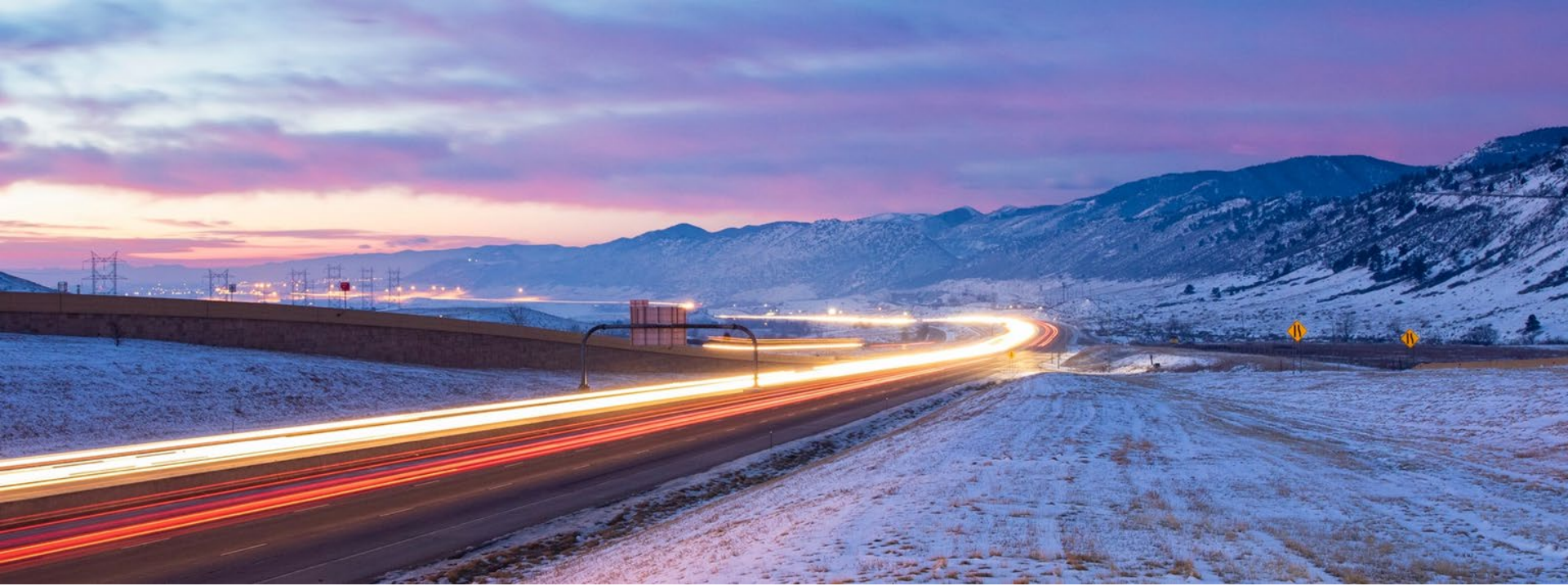


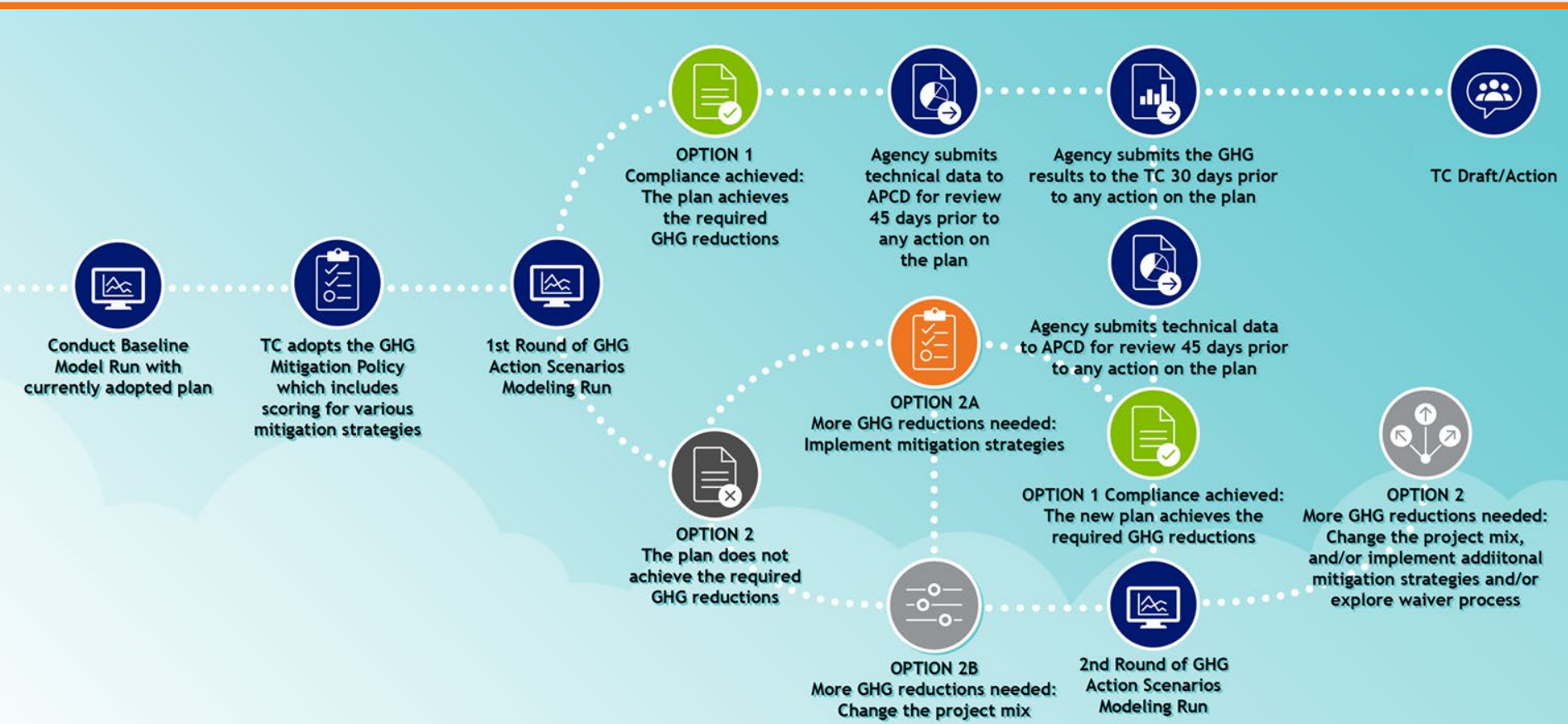
COLORADO
Department of Transportation

# GHG Pollution Standard for Transportation Planning:
## Policy Directive Development and Rule Implementation Update
April 14, 2022

# Agenda

- Current Status of Rule Implementation
- Policy Directive
  - Overview
  - Appendix A

# GHG Rule Planning Process



# Current Status

- April: TC and STAC Workshops (GHG Mitigation Policy Directive)
- May: TC Workshop and potential Approval of PD
- 10 Yr Plan Update and GHG Report to TC
  - CDOT, DRCOG and NFRMPO must have updated plans in place - before Oct 2022

# GHG Mitigations: Background

- GHG mitigation strategies are a key concept within the GHG Rule providing another pathway toward meeting the GHG reduction levels in the Rule.
- Staff has been working to develop both the overall guidance for these mitigation strategies as well as the detailed quantification of how much each measure would reduce GHG emissions.
- At last month's Transportation Commission meeting it was decided that all of this detailed work would live in a single Policy Directive to be adopted by the Commission.
- The Commission's Ad Hoc Committee has been meeting weekly to advise on the development of this Directive. Staff also has been meeting with CEO, CDPHE and the Interagency Consultation Team to receive their input.

