.30	4.38	Urban Restricted	73	8	24.11	0.59
Urban Unrestricted	74	4	16.57	2.30	Rural Restricted	74	1	8.62	4.53	Urban Restricted	74	8	24.11	0.59
Urban Unrestricted	75	4	16.89	2.47	Rural Restricted	75	1	9.27	4.96	Urban Restricted	75	8	23.94	0.63
Rural Unrestricted	1	5	69.61	32.44	Urban Restricted	1	1	65.65	48.04	Rural Restricted	1	9	70.94	26.91
Rural Unrestricted	2	5	35.49	16.51	Urban Restricted	2	1	33.01	24.54	Rural Restricted	2	9	36.51	13.63
Rural Unrestricted	3	5	26.75	12.21	Urban Restricted	3	1	22.95	18.08	Rural Restricted	3	9	29.04	9.77
Rural Unrestricted	4	5	23.23	10.36	Urban Restricted	4	1	18.21	15.03	Rural Restricted	4	9	26.59	7.97

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	5	5	21.17	9.18	Urban Restricted	5	1	15.48	13.01	Rural Restricted	5	9	25.24	6.81
Rural Unrestricted	6	5	19.88	8.31	Urban Restricted	6	1	13.79	11.44	Rural Restricted	6	9	24.47	5.94
Rural Unrestricted	7	5	18.96	7.69	Urban Restricted	7	1	12.58	10.31	Rural Restricted	7	9	23.92	5.31
Rural Unrestricted	8	5	18.26	7.22	Urban Restricted	8	1	11.68	9.47	Rural Restricted	8	9	23.51	4.84
Rural Unrestricted	9	5	17.72	6.86	Urban Restricted	9	1	10.99	8.84	Rural Restricted	9	9	23.01	4.48
Rural Unrestricted	10	5	17.29	6.57	Urban Restricted	10	1	10.46	8.41	Rural Restricted	10	9	22.18	4.18
Rural Unrestricted	11	5	17.00	6.30	Urban Restricted	11	1	10.09	8.06	Rural Restricted	11	9	21.61	3.94
Rural Unrestricted	12	5	16.92	6.03	Urban Restricted	12	1	9.92	7.77	Rural Restricted	12	9	21.34	3.74
Rural Unrestricted	13	5	16.84	5.80	Urban Restricted	13	1	9.78	7.53	Rural Restricted	13	9	21.12	3.56
Rural Unrestricted	14	5	16.78	5.60	Urban Restricted	14	1	9.65	7.33	Rural Restricted	14	9	20.93	3.41
Rural Unrestricted	15	5	16.73	5.43	Urban Restricted	15	1	9.54	7.15	Rural Restricted	15	9	20.76	3.29
Rural Unrestricted	16	5	16.67	5.27	Urban Restricted	16	1	9.43	6.98	Rural Restricted	16	9	20.92	3.14
Rural Unrestricted	17	5	16.59	5.13	Urban Restricted	17	1	9.30	6.80	Rural Restricted	17	9	21.88	2.91
Rural Unrestricted	18	5	16.52	5.00	Urban Restricted	18	1	9.19	6.64	Rural Restricted	18	9	22.73	2.71
Rural Unrestricted	19	5	16.49	4.81	Urban Restricted	19	1	9.09	6.50	Rural Restricted	19	9	23.50	2.53
Rural Unrestricted	20	5	16.52	4.54	Urban Restricted	20	1	9.00	6.37	Rural Restricted	20	9	24.19	2.37
Rural Unrestricted	21	5	16.55	4.29	Urban Restricted	21	1	8.90	6.25	Rural Restricted	21	9	24.58	2.24
Rural Unrestricted	22	5	16.61	4.03	Urban Restricted	22	1	8.73	6.14	Rural Restricted	22	9	24.61	2.13
Rural Unrestricted	23	5	16.67	3.79	Urban Restricted	23	1	8.57	6.04	Rural Restricted	23	9	24.63	2.03
Rural Unrestricted	24	5	16.73	3.57	Urban Restricted	24	1	8.43	5.94	Rural Restricted	24	9	24.65	1.93
Rural Unrestricted	25	5	16.72	3.43	Urban Restricted	25	1	8.33	5.87	Rural Restricted	25	9	24.64	1.87
Rural Unrestricted	26	5	16.54	3.39	Urban Restricted	26	1	8.28	5.83	Rural Restricted	26	9	24.59	1.83
Rural Unrestricted	27	5	16.31	3.37	Urban Restricted	27	1	8.22	5.79	Rural Restricted	27	9	24.54	1.79
Rural Unrestricted	28	5	16.10	3.35	Urban Restricted	28	1	8.18	5.75	Rural Restricted	28	9	24.50	1.76
Rural Unrestricted	29	5	15.91	3.33	Urban Restricted	29	1	8.13	5.72	Rural Restricted	29	9	24.47	1.73
Rural Unrestricted	30	5	15.72	3.31	Urban Restricted	30	1	8.09	5.68	Rural Restricted	30	9	24.43	1.70
Rural Unrestricted	31	5	15.55	3.30	Urban Restricted	31	1	8.07	5.66	Rural Restricted	31	9	24.56	1.66
Rural Unrestricted	32	5	15.49	3.18	Urban Restricted	32	1	7.89	5.51	Rural Restricted	32	9	24.67	1.60
Rural Unrestricted	33	5	15.29	2.98	Urban Restricted	33	1	7.56	5.25	Rural Restricted	33	9	24.62	1.51
Rural Unrestricted	34	5	15.11	2.80	Urban Restricted	34	1	7.25	5.00	Rural Restricted	34	9	24.57	1.42
Rural Unrestricted	35	5	15.07	2.70	Urban Restricted	35	1	7.09	4.87	Rural Restricted	35	9	24.65	1.36
Rural Unrestricted	36	5	15.11	2.65	Urban Restricted	36	1	7.04	4.81	Rural Restricted	36	9	24.82	1.32
Rural Unrestricted	37	5	15.16	2.61	Urban Restricted	37	1	6.99	4.75	Rural Restricted	37	9	24.98	1.28
Rural Unrestricted	38	5	15.20	2.57	Urban Restricted	38	1	6.94	4.69	Rural Restricted	38	9	25.13	1.24
Rural Unrestricted	39	5	15.24	2.53	Urban Restricted	39	1	6.89	4.64	Rural Restricted	39	9	25.27	1.20
Rural Unrestricted	40	5	15.27	2.49	Urban Restricted	40	1	6.85	4.59	Rural Restricted	40	9	25.41	1.16
Rural Unrestricted	41	5	15.31	2.46	Urban Restricted	41	1	6.81	4.54	Rural Restricted	41	9	25.54	1.13
Rural Unrestricted	42	5	15.34	2.43	Urban Restricted	42	1	6.77	4.49	Rural Restricted	42	9	25.66	1.10
Rural Unrestricted	43	5	15.37	2.40	Urban Restricted	43	1	6.73	4.45	Rural Restricted	43	9	25.78	1.07
