

Washington Commute Trip Reduction (CTR) Calculations

Vehicle Miles Traveled (VMT) Formula

- Single occupancy vehicle equivalent (SoVe) multiplied by commute distance equals vehicle miles traveled.
 $SOVe * Commute Distance = VMT$

Definitions:

- Single Occupancy Vehicle (SOV) – Vehicle with a single occupant (driver).
- Single Occupancy Vehicle Equivalent (SOVe) – Percent of SOV determined by number of occupants – also known as adjusted trips.
- Vehicle Miles Traveled (VMT) – Number of SOVe miles traveled.
- Vehicle Miles Traveled per Trip (VMT/Trip) – metric describing a one-way commute trip distance.
- Compressed Work Week (CWW)

SOVe is determined as follows:

- 100% for drive alone trips.
- XX% for pooled trips determined as one divided by number of occupants (e.g., 1/4 [or 25%] for a four-person carpool, 1/10 [or 10%] for a ten-person vanpool).
- 0% for all other mode types (public transportation, active transportation, remote work, compressed workweek [CWW] day off)

Occupancy to determine SOVe is determined as follows:

- Self-reported occupancy for carpool and vanpool trips.
- If not reported, use default occupancy of 1 for motorcycle, 2 for carpool, and 4 for vanpool.
- Cap motorcycle occupancy at 2 (i.e., reduce any number higher than 2).

Commute Distance is determined as follows:

- Distance created using pin drop and routing information from that location to worksite.
- If not available, use self-reported distance.

VMT example

Employee A: full-time, works 4/10s, and has a ten-mile commute:

- Monday, drove alone (100% * 10 miles = 10 VMT).
- Tuesday, vanpool with five total people (20% * 10 miles = 2.5 VMT).
- Wednesday, bus (0% * 10 miles = 0 VMT).
- Thursday, telework (0% * 10 miles = 0 VMT).
- Friday, CWW scheduled day off (0% * 10 miles = 0 VMT).

Employee B: part-time (three days a week [M, W, F]) and has a 20-mile commute:

- Monday, drove alone (100% * 20 miles = 20 VMT).
- Wednesday, carpool with two people total (50% * 20 miles = 10 VMT).
- Friday, bicycle (100% * 0 miles = 0 VMT).

Metrics for Employee A:

- Total VMT for week is 12 (10 + 2 + 0 + 0 + 0).
- Total VMT/Trip (also known as VMT/employee) is **2.4** (12 / 5 trips).

Metrics for Employee B:

- Total VMT for week is 30 (20 + 10 + 0).
- Total VMT/Trip is **10** (30 / 3 trips).

Metrics for Worksite:

- Total VMT for week is 42 (10 + 2 + 0 + 0 + 0 + 20 + 10 + 0).
- Total VMT/Trip is **5.25** (42 / 8 trips).

Notes:

- Total VMT/Trip is weighted by number of trips.
- Whereas average VMT for the two employees is 6.2 (2.4 + 10 / 2), the actual VMT is lower (5.25) because Employee B is only scheduled to work three days a week.

VMT Per Trip formula

Sum of vehicle miles traveled divided by sum of potential trips equals vehicle miles traveled per trip

Sum of VMT / Sum of Potential Trips = VMT/Trip

Notes:

- Sum of VMT is the sum of VMT for all reported trips.
- Sum of Potential Trips is the sum of every trip entered into the survey **plus CWW days calculated from schedule.**

Calculating Compressed work week (CWW) days from schedule:

- Selecting a schedule of 5/8s adds no CWW trips.

- Selecting a schedule of 4/10s adds one CWW trip.
- Selecting a schedule of 9/80s adds 0.5 CWW trips.
- Selecting a schedule of 3/12s adds 2 CWW trips.
- Note: If respondents select CWW schedules and enters more trips than days they are supposed to work, they still get additional credit for a CWW trip.

CWW example

Employee C: full-time, works 4/10s, and has a 12-mile commute enters:

- Monday, drove alone (100% * 12 miles = 12 VMT).
- Tuesday, drove alone (100% * 12 miles = 12 VMT).
- Wednesday, drove alone (100% * 12 miles = 12 VMT).
- Thursday, drove alone (100% * 12 miles = 12 VMT).
- Friday, drove alone (100% * 12 miles = 12 VMT).
- Unspecified CWW day (0% * 12 miles = 0 VMT).

Employee C's VMT is 60 (12 * 5), but her/his/their VMT/Trip is 10 (60 / 6 potential trips) to account for the CWW day. The hope is most people will mark their CWW as a "day off."

Example of an employee working 9/80 who fills out the survey for the week with the Friday **on**.

Employee D: full-time, works 9/80, and has a 15-mile commute:

- Monday, drove alone (100% * 15 miles = 15 VMT).
- Tuesday, drove alone (100% * 15 miles = 15 VMT).
- Wednesday, drove alone (100% * 15 miles = 15 VMT).
- Thursday, drove alone (100% * 15 miles = 15 VMT).
- Friday, drove alone (100% * 15 miles = 15 VMT).

Employee D's VMT is 75 (15 * 5) and her/his/their VMT/Trip is 13.64 (75 / **5.5** potential trips) to account for half a CWW day.

Example of an employee working 9/80 who fills out the survey for the week with the Friday **off**.

Employee E: full-time, works 9/80, and has a 15-mile commute:

- Monday, drove alone (100% * 15 miles = 15 VMT).
- Tuesday, drove alone (100% * 15 miles = 15 VMT).
- Wednesday, drove alone (100% * 15 miles = 15 VMT).
- Thursday, drove alone (100% * 15 miles = 15 VMT).
- Friday, day off

Employee E's VMT is 60 (15 * 4) and her/his/their VMT/Trip is 13.33 (60 / **4.5** potential trips) to account for half a CWW day.