# DRAFT GHG Mitigations Policy Directive

## Overarching framework

- Explains intent of mitigations and process for scoring
- High level enough to consider the 30 year life of the rule
- Reporting requirements

## Appendix A

- Lists actual GHG Mitigation Measures
- Scoring matrix
- Detailed calculation methodology with citations

# DRAFT Framework for GHG Policy Directive

Four main sections:

1. Process for Establishing GHG Mitigation Measures
2. Proposing and Approving New GHG Mitigation Measures
3. Scoring approach for GHG Mitigation Measures
4. Mitigation Action Plan & Status Report Requirements

# DRAFT Appendix A Overview

- Table 1 - GHG Mitigation Measures and points
  - State of the practice: Table 11 citations
  - Same measure has different impacts over time
  - Different measures have different lifetimes
    - Infrastructure - 30 years
    - Investment - 1 year
- Table 2-6 - Calculation Methodology
- Table 7 - Citations

DRAFT

# Mitigation Measures and their Point/Metric - Bike/Ped

| Project Type | Metric | Project Lifetime (Years) | Points/ Metric[1] Now - 2024[2] | Points/Metric 2025-2030 | Points/Metric 2031-2040 | Points/Metric 2041-2050 | Additional Multipliers |
|---|---|---|---|---|---|---|---|
| **Pedestrian/Bicycle** | | | | | | | |
| Bike lane/facility - urban[3] | Miles of two way facility built between plan year 1 and evaluation year | 30 | 10 | 8 | 4 | 2 | 2.0 – separated / protected lane or bike boulevard |
| Bike lane/facility – suburban | | | 3 | 3 | 1 | 1 | |
| Bike lane/facility – rural | | | 1 | 1 | 1 | 1 | |
| Sidewalk/ pedestrian facility - urban | | | 9 | 8 | 4 | 1 | 1.5 – within mixed-use district or ½ mi of transit station or school |
| Sidewalk/ pedestrian facility - suburban | | | 1 | 1 | 1 | 1 | |
| Sidewalk/ pedestrian facility – rural | | | 1 | 1 | 1 | 1 | |
| Shared-use path - urban | | | 22 | 18 | 9 | 3 | |
| Shared-use path – suburban | | | 7 | 6 | 3 | 1 | |
| Shared-use path – rural | | | 1 | 1 | 1 | 1 | |

# DRAFT Calculation Methodology - Bike/Ped

**PEDESTRIAN AND BICYCLE STRATEGIES**

| Ref | Parameter | Value 2025 | 2030 | 2040 | 2050 | Source/Calculation | Metric & Notes |
|---|---|---|---|---|---|---|---|
| | **Parameters Common Across Strategies** | | | | | | |
| A | grams CO2 per vehicle-mile (auto) | 303 | 256 | 119 | 46 | GHG Rule CBA (MOVES model) - high EV scenario | |
| | Prior drive mode share of new bikers/walkers | | | | | | |
| B1 | Owned bikes | 60% | | | | Transportation Investment Strategy Tool, Table A.4 | |
| B2 | Shared bikes and scooters | 40% | | | | Buehler et al (2019), Mobility Lab (2019), NABSA (2020), Ramboll (2020), MacArthu | |
| | Average trip length (mi) | | | | | | |
| C1 | Bike | 2.3 | | | | 2009 National Household Travel Survey | |
| C2 | Walk | 0.7 | | | | 2009 National Household Travel Survey | |
| C3 | Shared bike | 1.4 | | | | PBOT (2020) and NABSA (2020) | |
| C4 | Scooter | 1.1 | | | | PBOT (2020) and NABSA (2020) | |
| D | Annualization factor | 365 | | | | | |

| Per New Facility-Mile: | New Users (Daily) | Displaced Auto Miles/yr | Source/Calculation |
|---|---|---|---|
| Bike lane/facility - urban | 80 | 40,296 | New users: Transportation Investment Strategy Tool documentation, Table A.4 |
| Bike lane/facility – suburban | 25 | 12,593 | Displaced auto miles: New users * C1 * B1 * D |
| Bike lane/facility – rural | 5 | 2,519 | |
| Sidewalk/ pedestrian facility - urban | 247 | 124,414 | New users: Transportation Investment Strategy Tool documentation, Table 4.11 |
| Sidewalk/ pedestrian facility - suburban | 13 | 6,548 | Displaced auto miles: New users * C1 * B1 * D |
| Sidewalk/ pedestrian facility – rural | 2 | 1,007 | |

# DRAFT Calculation Methodologies

| Change in tons CO2 per new facility-mile (annual): | 2025 | 2030 | 2040 | 2050 | Source/Calculation | Metric & Notes |
|---|---|---|---|---|---|---|
| Bike lane/facility - urban | (12.2) | (10.3) | (4.8) | (1.8) | = Displaced auto miles * A / 1000000 | |
| Bike lane/facility – suburban | (3.8) | (3.2) | (1.5) | (0.6) | | |
| Bike lane/facility – rural | (0.8) | (0.6) | (0.3) | (0.1) | | |
| Sidewalk/ pedestrian facility - urban | (37.7) | (31.8) | (14.8) | (5.7) | | |
| Sidewalk/ pedestrian facility - suburban | (2.0) | (1.7) | (0.8) | (0.3) | | |
| Sidewalk/ pedestrian facility – rural | (0.3) | (0.3) | (0.1) | (0.0) | | |
| Shared-use path - urban | (26.6) | (22.5) | (10.4) | (4.0) | | |
| Shared-use path – suburban | (8.3) | (7.0) | (3.3) | (1.3) | | |
| Shared-use path – rural | (1.7) | (1.4) | (0.7) | (0.3) | | |
| "Complete Streets" reconstruction - urban | (49.9) | (42.1) | (19.6) | (7.5) | | |
| "Complete Streets" reconstruction – suburban | (5.8) | (4.9) | (2.3) | (0.9) | | |

| Change in tons CO2 per 100 new shared vehicles (annual): | 2025 | 2030 | 2040 | 2050 | Source/Calculation | Metric & Notes |
|---|---|---|---|---|---|---|
| Shared bike | (16.1) | (13.6) | (6.3) | (2.4) | = Displaced auto miles * A / 1000000 | |
| Scooter | (15.6) | (13.1) | (6.1) | (2.3) | | |

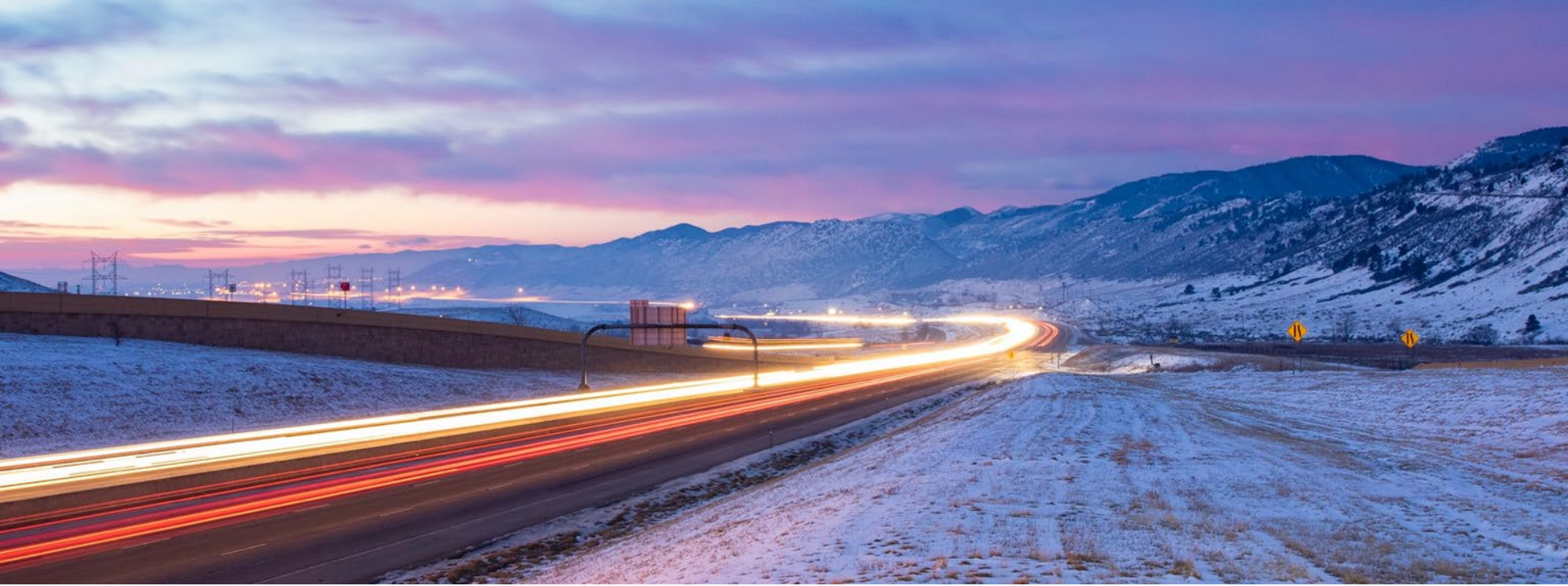
| Points per new facility-mile: | 2025 | 2030 | 2040 | 2050 | |
|---|---|---|---|---|---|
| Bike lane/facility - urban | 12 | 10 | 5 | 2 | Providing a minimum of 1 point, even if CO2 estimate rounds to 0 tons |
| Bike lane/facility – suburban | 4 | 3 | 1 | 1 | |
| Bike lane/facility – rural | 1 | 1 | 1 | 1 | |