Rural Unrestricted	44	5	15.40	2.37	Urban Restricted	44	1	6.69	4.41	Rural Restricted	44	9	25.89	1.04
Rural Unrestricted	45	5	15.41	2.34	Urban Restricted	45	1	6.65	4.36	Rural Restricted	45	9	25.96	1.01
Rural Unrestricted	46	5	15.38	2.30	Urban Restricted	46	1	6.59	4.32	Rural Restricted	46	9	26.01	0.98

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	47	5	15.36	2.27	Urban Restricted	47	1	6.53	4.28	Rural Restricted	47	9	25.97	0.95
Rural Unrestricted	48	5	15.34	2.25	Urban Restricted	48	1	6.47	4.23	Rural Restricted	48	9	25.92	0.92
Rural Unrestricted	49	5	15.32	2.22	Urban Restricted	49	1	6.41	4.19	Rural Restricted	49	9	25.87	0.89
Rural Unrestricted	50	5	15.36	2.20	Urban Restricted	50	1	6.36	4.15	Rural Restricted	50	9	25.83	0.86
Rural Unrestricted	51	5	15.40	2.18	Urban Restricted	51	1	6.30	4.11	Rural Restricted	51	9	25.79	0.84
Rural Unrestricted	52	5	15.44	2.17	Urban Restricted	52	1	6.26	4.08	Rural Restricted	52	9	25.74	0.81
Rural Unrestricted	53	5	15.47	2.15	Urban Restricted	53	1	6.21	4.04	Rural Restricted	53	9	25.70	0.79
Rural Unrestricted	54	5	15.51	2.13	Urban Restricted	54	1	6.16	4.00	Rural Restricted	54	9	25.66	0.76
Rural Unrestricted	55	5	15.54	2.12	Urban Restricted	55	1	6.12	3.97	Rural Restricted	55	9	25.63	0.74
Rural Unrestricted	56	5	15.57	2.10	Urban Restricted	56	1	6.06	3.93	Rural Restricted	56	9	25.60	0.72
Rural Unrestricted	57	5	15.60	2.07	Urban Restricted	57	1	6.01	3.89	Rural Restricted	57	9	25.59	0.70
Rural Unrestricted	58	5	15.62	2.05	Urban Restricted	58	1	5.95	3.85	Rural Restricted	58	9	25.58	0.68
Rural Unrestricted	59	5	15.64	2.02	Urban Restricted	59	1	5.91	3.82	Rural Restricted	59	9	25.55	0.67
Rural Unrestricted	60	5	15.67	2.00	Urban Restricted	60	1	5.94	3.81	Rural Restricted	60	9	25.48	0.66
Rural Unrestricted	61	5	15.75	1.98	Urban Restricted	61	1	6.04	3.81	Rural Restricted	61	9	25.46	0.65
Rural Unrestricted	62	5	15.88	1.95	Urban Restricted	62	1	6.19	3.82	Rural Restricted	62	9	25.47	0.64
Rural Unrestricted	63	5	16.00	1.93	Urban Restricted	63	1	6.32	3.83	Rural Restricted	63	9	25.48	0.63
Rural Unrestricted	64	5	16.21	1.90	Urban Restricted	64	1	6.46	3.84	Rural Restricted	64	9	25.49	0.63
Rural Unrestricted	65	5	16.58	1.88	Urban Restricted	65	1	6.63	3.89	Rural Restricted	65	9	25.52	0.61
Rural Unrestricted	66	5	16.93	1.85	Urban Restricted	66	1	6.82	3.97	Rural Restricted	66	9	25.55	0.60
Rural Unrestricted	67	5	17.28	1.83	Urban Restricted	67	1	7.03	4.04	Rural Restricted	67	9	25.52	0.58
Rural Unrestricted	68	5	17.62	1.81	Urban Restricted	68	1	7.26	4.10	Rural Restricted	68	9	25.45	0.57
Rural Unrestricted	69	5	17.94	1.79	Urban Restricted	69	1	7.48	4.16	Rural Restricted	69	9	25.38	0.56
Rural Unrestricted	70	5	18.26	1.77	Urban Restricted	70	1	7.69	4.21	Rural Restricted	70	9	25.32	0.55
Rural Unrestricted	71	5	18.56	1.75	Urban Restricted	71	1	7.90	4.27	Rural Restricted	71	9	25.26	0.54
Rural Unrestricted	72	5	18.86	1.73	Urban Restricted	72	1	8.10	4.32	Rural Restricted	72	9	25.20	0.53
Rural Unrestricted	73	5	19.16	1.71	Urban Restricted	73	1	8.30	4.38	Rural Restricted	73	9	25.15	0.52
Rural Unrestricted	74	5	19.39	1.71	Urban Restricted	74	1	8.63	4.52	Rural Restricted	74	9	25.08	0.52
Rural Unrestricted	75	5	19.32	1.80	Urban Restricted	75	1	9.28	4.95	Rural Restricted	75	9	24.89	0.53
Urban Unrestricted	1	5	69.41	32.26	Rural Restricted	1	2	67.18	42.65	Urban Restricted	1	9	70.79	26.78
Urban Unrestricted	2	5	35.39	16.42	Rural Restricted	2	2	33.89	21.79	Urban Restricted	2	9	36.43	13.56
Urban Unrestricted	3	5	26.68	12.15	Rural Restricted	3	2	23.92	16.12	Urban Restricted	3	9	28.97	9.72
Urban Unrestricted	4	5	23.17	10.31	Rural Restricted	4	2	19.28	13.50	Urban Restricted	4	9	26.54	7.93
Urban Unrestricted	5	5	21.13	9.14	Rural Restricted	5	2	16.61	11.76	Urban Restricted	5	9	25.19	6.78
Urban Unrestricted	6	5	19.84	8.27	Rural Restricted	6	2	14.99	10.38	Urban Restricted	6	9	24.43	5.91
Urban Unrestricted	7	5	18.92	7.66	Rural Restricted	7	2	13.83	9.40	Urban Restricted	7	9	23.89	5.29
Urban Unrestricted	8	5	18.23	7.19	Rural Restricted	8	2	12.95	8.67	Urban Restricted	8	9	23.48	4.82
Urban Unrestricted	9	5	17.69	6.83	Rural Restricted	9	2	12.28	8.10	Urban Restricted	9	9	22.98	4.46
Urban Unrestricted	10	5	17.26	6.55	Rural Restricted	10	2	11.76	7.68	Urban Restricted	10	9	22.15	4.17
Urban Unrestricted	11	5	16.98	6.28	Rural Restricted	11	2	11.40	7.34	Urban Restricted	11	9	21.57	3.93
Urban Unrestricted	12	5	16.89	6.01	Rural Restricted	12	2	11.21	7.05	Urban Restricted	12	9	21.31	3.72
Urban Unrestricted	13	5	16.82	5.78	Rural Restricted	13	2	11.06	6.82	Urban Restricted	13	9	21.08	3.55