Metrics for Worksite:

- Total VMT for week is 135 (15 * 9).
- Total VMT/Trip is **13.5** (135 / 10 trips).

Logic:

- If Employee D and Employee E were to fill out two weeks' worth of commute information, they would each have a VMT of 135 (15 miles * 9 trips made) with one full CWW day off.
- Using the 0.5 CWW day will approximate the two-week commute VMT/Trip with the assumption that roughly 50% of people will report their 9/80 with a day on and the other 50% will report their 9/80 off.
- Even if one way of filling out a 9/80 schedule is dominant, adding the 0.5 CWW day will limit misrepresentation by reducing the range of VMT/Trip.

Incomplete information:

It has been common for people to mark full-time, Monday through Friday schedules and then not fill out modes for all five days or fill out modes for extra days (e.g., Saturday and Sunday). Outside of CWW, potential trips should be determined by the total number of trips filled out by the respondent.

Examples:

- Full-time (5/8s) employee marks three commutes = three potential trips.
- Full-time (5/8s) employee marks seven commutes = seven potential trips.

Validation:

Ask respondent to verify distance information for the following scenarios:

- One-way commute distance greater than 100 miles unless the person indicates full-time remote work.
- One-way commute distance greater than 30 miles if the person indicates biking three or more times a week.
- One-way commute distance greater than 10 miles if the person indicates walking three or more times a week.

For calculations:

- **Exclude** any non-telework response of 150 miles or more.

Rationale:

- People, presumably those who feel "forced" to take the survey or who don't like the idea of CTR, have been shown to enter bad information. This data can have an outsized effect on VMT calculations and should not be included. All information entered by these respondents should be considered suspect and not included as official worksite data.

Drive-Along Rate (DAR)

Sum of adjusted trips divided by the sum of potential trips equals drive alone rate (Sum of adjusted trips / sum of potential trips = DAR).

Adjusted trips are determined as follows:

- 1 for drive alone trips.
- 0.XX for pooled trips determined as one divided by number of occupants (e.g., 1/4 [or 0.25] for a four-person carpool, 1/10 [or 0.1] for a ten-person vanpool).
- 0 for all other mode types (public transportation, active transportation, remote work, compressed workweek [CWW] day off)

DAR examples

(Using same information as used for VMT examples above):

Employee A: full-time, works 4/10s, and has a ten-mile commute:

- Monday, drove alone (1 adjusted trip, 1 potential trip).
- Tuesday, vanpool with five total people (0.2 adjusted trips, 1 potential trip).
- Wednesday, bus (0 adjusted trips, 1 potential trip).
- Thursday, telework (0 adjusted trips, 1 potential trip).
- Friday, CWW, not filled out on survey (automatic: 0 adjusted trips, 1 potential trip).

Employee B: part-time (three days a week [M, W, F]) and has a 20-mile commute:

- Monday, drove alone (1 adjusted trip, 1 potential trip).
- Wednesday, carpool with two people total (0.5 adjusted trips, 1 potential trip).
- Friday, bicycle (0 adjusted trips, 1 potential trip).

Metrics for Employee A:

- Total DAR for week is 24% (1.2 adjusted trips / 5 potential trips)

Metrics for Employee B:

- Total DAR for week is 50% (1.5 adjusted trips / 3 potential trips)

Metrics for Worksite:

- Total DAR for week is 33.8% (2.7 adjusted trips / 8 potential trips).

Additional calculations/metrics:

- Histogram showing % of employees by DAR categories (e.g., 0% to <20% DAR, 20% to <40% DAR, 40% to <60% DAR, 60% to <80% DAR, 80% to 100% DAR).
- Alternative: line chart showing % of employees at different DAR percentages (e.g., 0% to 100% by five percentage point increments).

Greenhouse Gas (GHG) Emissions

Worksite Annual GHG formula for Emissions Avoided by Electric Vehicles (EVs)

- Average GHG emissions per mile * Total VMT for Electric Vehicles * 0.001 = Average Annual GHG Emissions Avoided by EVs

Factors (and last used values) for calculating GHG:

- Light Duty Vehicle Assumed Fleet Economy (22.64 MPG).
- Carbon Dioxide per Gallon of Gasoline (8.89 KG).
- Carbon Dioxide to Carbon Dioxide Equivalent Factor (98%)
- The 0.001 to convert kilograms into metric tons

Total VMT for Electric Vehicles

Total VMT Reported for Electric Vehicles by Survey * 2 * 50

Formula notes:

- The 2 is to create roundtrips.
- The 50 is for work weeks in the year.

Worksite Annual GHG formula

Average GHG emissions per mile * Total VMT for Non-Electric Vehicles * 0.001 = Average Annual GHG Emissions (in metric tons)

Total VMT is for an entire year, calculated by this formula:

Total VMT = Total VMT Reported for Non-EVs by Survey * 2 * 50

Additional calculations/metrics:

- Have a total GHG for the worksite (in annual metric tons) and a GHG per employee.
- Have different GHG calculations for drive alone modes and pooled modes.
- Highlight tailpipe GHG savings for people using pooled trips vs if those trips were drive alone.
- Highlight tailpipe GHG savings for people using electric vehicles vs gas vehicle.
- Calculate NOx, particulates, and other emissions.

Final consideration:

For all these factors, we would like to show both the result of the calculations for the surveys that were returned and extrapolated to the total number of employees to show the estimate for the entire worksite.