# Next Steps

- Staff will continue to refine the PD based on input at April's workshops and additional stakeholder discussions.

- The Rule also provides for a formal review period for the Air Pollution Control Division. Staff has initiated that review in time for a May adoption of the PD.

- As noted in earlier meetings, this work will continue to evolve over time as both our models increase in sophistication and we receive additional data on the real-world impact of these mitigations.



Questions?

DRAFT
4/13/22

| COLORADO DEPARTMENT OF TRANSPORTATION | X POLICY DIRECTIVE<br>□ PROCEDURAL DIRECTIVE |
|---|---|
| Subject<br>**Greenhouse Gas Mitigation Measures** | **XXX** |

| Effective | Supersedes | Originating Office |
|---|---|---|
| **5/01/22** | **New** | **Division of Transportation Development** |

## I. PURPOSE

The purpose of this Policy Directive is to fulfill the requirements of the Rules Governing Statewide Transportation Planning Process and Transportation Planning Regions (the Rule), which directs the Colorado Department of Transportation (CDOT), in consultation with the Metropolitan Planning Organizations (MPOs), to establish an ongoing administrative process and guidelines for selecting, measuring, confirming, verifying, and reporting Greenhouse Gas (GHG) Mitigation Measures. CDOT and MPOs may use GHG Mitigation Measures in order to assist them in meeting the Regional GHG Planning Reduction Levels in 2 CCR 601-22. This Policy Directive sets forth the intent and principles of GHG mitigations, the process for establishing, verifying, and the calculation methodology for such measures, and the GHG reduction/score.

## II. AUTHORITY

Transportation Commission pursuant to § 43-1-106 (8)(a), C.R.S.
§ 43-1-128, C.R.S.
2 CCR 601-22, Rules Governing Statewide Transportation Planning Process and Transportation Planning Regions (the "Rule").

## III. APPLICABILITY

This Policy Directive shall apply to all CDOT Divisions, Regions, Branches, and Offices, the state's current five MPOs: Denver Regional Council of Governments (DRCOG), North Front Range Metropolitan Planning Organization (NFRMPO), Pikes Peak Area Council of Governments (PPACG), Grand Valley Metropolitan Planning Organization (GVMPO), and

Pueblo Area Council of Governments (PACOG), as well as any MPOs created during the lifetime of the Rule.

## IV. BACKGROUND

The broad purpose of this Policy Directive is to help achieve the objectives of the Rule, which is intended to reduce greenhouse gas (GHG) emissions from the transportation sector. Specifically, the Policy Directive fulfills the following requirement within 2 CCR 601-22, Section 8.02.4:

> "By May 1, 2022, CDOT in consultation with the MPOs shall establish an ongoing administrative process and guidelines, through a public process, for selecting, measuring, confirming, verifying, and reporting GHG Mitigation Measures. CDOT and MPOs may incorporate one or more GHG Mitigation Measures into their plans in order to assist in meeting the Regional GHG Planning Reduction Levels in Table 1. Such a process and guidelines shall include, but not be limited to, how CDOT and MPOs shall determine the relative benefits and impacts of GHG Mitigation Measures, and measure and prioritize localized benefits to communities and Disproportionately Impacted Communities in particular. The mitigation credit awarded to a specific solution shall consider both regional and community benefits."

GHG Mitigation Measures are an important, but voluntary, component of the Rule as they provide an additional option to demonstrate compliance with the GHG Reduction Levels (Table 1). For this reason, the GHG reductions achieved by Mitigation Measures must be real and quantifiable. The Mitigation Measures included in this Policy Directive--and the scores or reduction levels assigned to these measures--are based on the best available research, calculation methodology and forecasting tools available nationwide.

It also is important to understand how Mitigation Measures relate to transportation plans ("Applicable Planning Documents" in the Rule), which include a range of projects-- from roadway expansions to new transit and bike lanes. The Rule requires CDOT and MPOs to model "at a minimum… Regionally Significant Projects" to demonstrate compliance. This language provides the flexibility to model projects that would not be considered Regionally Significant. This approach has the benefit of providing a full analysis of all the projects within a plan and, further, of realizing the benefits of a model to capture the interrelationships of these strategies across the transportation network.

However, not all projects can be accurately modeled yet. This is either because they are too small to be detected within a model (e.g. a segment of bike lane) or are beyond the current overall capability of an agency's model. Thus, this Policy largely focuses on GHG Mitigation

Measures that cannot yet be accurately quantified within CDOT or an MPO's travel demand modeling runs. The Commission recognizes that this dynamic will change over time, as models continue to improve, which may require amendments to this Policy.

## V. DEFINITIONS

The defined terms in this Policy Directive have the same meaning as in the Rule except as explicitly set **forth** herein. Some definitions are repeated here for convenience.

"Applicable Planning Document", as stated in the Rule (1.02), are MPO Fiscally Constrained Regional Transportation Plan (RTP), Transportation Improvement Program (TIP) for MPOs in Non-Attainment Areas, CDOT's 10-Year Plan and Four-Year Prioritized Plan in Non-MPO areas, and amendments to the MPO RTPs and CDOT's 10-Year Plan and Four-Year Prioritized Plan in Non-MPO areas that include the addition of Regionally Significant Projects.

"Disproportionately Impacted Communities", as stated in the Rule (1.11), is defined in § 24-38.5-302(3), C.R.S. as a community that is in a census block group, as determined in accordance with the most recent United States Decennial Census where the proportion of households that are low income is greater than forty percent (40%), the proportion of households that identify as minority is greater than forty percent (40%), or the proportion of households that are housing cost-burdened is greater than forty percent (40%).

"Greenhouse Gas (GHG)", as stated in the Rule (1.16), are pollutants that are anthropogenic (man-made) emissions of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, nitrogen trifluoride, and sulfur hexafluoride

"Greenhouse Gas (GHG) Mitigation Measures", as stated in the Rule (1.18) or "Mitigation Measures", are non-Regionally Significant Project strategies that reduce transportation GHG pollution and help meet the GHG Reduction Levels.

"Greenhouse Gas (GHG) Reduction Level", as stated in the Rule (1.17), is the amount of the GHG expressed as CO2e reduced that CDOT and MPOs must attain through transportation planning.

"GHG Transportation Report" is the report that is required to be submitted as part of the Rule which shows compliance toward meeting the reductions levels.

“Metropolitan Planning Organization" or “MPO”, as stated in the Rule (1.28), is an organization designated by agreement among the units of general purpose local governments and the Governor, charged to develop the Regional Transportation Plans (RTPs) and programs in a Metropolitan Planning Area pursuant to 23 U.S.C. § 134. Colorado currently includes five designated MPOs: DRCOG, PPACG, PACOG, GVMPO and NFRMPO.

“Mitigation Action Plan” (MAP) is an element of the GHG Transportation Report that specifies which GHG Mitigation Measures shall be implemented that help achieve the GHG Reduction Levels.