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	14	5	16.76	5.58	Rural Restricted	14	2	10.93	6.61	Urban Restricted	14	9	20.89	3.40
Urban Unrestricted	15	5	16.71	5.41	Rural Restricted	15	2	10.81	6.43	Urban Restricted	15	9	20.72	3.28
Urban Unrestricted	16	5	16.65	5.26	Rural Restricted	16	2	10.71	6.25	Urban Restricted	16	9	20.88	3.13
Urban Unrestricted	17	5	16.57	5.12	Rural Restricted	17	2	10.64	6.04	Urban Restricted	17	9	21.85	2.90
Urban Unrestricted	18	5	16.50	4.99	Rural Restricted	18	2	10.57	5.85	Urban Restricted	18	9	22.71	2.70
Urban Unrestricted	19	5	16.47	4.80	Rural Restricted	19	2	10.51	5.68	Urban Restricted	19	9	23.48	2.52
Urban Unrestricted	20	5	16.50	4.53	Rural Restricted	20	2	10.46	5.53	Urban Restricted	20	9	24.18	2.36
Urban Unrestricted	21	5	16.53	4.28	Rural Restricted	21	2	10.39	5.39	Urban Restricted	21	9	24.58	2.23
Urban Unrestricted	22	5	16.60	4.02	Rural Restricted	22	2	10.27	5.26	Urban Restricted	22	9	24.60	2.12
Urban Unrestricted	23	5	16.66	3.78	Rural Restricted	23	2	10.17	5.14	Urban Restricted	23	9	24.63	2.02
Urban Unrestricted	24	5	16.71	3.56	Rural Restricted	24	2	10.07	5.03	Urban Restricted	24	9	24.65	1.93
Urban Unrestricted	25	5	16.70	3.42	Rural Restricted	25	2	9.97	4.96	Urban Restricted	25	9	24.64	1.86
Urban Unrestricted	26	5	16.52	3.38	Rural Restricted	26	2	9.87	4.93	Urban Restricted	26	9	24.59	1.82
Urban Unrestricted	27	5	16.30	3.36	Rural Restricted	27	2	9.79	4.91	Urban Restricted	27	9	24.55	1.79
Urban Unrestricted	28	5	16.09	3.34	Rural Restricted	28	2	9.70	4.88	Urban Restricted	28	9	24.51	1.75
Urban Unrestricted	29	5	15.89	3.32	Rural Restricted	29	2	9.63	4.86	Urban Restricted	29	9	24.47	1.72
Urban Unrestricted	30	5	15.71	3.30	Rural Restricted	30	2	9.55	4.84	Urban Restricted	30	9	24.44	1.69
Urban Unrestricted	31	5	15.53	3.29	Rural Restricted	31	2	9.53	4.83	Urban Restricted	31	9	24.56	1.66
Urban Unrestricted	32	5	15.47	3.17	Rural Restricted	32	2	9.41	4.69	Urban Restricted	32	9	24.68	1.59
Urban Unrestricted	33	5	15.26	2.97	Rural Restricted	33	2	9.17	4.44	Urban Restricted	33	9	24.63	1.50
Urban Unrestricted	34	5	15.08	2.78	Rural Restricted	34	2	8.94	4.21	Urban Restricted	34	9	24.59	1.42
Urban Unrestricted	35	5	15.03	2.67	Rural Restricted	35	2	8.82	4.09	Urban Restricted	35	9	24.68	1.36
Urban Unrestricted	36	5	15.07	2.63	Rural Restricted	36	2	8.77	4.05	Urban Restricted	36	9	24.85	1.31
Urban Unrestricted	37	5	15.11	2.58	Rural Restricted	37	2	8.73	4.01	Urban Restricted	37	9	25.01	1.27
Urban Unrestricted	38	5	15.14	2.54	Rural Restricted	38	2	8.69	3.97	Urban Restricted	38	9	25.16	1.23
Urban Unrestricted	39	5	15.18	2.50	Rural Restricted	39	2	8.65	3.93	Urban Restricted	39	9	25.31	1.20
Urban Unrestricted	40	5	15.21	2.46	Rural Restricted	40	2	8.61	3.90	Urban Restricted	40	9	25.44	1.16
Urban Unrestricted	41	5	15.24	2.42	Rural Restricted	41	2	8.57	3.87	Urban Restricted	41	9	25.58	1.13
Urban Unrestricted	42	5	15.27	2.39	Rural Restricted	42	2	8.54	3.84	Urban Restricted	42	9	25.70	1.09
Urban Unrestricted	43	5	15.30	2.36	Rural Restricted	43	2	8.51	3.81	Urban Restricted	43	9	25.82	1.06
Urban Unrestricted	44	5	15.32	2.33	Rural Restricted	44	2	8.48	3.78	Urban Restricted	44	9	25.93	1.03
Urban Unrestricted	45	5	15.31	2.30	Rural Restricted	45	2	8.43	3.75	Urban Restricted	45	9	26.01	1.01
Urban Unrestricted	46	5	15.28	2.28	Rural Restricted	46	2	8.37	3.73	Urban Restricted	46	9	26.06	0.98
Urban Unrestricted	47	5	15.25	2.25	Rural Restricted	47	2	8.30	3.69	Urban Restricted	47	9	26.02	0.95
Urban Unrestricted	48	5	15.22	2.23	Rural Restricted	48	2	8.24	3.65	Urban Restricted	48	9	25.97	0.92
Urban Unrestricted	49	5	15.19	2.20	Rural Restricted	49	2	8.17	3.62	Urban Restricted	49	9	25.93	0.89
Urban Unrestricted	50	5	15.16	2.18	Rural Restricted	50	2	8.12	3.59	Urban Restricted	50	9	25.88	0.86
Urban Unrestricted	51	5	15.13	2.16	Rural Restricted	51	2	8.06	3.55	Urban Restricted	51	9	25.84	0.83
Urban Unrestricted	52	5	15.11	2.14	Rural Restricted	52	2	8.00	3.52	Urban Restricted	52	9	25.80	0.81
Urban Unrestricted	53	5	15.10	2.12	Rural Restricted	53	2	7.95	3.49	Urban Restricted	53	9	25.76	0.78
Urban Unrestricted	54	5	15.17	2.11	Rural Restricted	54	2	7.90	3.46	Urban Restricted	54	9	25.72	0.76
Urban Unrestricted	55	5	15.25	2.09	Rural Restricted	55	2	7.85	3.43	Urban Restricted	55	9	25.69	0.74

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	56	5	15.31	2.07	Rural Restricted	56	2	7.82	3.40	Urban Restricted	56	9	25.66	0.71
Urban Unrestricted	57	5	15.38	2.05	Rural Restricted	57	2	7.80	3.36	Urban Restricted	57	9	25.65	0.70
Urban Unrestricted	58	5	15.44	2.03	Rural Restricted	58	2	7.78	3.33	Urban Restricted	58	9	25.64	0.68