“Off-Model” means tools are  better suited to use independent of the travel model, including calculation methodology in order to quantify or estimate the effects of GHG reductions.

“Policy Directive” is a document adopted by the Transportation Commission that specifies organizational and Commission goals and policies and is used to help implement the Rule.

“Regionally Significant Project”, as stated in the Rule (1.42), is a transportation project that is on a facility which serves regional transportation needs (such as access to and from the area outside of the region, major activity centers in the region, major planned developments such as new retail malls, sports complexes, etc., or transportation terminals as well as most terminals themselves) and would normally be included in the modeling of a metropolitan area's transportation network or state transportation network, including at a minimum all principal arterial highways and all fixed guideway transit facilities that offer an alternative to regional highway travel. Modifications of this definition shall be allowed if approved by the State Interagency Consultation Team. If the MPOs have received approval from the Environmental Protection Agency (EPA) to use a different definition of regionally significant project as defined in 40 C.F.R. § 93.101, the State Interagency Consultation Team will accept the modified definition. Necessary specificity for MPO Models or the Statewide Travel Model will be approved by the State Interagency Consultation Team. The Transportation Commission may issue guidance for implementation of this definition based on population density or other defined factors from time to time.

“State Interagency Consultation Team” (IACT), as stated in the Rule (1.44), consists of the Division Director or the Division Director’s designee, the Colorado Department of Public Health and Environment (CDPHE) Director of Air Pollution Control Division or the Director’s designee, the Director of each MPO or their designee, and the Colorado Energy Office Director or Director’s designee. The Division Director may appoint additional member(s) from outside of these organizations. The State Interagency Consultation Team works collaboratively and consults appropriately to approve modifications to Regionally Significant definitions, to address

classification of projects as Regionally Significant, and to consult on issues that may arise regarding modeling assumptions and projects that reduce GHG emissions.

## VI. POLICY

The Transportation Commission adopts the processes and priorities stated herein to guide the development of GHG Mitigation Measures, the approval of new GHG Mitigation Measures, the elements of a Mitigation Action Plan and GHG Mitigation Measure Status Report, and the analysis of the efficacy of GHG Mitigation Measures.

### A. Overall Process for Establishing GHG Mitigation Measures

This Policy Directive includes a list of approved GHG Mitigation Measures (Appendix A) that have been reviewed, vetted, and scored by the Department's subject matter experts, reviewed by the Interagency Coordination Team, and submitted to the Air Pollution Control Division as required by the Rule, Section 8.04.2. In order for a GHG Mitigation Measure to be included in a Mitigation Action Plan for compliance, it must be included in Appendix A.

Due to the evolving nature of evaluation techniques it is expected that Appendix A may be reviewed and amended in the early months and years of this Policy Directive.

#### 1. Proposing and Approving New GHG Mitigation Measures

This Policy recognizes the need to balance appropriate analytical rigor around the expected GHG reductions of GHG Mitigation Measures with encouraging new ideas and adapting to advancements in measurement methodologies. To that end, any individual or organization may nominate a new GHG Mitigation Measure for review and potential approval. CDOT shall develop an online form on CDOT's website to receive these nominations.

Additionally, CDOT staff will establish a regular process of inventorying best practices from around the country with a focus on identifying a range of effective GHG Mitigation Measures for urban, suburban, and rural contexts throughout the state. Staff shall engage CDOT's Environmental Justice branch in this process to help ensure that GHG Mitigation Measures and policy updates are regularly adapted to, and developed with, input from Disproportionately Impacted Communities.

In order to be included in Appendix A as an approved GHG Mitigation Measure, all new measures must follow the process outlined below:

- Assessment by CDOT GHG Program staff according to the framework listed in Table 1. The individual or group submitting the new measure shall be expected to provide, to the extent possible, this information and data upon submission of a proposed GHG Mitigation Measure,
- Review and recommendation by the Interagency Coordination Team.
- Confirmation and verification by the Air Pollution Control Division (APCD) (as required by 8.04.2), and
- Approval by the Transportation Commission for incorporation into Appendix A.

Staff, in consultation with the Transportation Commission, reserves the discretion to prioritize newly nominated GHG Mitigation Measures based on the information available and the effort required to assess.

Once a proposed GHG Mitigation Measure has been approved by the Transportation Commission, CDOT and the MPOs may immediately use the new GHG Mitigation Measure in their Mitigation Action Plans.

Table 1: Framework for Submitting New GHG Mitigation Measures

| **New GHG Mitigation Measure Submission Components** | **Description of New GHG Mitigation Measure** |
|---|---|
| Strategy Description | Describe the overall strategy, including:<br>● The nexus with the transportation sector<br>● Description of what the strategy implements<br>● Identification of how the strategy reduces CO2e emissions<br>● If possible, identification of how the strategy is not already reflected in land use and travel modeling tools, thus warranting an off-model estimate of CO2e emission reductions |
| Quantification Methodology | Describe the methodology for quantifying CO2e emissions reductions from the strategy<br>● Base methodology on empirical evidence supported by verifiable data sources<br>● Clearly document all assumptions, sources of data, and calculations |
| Challenges and Constraints | ● Potential challenges and constraints with quantifying and implementing strategy |

### B. Process for Scoring Approved GHG Mitigation Measure

Approved GHG Mitigation Measures will be scored and the scores included in Appendix A. The scoring is related to the ability of a GHG Mitigation Measure to reduce GHGs relative to a certain metric. It also provides a way to distinguish and value the location and context of these Mitigation Measures.

The scores are based on the following factors:

1. Metric
2. Points/metric
3. Additional multipliers

### C. GHG Mitigation Action Plan

Subsection 8.02.6.3 of the Rule states as follows: "If (GHG) Mitigation Measure(s) are needed to count toward the GHG Reduction Levels in Table 1, the MPO or CDOT may submit a Mitigation Action Plan that identifies GHG Mitigation Measures, if any, needed to meet the GHG Reduction Levels within Table 1". The Transportation Commission will evaluate Mitigation Action Plans and determine their sufficiency to assure that the Plan meets the GHG Reduction Levels needed for compliance.

The following information must be included in a Mitigation Action Plan:

a. GHG Emissions Reductions: Summary of emissions analysis from GHG Transportation Report, including the estimated gap to achieve the GHG Reduction Levels specified for each horizon year.
b. GHG Mitigation Measure Summary/Description: Each measure shall include the following details as listed in Table 2.

Table 2: Description for Each Mitigation Measure

| **Component** | **Description of information to be submitted with application.** |
|---|---|
| Measure Description | A description of the measure, including scale, location, and how it would affect travel activities expected to result in GHG reductions. |
| Timing | Anticipated start date, completion date, and dates of any other key milestones. |
| GHG Reductions | Using the scores in Appendix A, in each year of the project's lifetime. |
| Co-benefits | Quantification, where possible, of specific co-benefits including reduction of |

| | |
|---|---|
| | co-pollutants (PM2.5, NOx, etc.) as well as travel impacts (changes to VMT, pedestrian/bike use, transit ridership, etc. as applicable), for each relevant compliance year in the project's lifetime. |
| Benefits to Disproportionately Impacted Communities | A description of the benefits to Disproportionately Impacted Communities and stakeholder engagement conducted with those communities. Include an accounting of the amount of mitigation dollars directly spent in--or designed to serve--Disproportionately Impacted Communities as a subset of total dollars. |
| Measure History | If a project was specifically identified in a previous fiscally constrained plan(as of January 30, 2022 , it is not eligible as a GHG Mitigation Measure in a new plan UNLESS the new GHG Mitigation Measure is funded from a pool of non-specific projects (and not otherwise modeled in a previous plan), in which case it may be used as a GHG Mitigation Measure in the new plan. |
| Funding/Resources/ Partnerships | Funding source(s), including if those funds are confirmed if any partnerships have been made or in-kind/matches are included. |
| Other Info As Needed | Any other relevant information that may be needed for thorough review of the proposed GHG Mitigation Measure. |

## D. GHG Mitigation Measure Status Reports and Follow-Up Analysis.

### 1. Submitting a GHG Mitigation Measure Status Report.

Following the approval and implementation of a GHG Mitigation Action Plan, CDOT and the MPOs are required to submit an annual status report for each GHG Mitigation Measure to the Transportation Commission starting on April 1 of each calendar year subsequent to the approval of the MAP The following information shall be included in each status report (as outlined in the Rule):

- The implementation timelines;
- The current status
- For measures that are in progress or completed, quantification of the annual benefit of such measures
- For measures that are delayed, canceled, or substituted, an explanation of why that decision was made and, how these measures or the equivalent will be achieved
- For measures located in a Disproportionately Impacted Community that are delayed, canceled, or substituted, an explanation of why that decision was made and, how these measures or the equivalent will still be achieved in Disproportionately Impacted Communities

The Commission shall consider failure to submit reports and any analysis therein in subsequent review of plans presented for consideration.