Urban Unrestricted	59	5	15.49	2.00	Rural Restricted	59	2	7.78	3.30	Urban Restricted	59	9	25.61	0.66
Urban Unrestricted	60	5	15.55	1.98	Rural Restricted	60	2	7.85	3.29	Urban Restricted	60	9	25.55	0.65
Urban Unrestricted	61	5	15.67	1.96	Rural Restricted	61	2	7.99	3.28	Urban Restricted	61	9	25.53	0.65
Urban Unrestricted	62	5	15.83	1.94	Rural Restricted	62	2	8.17	3.27	Urban Restricted	62	9	25.54	0.64
Urban Unrestricted	63	5	15.98	1.91	Rural Restricted	63	2	8.34	3.25	Urban Restricted	63	9	25.55	0.63
Urban Unrestricted	64	5	16.21	1.89	Rural Restricted	64	2	8.51	3.24	Urban Restricted	64	9	25.56	0.62
Urban Unrestricted	65	5	16.58	1.87	Rural Restricted	65	2	8.74	3.25	Urban Restricted	65	9	25.58	0.61
Urban Unrestricted	66	5	16.93	1.84	Rural Restricted	66	2	9.01	3.27	Urban Restricted	66	9	25.62	0.59
Urban Unrestricted	67	5	17.28	1.82	Rural Restricted	67	2	9.31	3.29	Urban Restricted	67	9	25.58	0.58
Urban Unrestricted	68	5	17.62	1.80	Rural Restricted	68	2	9.63	3.32	Urban Restricted	68	9	25.52	0.57
Urban Unrestricted	69	5	17.94	1.78	Rural Restricted	69	2	9.93	3.35	Urban Restricted	69	9	25.45	0.56
Urban Unrestricted	70	5	18.26	1.76	Rural Restricted	70	2	10.23	3.37	Urban Restricted	70	9	25.39	0.55
Urban Unrestricted	71	5	18.57	1.74	Rural Restricted	71	2	10.52	3.40	Urban Restricted	71	9	25.32	0.54
Urban Unrestricted	72	5	18.87	1.72	Rural Restricted	72	2	10.81	3.42	Urban Restricted	72	9	25.26	0.53
Urban Unrestricted	73	5	19.17	1.70	Rural Restricted	73	2	11.08	3.45	Urban Restricted	73	9	25.21	0.52
Urban Unrestricted	74	5	19.40	1.70	Rural Restricted	74	2	11.34	3.54	Urban Restricted	74	9	25.14	0.52
Urban Unrestricted	75	5	19.34	1.78	Rural Restricted	75	2	11.71	3.85	Urban Restricted	75	9	24.95	0.53
Rural Unrestricted	1	6	70.06	31.21	Urban Restricted	1	2	67.04	42.52	Rural Restricted	1	10	71.38	25.40
Rural Unrestricted	2	6	35.80	15.82	Urban Restricted	2	2	33.82	21.72	Rural Restricted	2	10	36.82	12.86
Rural Unrestricted	3	6	27.43	11.50	Urban Restricted	3	2	23.86	16.07	Rural Restricted	3	10	29.83	9.18
Rural Unrestricted	4	6	24.29	9.58	Urban Restricted	4	2	19.23	13.46	Rural Restricted	4	10	27.89	7.47
Rural Unrestricted	5	6	22.48	8.39	Urban Restricted	5	2	16.57	11.72	Rural Restricted	5	10	26.92	6.38
Rural Unrestricted	6	6	21.36	7.54	Urban Restricted	6	2	14.95	10.35	Rural Restricted	6	10	26.51	5.55
Rural Unrestricted	7	6	20.57	6.94	Urban Restricted	7	2	13.79	9.38	Rural Restricted	7	10	26.21	4.96
Rural Unrestricted	8	6	19.97	6.49	Urban Restricted	8	2	12.92	8.64	Rural Restricted	8	10	25.99	4.52
Rural Unrestricted	9	6	19.50	6.13	Urban Restricted	9	2	12.26	8.08	Rural Restricted	9	10	25.54	4.17
Rural Unrestricted	10	6	19.13	5.85	Urban Restricted	10	2	11.74	7.66	Rural Restricted	10	10	24.56	3.89
Rural Unrestricted	11	6	18.90	5.60	Urban Restricted	11	2	11.37	7.32	Rural Restricted	11	10	23.81	3.65
Rural Unrestricted	12	6	18.88	5.35	Urban Restricted	12	2	11.19	7.04	Rural Restricted	12	10	23.30	3.46
Rural Unrestricted	13	6	18.87	5.14	Urban Restricted	13	2	11.03	6.80	Rural Restricted	13	10	22.87	3.30
Rural Unrestricted	14	6	18.86	4.96	Urban Restricted	14	2	10.90	6.60	Rural Restricted	14	10	22.50	3.16
Rural Unrestricted	15	6	18.85	4.80	Urban Restricted	15	2	10.79	6.42	Rural Restricted	15	10	22.18	3.04
Rural Unrestricted	16	6	18.83	4.66	Urban Restricted	16	2	10.69	6.24	Rural Restricted	16	10	22.35	2.90
Rural Unrestricted	17	6	18.80	4.52	Urban Restricted	17	2	10.62	6.03	Rural Restricted	17	10	23.70	2.67
Rural Unrestricted	18	6	18.77	4.39	Urban Restricted	18	2	10.55	5.84	Rural Restricted	18	10	24.90	2.47
Rural Unrestricted	19	6	18.77	4.22	Urban Restricted	19	2	10.49	5.67	Rural Restricted	19	10	25.97	2.29
Rural Unrestricted	20	6	18.80	3.99	Urban Restricted	20	2	10.44	5.52	Rural Restricted	20	10	26.93	2.13
Rural Unrestricted	21	6	18.82	3.77	Urban Restricted	21	2	10.37	5.38	Rural Restricted	21	10	27.47	2.01
Rural Unrestricted	22	6	18.82	3.55	Urban Restricted	22	2	10.25	5.24	Rural Restricted	22	10	27.45	1.91

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	23	6	18.82	3.34	Urban Restricted	23	2	10.14	5.12	Rural Restricted	23	10	27.43	1.81
Rural Unrestricted	24	6	18.82	3.16	Urban Restricted	24	2	10.05	5.01	Rural Restricted	24	10	27.42	1.73
Rural Unrestricted	25	6	18.77	3.03	Urban Restricted	25	2	9.95	4.95	Rural Restricted	25	10	27.38	1.67
Rural Unrestricted	26	6	18.65	2.98	Urban Restricted	26	2	9.85	4.92	Rural Restricted	26	10	27.32	1.64
Rural Unrestricted	27	6	18.50	2.94	Urban Restricted	27	2	9.76	4.89	Rural Restricted	27	10	27.26	1.61
Rural Unrestricted	28	6	18.37	2.91	Urban Restricted	28	2	9.68	4.87	Rural Restricted	28	10	27.21	1.59
Rural Unrestricted	29	6	18.24	2.88	Urban Restricted	29	2	9.61	4.85	Rural Restricted	29	10	27.16	1.56
Rural Unrestricted	30	6	18.13	2.85	Urban Restricted	30	2	9.53	4.83	Rural Restricted	30	10	27.11	1.54
Rural Unrestricted	31	6	18.02	2.83	Urban Restricted	31	2	9.51	4.81	Rural Restricted	31	10	27.21	1.51
Rural Unrestricted	32	6	17.98	2.71	Urban Restricted	32	2	9.39	4.68	Rural Restricted	32	10	27.26	1.45
Rural Unrestricted	33	6	17.80	2.52	Urban Restricted	33	2	9.15	4.43	Rural Restricted	33	10	27.16	1.35
Rural Unrestricted	34	6	17.63	2.35	Urban Restricted	34	2	8.92	4.20	Rural Restricted	34	10	27.06	1.27
Rural Unrestricted	35	6	17.61	2.25	Urban Restricted	35	2	8.81	4.08	Rural Restricted	35	10	27.09	1.21
Rural Unrestricted	36	6	17.67	2.19	Urban Restricted	36	2	8.76	4.04	Rural Restricted	36	10	27.21	1.17
Rural Unrestricted	37	6	17.74	2.14	Urban Restricted	37	2	8.72	4.00	Rural Restricted	37	10	27.32	1.14
Rural Unrestricted	38	6	17.80	2.09	Urban Restricted	38	2	8.68	3.96	Rural Restricted	38	10	27.42	1.10
Rural Unrestricted	39	6	17.86	2.04	Urban Restricted	39	2	8.64	3.92	Rural Restricted	39	10	27.52	1.07
Rural Unrestricted	40	6	17.91	2.00	Urban Restricted	40	2	8.60	3.89	Rural Restricted	40	10	27.62	1.04
Rural Unrestricted	41	6	17.97	1.96	Urban Restricted	41	2	8.56	3.86	Rural Restricted	41	10	27.71	1.01
Rural Unrestricted	42	6	18.02	1.92	Urban Restricted	42	2	8.53	3.83	Rural Restricted	42	10	27.79	0.98
Rural Unrestricted	43	6	18.06	1.88	Urban Restricted	43	2	8.50	3.80	Rural Restricted	43	10	27.87	0.95
Rural Unrestricted	44	6	18.11	1.84	Urban Restricted	44	2	8.47	3.77	Rural Restricted	44	10	27.95	0.93
Rural Unrestricted	45	6	18.12	1.80	Urban Restricted	45	2	8.42	3.74	Rural Restricted	45	10	27.99	0.90
Rural Unrestricted	46	6	18.11	1.76	Urban Restricted	46	2	8.36	3.72	Rural Restricted	46	10	27.99	0.88
Rural Unrestricted	47	6	18.09	1.72	Urban Restricted	47	2	8.29	3.68	Rural Restricted	47	10	27.96	0.85
Rural Unrestricted	48	6	18.08	1.68	Urban Restricted	48	2	8.23	3.64	Rural Restricted	48	10	27.93	0.83
Rural Unrestricted	49	6	18.07	1.64	Urban Restricted	49	2	8.17	3.61	Rural Restricted	49	10	27.89	0.80
Rural Unrestricted	50	6	18.13	1.62	Urban Restricted	50	2	8.11	3.57	Rural Restricted	50	10	27.86	0.78
Rural Unrestricted	51	6	18.19	1.59	Urban Restricted	51	2	8.05	3.54	Rural Restricted	51	10	27.83	0.76
Rural Unrestricted	52	6	18.26	1.56	Urban Restricted	52	2	8.00	3.51	Rural Restricted	52	10	27.81	0.74
Rural Unrestricted	53	6	18.32	1.54	Urban Restricted	53	2	7.95	3.48	Rural Restricted	53	10	27.78	0.72
Rural Unrestricted	54	6	18.37	1.52	Urban Restricted	54	2	7.90	3.45	Rural Restricted	54	10	27.75	0.70
Rural Unrestricted	55	6	18.43	1.49	Urban Restricted	55	2	7.85	3.42	Rural Restricted	55	10	27.73	0.68
Rural Unrestricted	56	6	18.49	1.47	Urban Restricted	56	2	7.82	3.39	Rural Restricted	56	10	27.71	0.66
Rural Unrestricted	57	6	18.55	1.44	Urban Restricted	57	2	7.79	3.35	Rural Restricted	57	10	27.71	0.64
Rural Unrestricted	58	6	18.61	1.42	Urban Restricted	58	2	7.77	3.32	Rural Restricted	58	10	27.71	0.63
Rural Unrestricted	59	6	18.66	1.40	Urban Restricted	59	2	7.77	3.29	Rural Restricted	59	10	27.66	0.61
Rural Unrestricted	60	6	18.72	1.37	Urban Restricted	60	2	7.85	3.28	Rural Restricted	60	10	27.46	0.60
Rural Unrestricted	61	6	18.84	1.35	Urban Restricted	61	2	7.99	3.27	Rural Restricted	61	10	27.32	0.59
Rural Unrestricted	62	6	19.01	1.34	Urban Restricted	62	2	8.17	3.26	Rural Restricted	62	10	27.22	0.58
Rural Unrestricted	63	6	19.17	1.32	Urban Restricted	63	2	8.34	3.24	Rural Restricted	63	10	27.12	0.57
Rural Unrestricted	64	6	19.37	1.30	Urban Restricted	64	2	8.51	3.23	Rural Restricted	64	10	27.03	0.57

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	65	6	19.63	1.27	Urban Restricted	65	2	8.74	3.24	Rural Restricted	65	10	26.94	0.55
Rural Unrestricted	66	6	19.89	1.25	Urban Restricted	66	2	9.01	3.26	Rural Restricted	66	10	26.86	0.54
Rural Unrestricted	67	6	20.15	1.23	Urban Restricted	67	2	9.31	3.28	Rural Restricted	67	10	26.75	0.52
Rural Unrestricted	68	6	20.39	1.21	Urban Restricted	68	2	9.63	3.31	Rural Restricted	68	10	26.63	0.52
Rural Unrestricted	69	6	20.63	1.19	Urban Restricted	69	2	9.94	3.34	Rural Restricted	69	10	26.51	0.51
Rural Unrestricted	70	6	20.86	1.16	Urban Restricted	70	2	10.24	3.36	Rural Restricted	70	10	26.40	0.50
Rural Unrestricted	71	6	21.08	1.14	Urban Restricted	71	2	10.54	3.39	Rural Restricted	71	10	26.28	0.49
Rural Unrestricted	72	6	21.30	1.13	Urban Restricted	72	2	10.82	3.42	Rural Restricted	72	10	26.18	0.49