**2. Analyzing the Efficacy of GHG Mitigation Measures.**

On a periodic basis, but no later than 2026 on the first occasion, CDOT shall evaluate the effectiveness of implemented GHG Mitigation Measures against predicted achievement of those measures. Such analysis shall be provided to the Interagency Coordination Team for their review and consideration as to whether this information merits a change to the score applied to relevant measure(s). The Commission shall incorporate subsequent review and revisions into this Policy Directive.

## V. IMPLEMENTATION PLAN

This Policy Directive shall be effective immediately upon approval by the Transportation Commission.

The Office of Policy and Government Relations shall post this Policy Directive on CDOT's intranet as well as on public announcements.

## VI. REVIEW DATE

This Directive shall be reviewed by January, 2023, following the adoption of various transportation plans in 2022. Further, this Directive shall be reviewed no later than ____, 2025.

_____ _____

Herman Stockinger
Transportation Commission Secretary

Date of Approval

**APPENDIX A.**

# Table of Contents

## Table 1. GHG Mitigation Measures and their points/metric in each compliance year.

| Project Type | Metric | Project Lifetime (Years) | Points/ Metric[1] Now - 2024[2] | Points/Metric 2025-2030 | Points/Metric 2031-2040 | Points/Metric 2041-2050 | Additional Multipliers |
|---|---|---|---|---|---|---|---|
| **Pedestrian/Bicycle** | | | | | | | |
| Bike lane/facility - urban[3] | Miles of two way facility built between plan year 1 and evaluation year | 30 | 10 | 8 | 4 | 2 | 2.0 – separated / protected lane or bike boulevard |
| Bike lane/facility – suburban | | | 3 | 3 | 1 | 1 | |
| Bike lane/facility – rural | | | 1 | 1 | 1 | 1 | |
| Sidewalk/ pedestrian facility - urban | | | 9 | 8 | 4 | 1 | 1.5 – within mixed-use district or ½ mi of transit station or school |
| Sidewalk/ pedestrian facility - suburban | | | 1 | 1 | 1 | 1 | |
| Sidewalk/ pedestrian facility – rural | | | 1 | 1 | 1 | 1 | |
| Shared-use path - urban | | | 22 | 18 | 9 | 3 | |
| Shared-use path – suburban | | | 7 | 6 | 3 | 1 | |

[1] 1 point corresponds to 1 metric ton of CO2 reduced.
[2] Year of emissions factor basis for points: now-2024: 2025; 2025-2030: 2030; 2031-2040: 2040; and 2041-2050: 2050.
[3] For pedestrian and bicycle facilities, "urban" corresponds to census tract or block group population density of greater than 4,000 persons per square mile; "suburban" to density between 500 and 4,000 persons per square mile; and "rural" to density of less than 500 persons per square mile. "Sharrows" are not considered bike facilities in this application; however, a bike boulevard (low-volume street that includes pavement markings, signage, and traffic calming measures) is considered a bike facility. A "mixed-use district" is a street along which both residential and commercial (including retail) uses are permitted by zoning and where multiple non-residential uses (including retail) are present or planned.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Shared-use path – rural | | | 1 | 1 | 1 | 1 | |
| "Complete Streets" reconstruction - urban | | 30 | 19 | 16 | 8 | 3 | 2.0 – separated / protected lane or bike boulevard vs. bike lane<br><br>1.5 – within mixed-use district or ½ mi of transit station or school |
| "Complete Streets" reconstruction - suburban | | | 4 | 3 | 1 | 1 | |
| Bikeshare | Per 100 vehicles in service in evaluation year | 2 | 16 | 14 | 6 | 2 | |
| Scooter share | | | 16 | 13 | 6 | 2 | |
| **Transit** | | | | | | | |
| New/increased fixed-route transit service - urban/suburban - electric | Per 1,000 additional vehicle revenue-hours in evaluation year[4] | 1 | 27 | 23 | 11 | 4 | |

[4] "Evaluation year" is the year for which projected GHG mitigation is being compared against a target, i.e., 2025, 2030, 2040, 2050.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| New/increased fixed-route transit service - urban/suburban - electric/diesel fleet average | | 1 | 7 | 18 | 11 | 4 | |
| New/increased transit service - inter regional | | | 7 | 18 | 11 | 4 | |
| Reduce transit fares 25% | Per million annual trips current ridership base | | 90 | 75 | 35 | 14 | |
| Reduce transit fares 50% | | | 180 | 150 | 70 | 30 | |
| Free fares | | | 360 | 300 | 140 | 55 | |
| Implement bus priority treatments[5] | Per 1,000 vehicle revenue-miles per weekday of affected service in evaluation year | 30 | 20 | 12 | 5 | 2 | |
| **Transportation Demand Management** | | | | | | | |
| Trip Reduction program - voluntary | Per program $1,000 expenditure in evaluation year | 1 | 30 | 25 | 12 | 5 | |
| Trip Reduction marketing | Per program $1,000 expenditure in evaluation year | | 2 | 2 | 1 | 1 | |

[5] Bus priority treatments will need to meet minimum standards, e.g., anticipated >+10% travel time reduction on high-frequency (<=20 min headway) routes.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Employer sponsored vanpool | # of participants in evaluation year | | 1 | 1 | 1 | 1 | |
| Carshare program | # of cars provided in evaluation year | | 14 | 12 | 5 | 2 | 3.0 for EVs |
| **Traffic Operations** | | | | | | | |
| Retime/optimize arterial signals | Per 10,000 AADT per signal optimized within five years prior to evaluation year | 5 | 75 | 65 | 35 | 20 | |
| Replace signalized intersection with roundabout in urban area | Per roundabout constructed between current year and evaluation year | 30 | 150 | 120 | 70 | 45 | |
| **Parking Management** | | | | | | | |
| Reduce minimum parking requirements to "smart growth" levels[6] and set maximum levels no more than 125% of "smart growth" levels | # of DUs that can be built in rezoned area between current year and evaluation year | 30 | 650 | 550 | 250 | 95 | |

[6] "Smart growth" parking levels are defined as minimum requirements of less than 1 space per dwelling unit or 2 spaces per 1,000 sq. ft. of commercial floor area, and maximum requirements of no more than 1.25 spaces per dwelling unit or 2.5 spaces per 1,000 sq. ft. of commercial floor area. Additional definitions for other land use types may be added.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Unbundle residential parking | # of parking spaces rented for at least $100 per month in evaluation year | 1 | 160 | 130 | 60 | 25 | |
| Additional tax or fee on public and/or private parking | Per # of parking spaces per $1 fee in evaluation year | 1 | 170 | 140 | 65 | 25 | |

**Definitions:**

**Bus priority treatments:** Infrastructure and/or operational improvements to reduce run times and improve reliability. These may include transit signal priority, queue jump lanes, exclusive bus lanes, bulb-outs, and/or other treatments. Treatments should reduce run times by at least 10% along the improved segment on high-frequency (<=20 min headway) routes.

**Trip reduction program**: Minimum requirements for such programs include staff dedicated to performing outreach to employers to promote and provide information on travel options for employees; resources for employers to communicate travel options to employees (e.g., websites, flyers, social media, trip planning tools, model telework policies, vanpool support); guaranteed ride home program; ride matching platform; incentives for participation (e.g., prizes, recognition); and support for measuring and tracking performance (e.g., participation in alternative mode use) via apps or surveys.

**Support medium/heavy truck fleet electrification:** Supporting actions may include providing rebates/incentives for depot charging; constructing or supporting public charging intended to serve trucks; providing funding for other electricity infrastructure/grid improvements to support high-speed charging; and/or providing technical support for charging development and/or vehicle procurement.

**Unbundle residential parking:** Developers of residential projects charge tenants or unit buyers per parking space rather than including parking costs as part of the rent or sale price.

**“Complete Streets” reconstruction:** Reconstruct streets to include or enhance bicycle and pedestrian facilities as well as transit priority treatments if appropriate.

**Additional comments:**

Transit: Expressing service expansion in vehicle-hours captures a wide range of specific actions including adding route-miles, reducing headways, and extending service hours or days. Ridership elasticities are available to relate to overall service metrics, but will be less available for more specific actions. Data to support ridership response to other improvements (e.g., bus stops and other amenities) will be less available.

Lifetime Effectiveness of GHG Mitigation Measures: The table lists the number of years after implementation or expenditure for which a strategy remains effective.Some infrastructure projects have long lasting effects, while other programs must be annually reinstated e.g., transit operations and parking pricing. For those programs that must be annually reinstated, agencies may take credit for as many years as the applicable planning document commits to funding said program. An agency may take credit for the GHG reductions of a given project over its lifetime effectiveness.



## Table 2. GHG Point Estimate Calculation Methodologies - Pedestrian and Bicycle Strategies

| PEDESTRIAN AND BICYCLE STRATEGIES | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | | **Value** | | | | |
| **Ref** | **Parameter** | **2025** | **2030** | **2040** | **2050** | **Source/Calculation** |
| | **Parameters Common Across Strategies** | | | | | |
| A | grams CO2 per vehicle-mile (auto) | 303 | 256 | 119 | 46 | CDOT (2021) - high EV scenario |
| | Prior drive mode share of new bikers/walkers | | | | | |
| B1 | Owned bikes | 60% | | | | Transportation Investment Strategy Tool, Table A.4 |

| | | | | |
|---|---|---|---|---|
| B2 | Shared bikes and scooters | 40% | | Buehler et al (2019), Mobility Lab (2019), NABSA (2020), Ramboll (2020), MacArthur et al (2018) |
| | Average trip length (mi) | | | |
| C1 | Bike | 2.3 | | 2009 National Household Travel Survey |
| C2 | Walk | 0.7 | | 2009 National Household Travel Survey |
| C3 | Shared bike | 1.4 | | PBOT (2020) and NABSA (2020) |
| C4 | Scooter | 1.1 | | PBOT (2020) and NABSA (2020) |
| D | Annualization factor | 365 | | |
| | | | | |
| | | | | |

| | **Per New Facility-Mile:** | **New Users (Daily)** | **Displaced Auto Miles/yr** | | | **Source/ Calculation** |
|---|---|---|---|---|---|---|
| | Bike lane/facility - urban | 80 | 40,296 | | | New users: Transportation Investment Strategy Tool documentation, Table A.4 |
| | Bike lane/facility – suburban | 25 | 12,593 | | | Displaced auto miles: New users * C1 * B1 * D |
| | Bike lane/facility – rural | 5 | 2,519 | | | |
| | Sidewalk/ pedestrian facility - urban | 247 | 124,414 | | | New users: Transportation Investment Strategy Tool documentation, Table 4.11 |
| | Sidewalk/ pedestrian facility - suburban | 13 | 6,548 | | | Displaced auto miles: New users * C1 * B1 * D |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Sidewalk/ pedestrian facility – rural | 2 | 1,007 | | | |
| | Shared-use path - urban | 174 | 87,845 | | | New users: Transportation Investment Strategy Tool documentation, Table A.4 |
| | Shared-use path – suburban | 55 | 27,452 | | | Displaced auto miles: New users * C1 * B1 * D |
| | Shared-use path – rural | 11 | 5,490 | | | |
| | "Complete Streets" reconstruction - urban | 327 | 164,710 | | | = Sum of value for bike lane + pedestrian improvements |
| | "Complete Streets" reconstruction – suburban | 38 | 19,141 | | | |
| | | | | | | |
| | **Per New Shared Vehicle:** | **Trips per Day** | **Annual Person-Miles** | **Displaced Auto Miles** | | **Source/ Calculation** |
| | Shared bike | 2.6 | 1329 | 531 | | Trips per day: PBOT (2020) and NABSA (2020) |
| | Scooter | 3.2 | 1285 | 514 | | Annual person-miles: Trips per day * [C3 or C4]* 365 |
| | | | | | | Displaced auto miles: Annual person-miles * B2 |
| | | | | | | |
| | **Change in tons CO2 per new facility-mile (annual):** | **2025** | **2030** | **2040** | **2050** | **Source/ Calculation** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Bike lane/facility - urban | -12.2 | -10.3 | -4.8 | -1.8 | =Displaced auto miles * A / 1000000 |
| | Bike lane/facility – suburban | -3.8 | -3.2 | -1.5 | -0.6 | |
| | Bike lane/facility – rural | -0.8 | -0.6 | -0.3 | -0.1 | |
| | Sidewalk/ pedestrian facility - urban | -37.7 | -31.8 | -14.8 | -5.7 | |
| | Sidewalk/ pedestrian facility - suburban | -2 | -1.7 | -0.8 | -0.3 | |
| | Sidewalk/ pedestrian facility – rural | -0.3 | -0.3 | -0.1 | 0 | |
| | Shared-use path - urban | -26.6 | -22.5 | -10.4 | -4 | |
| | Shared-use path – suburban | -8.3 | -7 | -3.3 | -1.3 | |
| | Shared-use path – rural | -1.7 | -1.4 | -0.7 | -0.3 | |
| | “Complete Streets” reconstruction - urban | -49.9 | -42.1 | -19.6 | -7.5 | |
| | “Complete Streets” reconstruction – suburban | -5.8 | -4.9 | -2.3 | -0.9 | |
| | | | | | | |

| | Change in tons CO2 per 100 new shared vehicles (annual): | 2025 | 2030 | 2040 | 2050 | Source/Calculation |
|---|---|---|---|---|---|---|
| | Shared bike | -16.1 | -13.6 | -6.3 | -2.4 | = Displaced auto miles * A / 1000000 |
| | Scooter | -15.6 | -13.1 | -6.1 | -2.3 | |
| | | | | | | |
| | **Points per new facility-mile:** | **2025** | **2030** | **2040** | **2050** | |
| | Bike lane/facility - urban | 12 | 10 | 5 | 2 | Providing a minimum of 1 point, even if CO2 estimate rounds to 0 tons |
| | Bike lane/facility – suburban | 4 | 3 | 1 | 1 | |
| | Bike lane/facility – rural | 1 | 1 | 1 | 1 | |
| | Sidewalk/ pedestrian facility - urban | 38 | 32 | 15 | 6 | |
| | Sidewalk/ pedestrian facility - suburban | 2 | 2 | 1 | 1 | |
| | Sidewalk/ pedestrian facility – rural | 1 | 1 | 1 | 1 | |
| | Shared-use path - urban | 27 | 22 | 10 | 4 | |
| | Shared-use path – suburban | 8 | 7 | 3 | 1 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Shared-use path – rural | 2 | 1 | 1 | 1 | |
| | "Complete Streets" reconstruction - urban | 50 | 42 | 20 | 8 | |
| | "Complete Streets" reconstruction – suburban | 6 | 5 | 2 | 1 | |
| | | | | | | |
| | **Points per 100 new shared vehicles:** | **2025** | **2030** | **2040** | **2050** | |
| | Shared bike | 16 | 14 | 6 | 2 | |
| | Scooter | 16 | 13 | 6 | 2 | |