Rural Unrestricted	73	6	21.51	1.11	Urban Restricted	73	2	11.09	3.44	Rural Restricted	73	10	26.08	0.48
Rural Unrestricted	74	6	21.60	1.11	Urban Restricted	74	2	11.35	3.53	Rural Restricted	74	10	25.98	0.48
Rural Unrestricted	75	6	21.25	1.20	Urban Restricted	75	2	11.73	3.84	Rural Restricted	75	10	25.78	0.48
Urban Unrestricted	1	6	69.86	31.02	Rural Restricted	1	3	68.11	41.63	Urban Restricted	1	10	71.23	25.26
Urban Unrestricted	2	6	35.69	15.73	Rural Restricted	2	3	34.54	21.18	Urban Restricted	2	10	36.73	12.78
Urban Unrestricted	3	6	27.36	11.44	Rural Restricted	3	3	25.02	15.38	Urban Restricted	3	10	29.76	9.13
Urban Unrestricted	4	6	24.23	9.54	Rural Restricted	4	3	20.70	12.65	Urban Restricted	4	10	27.84	7.43
Urban Unrestricted	5	6	22.43	8.35	Rural Restricted	5	3	18.15	10.90	Urban Restricted	5	10	26.88	6.34
Urban Unrestricted	6	6	21.32	7.51	Rural Restricted	6	3	16.50	9.60	Urban Restricted	6	10	26.47	5.53
Urban Unrestricted	7	6	20.53	6.91	Rural Restricted	7	3	15.33	8.66	Urban Restricted	7	10	26.18	4.94
Urban Unrestricted	8	6	19.94	6.46	Rural Restricted	8	3	14.44	7.96	Urban Restricted	8	10	25.96	4.50
Urban Unrestricted	9	6	19.47	6.11	Rural Restricted	9	3	13.74	7.44	Urban Restricted	9	10	25.52	4.16
Urban Unrestricted	10	6	19.10	5.83	Rural Restricted	10	3	13.13	7.06	Urban Restricted	10	10	24.53	3.87
Urban Unrestricted	11	6	18.88	5.58	Rural Restricted	11	3	12.69	6.73	Urban Restricted	11	10	23.78	3.64
Urban Unrestricted	12	6	18.86	5.33	Rural Restricted	12	3	12.47	6.43	Urban Restricted	12	10	23.27	3.45
Urban Unrestricted	13	6	18.85	5.12	Rural Restricted	13	3	12.27	6.17	Urban Restricted	13	10	22.83	3.29
Urban Unrestricted	14	6	18.84	4.94	Rural Restricted	14	3	12.11	5.95	Urban Restricted	14	10	22.46	3.15
Urban Unrestricted	15	6	18.83	4.79	Rural Restricted	15	3	11.96	5.75	Urban Restricted	15	10	22.14	3.03
Urban Unrestricted	16	6	18.81	4.64	Rural Restricted	16	3	11.88	5.57	Urban Restricted	16	10	22.32	2.89
Urban Unrestricted	17	6	18.78	4.51	Rural Restricted	17	3	11.92	5.35	Urban Restricted	17	10	23.68	2.66
Urban Unrestricted	18	6	18.76	4.38	Rural Restricted	18	3	11.95	5.15	Urban Restricted	18	10	24.88	2.46
Urban Unrestricted	19	6	18.75	4.21	Rural Restricted	19	3	11.97	4.98	Urban Restricted	19	10	25.96	2.28
Urban Unrestricted	20	6	18.78	3.98	Rural Restricted	20	3	12.00	4.82	Urban Restricted	20	10	26.94	2.12
Urban Unrestricted	21	6	18.80	3.76	Rural Restricted	21	3	11.99	4.67	Urban Restricted	21	10	27.48	2.00
Urban Unrestricted	22	6	18.80	3.54	Rural Restricted	22	3	11.91	4.51	Urban Restricted	22	10	27.46	1.90
Urban Unrestricted	23	6	18.80	3.33	Rural Restricted	23	3	11.84	4.36	Urban Restricted	23	10	27.44	1.81
Urban Unrestricted	24	6	18.80	3.15	Rural Restricted	24	3	11.78	4.22	Urban Restricted	24	10	27.43	1.72
Urban Unrestricted	25	6	18.76	3.02	Rural Restricted	25	3	11.70	4.16	Urban Restricted	25	10	27.39	1.67
Urban Unrestricted	26	6	18.63	2.97	Rural Restricted	26	3	11.61	4.16	Urban Restricted	26	10	27.33	1.64
Urban Unrestricted	27	6	18.49	2.93	Rural Restricted	27	3	11.53	4.17	Urban Restricted	27	10	27.27	1.61
Urban Unrestricted	28	6	18.36	2.90	Rural Restricted	28	3	11.45	4.17	Urban Restricted	28	10	27.22	1.58
Urban Unrestricted	29	6	18.23	2.87	Rural Restricted	29	3	11.38	4.17	Urban Restricted	29	10	27.17	1.56
Urban Unrestricted	30	6	18.12	2.84	Rural Restricted	30	3	11.32	4.18	Urban Restricted	30	10	27.13	1.53
Urban Unrestricted	31	6	18.01	2.82	Rural Restricted	31	3	11.30	4.18	Urban Restricted	31	10	27.22	1.51

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	32	6	17.93	2.70	Rural Restricted	32	3	11.18	4.07	Urban Restricted	32	10	27.28	1.44
Urban Unrestricted	33	6	17.70	2.51	Rural Restricted	33	3	10.91	3.87	Urban Restricted	33	10	27.18	1.35
Urban Unrestricted	34	6	17.49	2.34	Rural Restricted	34	3	10.65	3.67	Urban Restricted	34	10	27.08	1.26
Urban Unrestricted	35	6	17.43	2.23	Rural Restricted	35	3	10.55	3.57	Urban Restricted	35	10	27.12	1.21
Urban Unrestricted	36	6	17.46	2.18	Rural Restricted	36	3	10.53	3.53	Urban Restricted	36	10	27.24	1.17
Urban Unrestricted	37	6	17.49	2.13	Rural Restricted	37	3	10.52	3.49	Urban Restricted	37	10	27.35	1.13
Urban Unrestricted	38	6	17.52	2.08	Rural Restricted	38	3	10.51	3.45	Urban Restricted	38	10	27.46	1.10
Urban Unrestricted	39	6	17.54	2.03	Rural Restricted	39	3	10.49	3.42	Urban Restricted	39	10	27.56	1.06
Urban Unrestricted	40	6	17.57	1.98	Rural Restricted	40	3	10.48	3.39	Urban Restricted	40	10	27.66	1.03
Urban Unrestricted	41	6	17.59	1.94	Rural Restricted	41	3	10.47	3.36	Urban Restricted	41	10	27.75	1.00