## Table 3. GHG Point Estimate Calculation Methodologies - Transit Strategies

| **TRANSIT STRATEGIES** | | | | | | |
|---|---|---|---|---|---|---|
| | | **Value** | | | | |
| **Ref** | **Parameter** | **2025** | **2030** | **2040** | **2050** | **Metric; Source/Calculation** |
| **Parameters Common Across Strategies** | | | | | | |
| Vehicle revenue-miles per revenue-hour | | | | | | |
| A1 | Fixed-route bus | 13 | 13 | 13 | 13 | NTD (2019), Colorado agencies |
| Passenger-miles per vehicle-mile | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| B1 | Fixed-route bus | 11.5 | 11.5 | 11.5 | 11.5 | NTD (2019), Colorado agencies - Rapid Bus (RB) service |
| | | | | | | |
| grams CO2 per vehicle-mile | | | | | | |
| C1 | Fixed-route bus | 1,555 | 399 | - | - | CDOT (2021) - high bus electrification (100% electric by 2033) |
| | | | | | | |
| C3 | Auto | 303 | 256 | 119 | 46 | CDOT (2021) - high bus electrification |
| grams CO2 per vehicle-hour | | | | | | |
| C4 | Fixed-route bus | 3,966 | 1,018 | - | - | CS (2021), scaled by g/mi from CDOT (2021) for future years |
| D | Prior drive mode share of new riders | 60% | 60% | 60% | 60% | CS (2021) |
| Average trip length (mi) | | | | | | |
| F1 | Fixed-route bus | 9.9 | 9.9 | 9.9 | 9.9 | FHWA (2017), average trip length (all modes/purposes) * average transit work trip length / average all mode work trip length |
| | | | | | | |
| G | Annualization factor | 300 | 300 | 300 | 300 | |
| | | | | | | |
| | **New/increased fixed-route bus service - urban/suburban** | | | | | **1,000 new vehicle revenue-hours** |
| | Tons CO2 per new VRH | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Displaced auto | -27.2 | -22.9 | -10.7 | -4.1 | =A1 * B1 * C3 * D/1000 |
| | New bus (fleet average) | 20.2 | 5.2 | - | - | =C1 * A1 * 1000/1000000 |
| | New bus (electric) | - | - | - | - | |
| | Net (fleet average bus) | -7.0 | -17.7 | -10.7 | -4.1 | = new bus + displaced auto |
| | Net (electric bus) | -27.212.9 | -2210.9 | -10.75.1 | -4.11.9 | |
| | Points per new VRH (fleet average bus) | 7 | 18 | 11 | 4 | |
| | Points per new VRH (electric bus) | 27 | 23 | 11 | 4 | |
| | **Reduce transit fares** | | | | | **1 million base annual trips** |
| | Fare elasticity | -0.3 | -0.3 | -0.3 | -0.3 | TCRP Report 95, Chapter 12; CAPCOA (2021) |
| | Effects per million annual trip base @ 100% fare reduction (annual) | | | | | |
| | New trips | 300,000 | 300,000 | 300,000 | 300,000 | = 1000 * -(fare elasticity) |
| | Change in auto VMT | -1,191,094 | -1,191,094 | -1,191,094 | -1,191,094 | = new riders * F1 * D |
| | Change in tons CO2 | -361 | -304.4 | -141.4 | -54.3 | = change in auto VMT * C3 / 1000000 |
| | Points per million trips - free fares | 361 | 304 | 141 | 54 | |
| | Points per million trips - 50% fare reduction | 181 | 152 | 71 | 27 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Points per million trips - 25% fare reduction | 90 | 76 | 35 | 14 | |
| | **Implement bus priority treatments** | | | | | **Affected 1,000 VRM per weekday** |
| | Bus ridership travel time elasticity | -0.4 | -0.4 | -0.4 | -0.4 | TCRP Report 95, Chapter 12 |
| | Typical travel time change (%) | -10% | -10% | -10% | -10% | CAPCOA (2021) |
| | Effects per 1,000 affected VRM (annual) | | | | | |
| | New bus passenger-miles | 98,400 | 98,400 | 98,400 | 98,400 | = B1 * elasticity * travel time change * G * 1000 |
| | Change in auto VMT | -39,360 | -39,360 | -39,360 | -39,360 | = new passenger-mi * D |
| | Change in auto emissions (t CO2) | -12 | -10 | -5 | -2 | = change in auto VMT * C3 / 1000000 |
| | Change in bus idle emissions (t CO2) | -9 | -2 | - | - | |
| | Change in tons CO2 | -21 | -12 | -5 | -2 | |
| | Points per 1,000 affected weekday VRM | 21 | 12 | 5 | 2 | |

## Table 4. GHG Point Estimate Calculation Methodologies - Parking Strategies

| PARKING STRATEGIES | | | | | | |
|---|---|---|---|---|---|---|
| | | Value | | | | |
| **Ref** | **Parameter** | **2025** | **2030** | **2040** | **2050** | **Metric; Source/Calculation** |
| | **Parameters Common Across Strategies** | | | | | |
| A | grams CO2 per vehicle-mile (auto) | 303 | 256 | 119 | 46 | CDOT (2021) - high EV scenario |
| B | Average trip length (mi) - all purposes | 10.5 | | | | FHWA (2018)s, Table 6b |
| C | Annualization factor | 300 | | | | |
| | Annual miles driven | | | | | |
| D1 | Per vehicle | 10,450 | | | | CDOT (2021) |
| D2 | Per household | 19,642 | | | | FHWA (2018) |
| D3 | Per worker (commuting) | 6,400 | | | | FHWA (2018) - 2017 NHTS work trip length * 2 * 250 |
| | | | | | | |
| | **Additional Fee on Parking** | | | | | **Per covered spaces per daily dollar fee** |
| | Elasticity of driving w/r/t fuel price | -0.12 | | | | Small and van Dender (2007) |
| | Price of gasoline ($/gal) | $3.11 | | | | AEO 2022 Reference case for 2021 |
| | Average mpg | 23.8 | | | | AEO 2020 Reference Case, Table 7 |
| | $1 parking fee equivalent cost per mile | $0.10 | | | | $1.00 / B |

| | | | | | | |
|---|---|---|---|---|---|---|
| | $1 parking fee equivalent cost per gallon | $2.27 | | | | = Cost per mile * miles per gallon |
| | Leakage factor (destination change) | 0% | | | | Placeholder for people to shift trip destination rather than paying fee. No good research. |
| | % VMT change for affected trips | -9% | | | | = Fee cost per gallon / gas cost per gallon * elasticity |
| | Trips per covered space per day | 2 | | | | Assumes 1 round trip to a workplace or home. For short-term parking, fee is prorated. |
| | Change in annual VMT per space per $ | -551 | -551 | -551 | -551 | |
| | Change in annual tons CO2 per space per $ | -167 | -140.8 | -65.4 | -25.1 | = Change in VMT * 1000 * A / 1000000 |
| | Points per space per $ daily fee | 167 | 141 | 65 | 25 | |
| | | | | | | |
| | **Unbundle Residential Parking** | | | | | **Per covered spaces @ $100/mo** |
| | Annual parking cost per space | $1,200 | | | | = $100 * 12 |
| | Annual vehicle cost | $9,666 | | | | AAA (2021) |
| | Elasticity of vehicle ownership with respect to total vehicle cost | -0.4 | | | | Litman (2021) |
| | Adjustment factor from vehicle ownership to VMT | 1.01 | | | | FHWA (2017), as cited in CAPCOA (2021) |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Percent reduction in miles per vehicle | -5.00% | | | | = (parking cost) / (vehicle cost) * elasticity * adjustment factor |
| | Change in annual VMT per space per $100/mo | -524 | -524 | -524 | -524 | = D1 * percent reduction |
| | Change in annual tons CO2 per space per $ | -158.9 | -133.9 | -62.2 | -23.9 | = Change in VMT * 1000 * A / 1000000 |
| | Points per space per $100 monthly cost | 159 | 134 | 62 | 24 | |
| | | | | | | |
| | **Eliminate minimum parking requirements and set maximum levels (residential)** | | | | | **Per dwelling unit (DU)** |
| | % change in commute driving for workers with limited parking (<1 space/unit) | -37% | | | | Chatman (2013), as cited in CAPCOA (2021) |
| | % of vehicle-travel that is commute travel | 29% | | | | FHWA (2018), based on 2017 NHTS |
| | % change in vehicle-travel from limited parking | -11% | | | | = % change in commute driving * % travel that is commute travel |
| | Change in annual VMT per DU | -2,136 | -2,136 | -2,136 | -2,136 | = D2 * percent reduction |
| | Change in annual tons CO2 per DU | -647.5 | -546 | -253.7 | -97.3 | = Change in VMT * 1000 * A / 1000000 |
| | Points per DU | 648 | 546 | 254 | 97 | |