Urban Unrestricted	42	6	17.62	1.90	Rural Restricted	42	3	10.46	3.33	Urban Restricted	42	10	27.84	0.97
Urban Unrestricted	43	6	17.64	1.86	Rural Restricted	43	3	10.45	3.30	Urban Restricted	43	10	27.92	0.95
Urban Unrestricted	44	6	17.69	1.82	Rural Restricted	44	3	10.44	3.27	Urban Restricted	44	10	28.00	0.92
Urban Unrestricted	45	6	17.72	1.79	Rural Restricted	45	3	10.42	3.25	Urban Restricted	45	10	28.04	0.90
Urban Unrestricted	46	6	17.72	1.74	Rural Restricted	46	3	10.37	3.24	Urban Restricted	46	10	28.04	0.87
Urban Unrestricted	47	6	17.72	1.71	Rural Restricted	47	3	10.35	3.21	Urban Restricted	47	10	28.02	0.85
Urban Unrestricted	48	6	17.71	1.67	Rural Restricted	48	3	10.33	3.18	Urban Restricted	48	10	27.98	0.82
Urban Unrestricted	49	6	17.71	1.63	Rural Restricted	49	3	10.31	3.16	Urban Restricted	49	10	27.95	0.80
Urban Unrestricted	50	6	17.71	1.60	Rural Restricted	50	3	10.28	3.13	Urban Restricted	50	10	27.92	0.78
Urban Unrestricted	51	6	17.71	1.56	Rural Restricted	51	3	10.27	3.11	Urban Restricted	51	10	27.90	0.76
Urban Unrestricted	52	6	17.71	1.53	Rural Restricted	52	3	10.25	3.09	Urban Restricted	52	10	27.87	0.73
Urban Unrestricted	53	6	17.73	1.50	Rural Restricted	53	3	10.23	3.06	Urban Restricted	53	10	27.84	0.71
Urban Unrestricted	54	6	17.85	1.48	Rural Restricted	54	3	10.21	3.04	Urban Restricted	54	10	27.82	0.70
Urban Unrestricted	55	6	17.97	1.46	Rural Restricted	55	3	10.19	3.02	Urban Restricted	55	10	27.79	0.68
Urban Unrestricted	56	6	18.09	1.44	Rural Restricted	56	3	10.21	2.99	Urban Restricted	56	10	27.78	0.66
Urban Unrestricted	57	6	18.21	1.42	Rural Restricted	57	3	10.24	2.96	Urban Restricted	57	10	27.78	0.64
Urban Unrestricted	58	6	18.33	1.40	Rural Restricted	58	3	10.27	2.92	Urban Restricted	58	10	27.78	0.62
Urban Unrestricted	59	6	18.44	1.38	Rural Restricted	59	3	10.32	2.89	Urban Restricted	59	10	27.74	0.61
Urban Unrestricted	60	6	18.54	1.36	Rural Restricted	60	3	10.42	2.88	Urban Restricted	60	10	27.53	0.60
Urban Unrestricted	61	6	18.72	1.34	Rural Restricted	61	3	10.54	2.87	Urban Restricted	61	10	27.39	0.59
Urban Unrestricted	62	6	18.93	1.32	Rural Restricted	62	3	10.67	2.86	Urban Restricted	62	10	27.29	0.58
Urban Unrestricted	63	6	19.14	1.31	Rural Restricted	63	3	10.79	2.84	Urban Restricted	63	10	27.19	0.57
Urban Unrestricted	64	6	19.37	1.29	Rural Restricted	64	3	10.91	2.83	Urban Restricted	64	10	27.10	0.56
Urban Unrestricted	65	6	19.64	1.26	Rural Restricted	65	3	11.15	2.83	Urban Restricted	65	10	27.01	0.55
Urban Unrestricted	66	6	19.90	1.24	Rural Restricted	66	3	11.46	2.83	Urban Restricted	66	10	26.93	0.53
Urban Unrestricted	67	6	20.15	1.22	Rural Restricted	67	3	11.78	2.83	Urban Restricted	67	10	26.82	0.52
Urban Unrestricted	68	6	20.40	1.20	Rural Restricted	68	3	12.09	2.82	Urban Restricted	68	10	26.70	0.51
Urban Unrestricted	69	6	20.64	1.18	Rural Restricted	69	3	12.39	2.82	Urban Restricted	69	10	26.58	0.51
Urban Unrestricted	70	6	20.87	1.16	Rural Restricted	70	3	12.69	2.81	Urban Restricted	70	10	26.46	0.50
Urban Unrestricted	71	6	21.09	1.14	Rural Restricted	71	3	12.97	2.80	Urban Restricted	71	10	26.35	0.49
Urban Unrestricted	72	6	21.31	1.12	Rural Restricted	72	3	13.25	2.80	Urban Restricted	72	10	26.24	0.48
Urban Unrestricted	73	6	21.52	1.10	Rural Restricted	73	3	13.52	2.79	Urban Restricted	73	10	26.14	0.48

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Urban Unrestricted	74	6	21.61	1.10	Rural Restricted	74	3	13.81	2.85	Urban Restricted	74	10	26.05	0.47
Urban Unrestricted	75	6	21.26	1.19	Rural Restricted	75	3	14.13	3.11	Urban Restricted	75	10	25.84	0.48
Rural Unrestricted	1	7	70.22	30.18	Urban Restricted	1	3	67.97	41.50					
Rural Unrestricted	2	7	35.98	15.30	Urban Restricted	2	3	34.47	21.11					
Rural Unrestricted	3	7	28.10	11.08	Urban Restricted	3	3	24.96	15.34					
Rural Unrestricted	4	7	25.37	9.19	Urban Restricted	4	3	20.65	12.61					
Rural Unrestricted	5	7	23.81	8.00	Urban Restricted	5	3	18.11	10.87					
Rural Unrestricted	6	7	22.85	7.12	Urban Restricted	6	3	16.46	9.57					
Rural Unrestricted	7	7	22.17	6.49	Urban Restricted	7	3	15.29	8.64					
Rural Unrestricted	8	7	21.66	6.02	Urban Restricted	8	3	14.41	7.94					
Rural Unrestricted	9	7	21.26	5.65	Urban Restricted	9	3	13.71	7.42					
Rural Unrestricted	10	7	20.93	5.35	Urban Restricted	10	3	13.10	7.04					
Rural Unrestricted	11	7	20.75	5.11	Urban Restricted	11	3	12.67	6.72					
Rural Unrestricted	12	7	20.77	4.89	Urban Restricted	12	3	12.44	6.41					
Rural Unrestricted	13	7	20.79	4.70	Urban Restricted	13	3	12.24	6.15					
Rural Unrestricted	14	7	20.80	4.54	Urban Restricted	14	3	12.08	5.93					
Rural Unrestricted	15	7	20.82	4.40	Urban Restricted	15	3	11.94	5.74					
Rural Unrestricted	16	7	20.82	4.27	Urban Restricted	16	3	11.85	5.55					
Rural Unrestricted	17	7	20.82	4.15	Urban Restricted	17	3	11.89	5.33					
Rural Unrestricted	18	7	20.81	4.04	Urban Restricted	18	3	11.92	5.14					
Rural Unrestricted	19	7	20.86	3.88	Urban Restricted	19	3	11.95	4.97					
Rural Unrestricted	20	7	20.99	3.65	Urban Restricted	20	3	11.98	4.81					
Rural Unrestricted	21	7	21.09	3.44	Urban Restricted	21	3	11.97	4.66					
Rural Unrestricted	22	7	21.15	3.21	Urban Restricted	22	3	11.89	4.50					
Rural Unrestricted	23	7	21.20	3.00	Urban Restricted	23	3	11.82	4.35					
Rural Unrestricted	24	7	21.25	2.80	Urban Restricted	24	3	11.75	4.21					
Rural Unrestricted	25	7	21.27	2.67	Urban Restricted	25	3	11.68	4.15					
Rural Unrestricted	26	7	21.17	2.61	Urban Restricted	26	3	11.59	4.15					
Rural Unrestricted	27	7	21.02	2.57	Urban Restricted	27	3	11.51	4.16					
Rural Unrestricted	28	7	20.89	2.53	Urban Restricted	28	3	11.43	4.16					
Rural Unrestricted	29	7	20.76	2.49	Urban Restricted	29	3	11.36	4.16					
Rural Unrestricted	30	7	20.64	2.46	Urban Restricted	30	3	11.30	4.17					
Rural Unrestricted	31	7	20.53	2.43	Urban Restricted	31	3	11.28	4.17					
Rural Unrestricted	32	7	20.56	2.32	Urban Restricted	32	3	11.16	4.06					
Rural Unrestricted	33	7	20.43	2.14	Urban Restricted	33	3	10.89	3.85					
Rural Unrestricted	34	7	20.30	1.98	Urban Restricted	34	3	10.64	3.66					
Rural Unrestricted	35	7	20.33	1.89	Urban Restricted	35	3	10.53	3.56					
Rural Unrestricted	36	7	20.45	1.83	Urban Restricted	36	3	10.52	3.52					
Rural Unrestricted	37	7	20.57	1.78	Urban Restricted	37	3	10.51	3.48					
Rural Unrestricted	38	7	20.68	1.73	Urban Restricted	38	3	10.50	3.44					
Rural Unrestricted	39	7	20.79	1.68	Urban Restricted	39	3	10.48	3.41					
Rural Unrestricted	40	7	20.89	1.63	Urban Restricted	40	3	10.47	3.38					

Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade	Road Type	Speed (MPH)	Grade (%)	Grams/Vehicle Mile Upgrade	Grams/Vehicle Mile Downgrade
Rural Unrestricted	41	7	20.99	1.59	Urban Restricted	41	3	10.46	3.35					
Rural Unrestricted	42	7	21.08	1.55	Urban Restricted	42	3	10.45	3.32					
Rural Unrestricted	43	7	21.17	1.51	Urban Restricted	43	3	10.45	3.29					
Rural Unrestricted	44	7	21.25	1.47	Urban Restricted	44	3	10.44	3.26					
Rural Unrestricted	45	7	21.30	1.43	Urban Restricted	45	3	10.41	3.24					
Rural Unrestricted	46	7	21.32	1.39	Urban Restricted	46	3	10.37	3.23					
Rural Unrestricted	47	7	21.34	1.36	Urban Restricted	47	3	10.34	3.20					
Rural Unrestricted	48	7	21.35	1.32	Urban Restricted	48	3	10.32	3.17					
Rural Unrestricted	49	7	21.37	1.28	Urban Restricted	49	3	10.30	3.15					
Rural Unrestricted	50	7	21.36	1.26	Urban Restricted	50	3	10.28	3.12					
Rural Unrestricted	51	7	21.35	1.23	Urban Restricted	51	3	10.26	3.10					
Rural Unrestricted	52	7	21.33	1.20	Urban Restricted	52	3	10.25	3.08					
Rural Unrestricted	53	7	21.32	1.18	Urban Restricted	53	3	10.23	3.05					
Rural Unrestricted	54	7	21.31	1.16	Urban Restricted	54	3	10.21	3.03					
Rural Unrestricted	55	7	21.30	1.13	Urban Restricted	55	3	10.20	3.01					
Rural Unrestricted	56	7	21.31	1.11	Urban Restricted	56	3	10.21	2.98					
Rural Unrestricted	57	7	21.33	1.08	Urban Restricted	57	3	10.24	2.95					
Rural Unrestricted	58	7	21.34	1.05	Urban Restricted	58	3	10.27	2.91					
Rural Unrestricted	59	7	21.36	1.02	Urban Restricted	59	3	10.32	2.88					
Rural Unrestricted	60	7	21.38	1.00	Urban Restricted	60	3	10.43	2.87					
Rural Unrestricted	61	7	21.45	0.98	Urban Restricted	61	3	10.55	2.86					
Rural Unrestricted	62	7	21.55	0.96	Urban Restricted	62	3	10.67	2.84					
Rural Unrestricted	63	7	21.65	0.94	Urban Restricted	63	3	10.80	2.83					
Rural Unrestricted	64	7	21.76	0.93	Urban Restricted	64	3	10.92	2.82					
Rural Unrestricted	65	7	21.92	0.91	Urban Restricted	65	3	11.16	2.81					
Rural Unrestricted	66	7	22.08	0.89	Urban Restricted	66	3	11.47	2.82					
Rural Unrestricted	67	7	22.23	0.87	Urban Restricted	67	3	11.79	2.82					
Rural Unrestricted	68	7	22.37	0.85	Urban Restricted	68	3	12.11	2.81					
Rural Unrestricted	69	7	22.51	0.83	Urban Restricted	69	3	12.41	2.81					
Rural Unrestricted	70	7	22.65	0.82	Urban Restricted	70	3	12.71	2.80					
Rural Unrestricted	71	7	22.78	0.80	Urban Restricted	71	3	13.00	2.79					
Rural Unrestricted	72	7	22.91	0.79	Urban Restricted	72	3	13.28	2.79					
Rural Unrestricted	73	7	23.03	0.77	Urban Restricted	73	3	13.55	2.78					
Rural Unrestricted	74	7	23.07	0.77	Urban Restricted	74	3	13.84	2.84					
Rural Unrestricted	75	7	22.76	0.86	Urban Restricted	75	3	14.17	3.11					