## Table 5. GHG Point Estimate Calculation Methodologies - Travel Demand Management Strategies

| TRAVEL DEMAND MANAGEMENT STRATEGIES | | | | | | |
|---|---|---|---|---|---|---|
| | | Value | | | | |
| **Ref** | **Parameter** | **2025** | **2030** | **2040** | **2050** | **Metric; Source/Calculation** |
| | **Parameters Common Across Strategies** | | | | | |
| | grams CO2 per vehicle-mile | | | | | |
| A1 | Auto | 303 | 256 | 119 | 46 | CDOT (2021) - high EV scenario |
| A2 | Vanpool | 758 | 639 | 250 | 38 | Base year assumed 10 mpg, future year efficiency/electrification adjustments proportional to auto |
| | Average work trip length (mi) | | | | | |
| B1 | Auto | 12.7 | 12.7 | 12.7 | 12.7 | FHWA (2018), Table 26 |
| B2 | Vanpool | 25 | 25 | 25 | 25 | TCRP Report 95, Chapter 5. Typical average length is close to 25 miles (p. 5-13, Table 5-5) |
| C | Annualization factor | 250 | 250 | 250 | 250 | TCRP Report 95, Chapter 5, Table 5-6 |
| | | | | | | |
| | **Trip Reduction Program - Voluntary** | | | | | **Per Program $1,000** |
| | Change in annual VMT per program $ | -100 | | | | MWCOG (2009), as analyzed by CS for Colorado DOT (2010) and updated 2022 |
| | Change in annual tons CO2 per $1,000 | -30.3 | -25.6 | -11.9 | -4.6 | = Change in VMT * 1000 * A1 / 1000000 |
| | Points per program | 30 | 26 | 12 | 5 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | $1,000 | | | | | |
| | | | | | | |
| | **Trip Reduction Program - Marketing** | | | | | **Per Program $1,000** |
| | Annual VMT reduced per program $ | 7 | 7 | 7 | 7 | MWCOG (2009), as analyzed by CS for Colorado DOT (2010) and updated 2022 |
| | Change in annual tons CO2 per $ | -2.1 | -1.8 | -0.8 | -0.3 | = Change in VMT * 1000 * A1 / 1000000 |
| | Points per program $1,000 | 2 | 2 | 1 | - | |
| | | | | | | |
| | **Employer Sponsored Vanpool** | | | | | **Per New Vanpool** |
| | Average vanpool occupancy | 5.8 | 5.8 | 5.8 | 5.8 | CDOT (2019), total participants / total vans |
| | Prior drive mode share of new vanpoolers | 65% | 65% | 65% | 65% | TCRP Report 95, Chapter 5, p. 5-34. Total prior auto drivers, counting in carpool drivers, are in the 45 to over 65% range |
| | Vanpool circuity factor | 1.2 | 1.2 | 1.2 | 1.2 | Estimate |
| | Annual VMT change per new vanpool | | | | | |
| | Auto | -23,563 | -23,563 | -23,563 | -23,563 | = occupancy * prior drive mode share * B1 * C |
| | Vanpool | 7,500 | 7,500 | 7,500 | 7,500 | = circuity factor * B1 * C |
| | Change in annual tons CO2 per new vanpool | | | | | |
| | Auto | -7.1 | -6.0 | -2.8 | -1.1 | = Change in auto VMT * A1 / 1000000 |
| | Vanpool | 5.7 | 4.8 | 1.9 | 0.3 | = Change in vanpool VMT * A2 / 1000000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Net | -1.5 | -1.2 | -0.9 | -0.8 | = Sum of auto and vanpool change |
| | Points per new vanpool | 1 | 1 | 1 | 1 | |
| | | | | | | |
| | **Carshare** | | | | | **Per # cars provided** |
| | Households served per car | 15 | | | | Litman (2018) - typically 10-20 members per vehicle |
| | Annual VMT reduction per HH served | 3,000 | | | | Litman (2018) - carshare HHs are typically lower mileage HHs who reduce travel 50% (6,000 to 3,000 annual miles) |
| | Change in annual CO2 per car (tons) | -14 | -12 | -5 | -2 | |
| | Points per new carshare vehicle | 14 | 12 | 5 | 2 | |

## Table 6. GHG Point Estimate Calculation Methodologies - Traffic Operation Strategies

| **TRAFFIC OPERATION STRATEGIES** | | | | | | |
|---|---|---|---|---|---|---|
| | | **Value** | | | | |
| **Ref** | **Parameter** | **2025** | **2030** | **2040** | **2050** | **Metric; Source/Calculation** |
| | **Parameters Common Across Strategies** | | | | | |
| | grams CO2 per vehicle-mile (auto) | 313 | 256 | 119 | 46 | CDOT (2021) - high EV scenario |

| | | | | | | |
|---|---|---|---|---|---|---|
| | grams CO2 per vehicle-mile (heavy truck) | 1,307 | 1,199 | 1,074 | 1,074 | Based on AEO forecast mpg (no electrification) |
| | CO2 fraction from heavy vehicles (2019) | 21% | | | | National average based on AEO data |
| | kg CO2 per hour of delay (all traffic) | 3.5 | 2.9 | 1.6 | 1 | 2019 based on TTI (2021), future years adjusted by relative efficiency improvement of autos and heavy trucks |
| | | | | | | |
| | **Retime/optimize arterial signals** | | | | | **Per 10,000 AADT per signal** |
| | Sample corridor length (mi) | 1 | | | | Assumption |
| | Signals per mile | 2 | | | | Assumption |
| | Baseline corridor travel speed (mph) | 20 | | | | Assumption |
| | Corridor travel time reduction (%) | 12% | | | | USDOT (2010), p. 4-24: travel time reductions of 8-25% possible for preset signals, or 8-41% for actuated signals |
| | New corridor travel speed (mph) | 22.7 | | | | Calculation |
| | Average daily arterial traffic volume at signal | 10,000 | | | | Assumption |
| | Change in travel time per vehicle (hours) | -0.006 | | | | Calculation |
| | Daily total delay reduction (hours) | -60 | | | | Calculation |
| | Annual change in tons CO2 per signal | -75.7 | -63.3 | -35.7 | -21.8 | Calculation |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Points per signal per 10,000 AADT | 76 | 63 | 36 | 22 | |
| | | | | | | |
| | **Roundabout** | | | | | **Per roundabout** |
| | Annual t CO2 reduced per roundabout | 147 | 122 | 70 | 43 | Based on San Diego County and NYT (2021) citing 20,000 gallons saved/year; reducing 22% to account for 2025 vs. 2012 fuel consumption rates |
| | Points per roundabout | 147 | 122 | 70 | 43 | |



## Table 7. GHG Point Estimate Calculation Methodologies - Sources

| **SOURCES** | |
|---|---|
| **Short Name** | **Citation** |
| AAA (2021) | AAA (2021). Your Driving Costs. |
| AEO | U.S. Department of Energy, Annual Energy Outlook Reference Case, 2019 or 2022 |
| Buehler (2012) | Buehler, R., and J. Pucher (2012). "Cycling to Work in 90 Large American Cities: New Evidence on the Role of Bike Paths and Lanes." Transportation 39:409–432. |
| CAPCOA (2021) | California Air Pollution Control Officers Association (2021). Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity. |

| | |
|---|---|
| CDOT (2019) | Colorado Department of Transportation (2019). Statewide Transportation Demand Management Plan. Phase 1 Report: Colorado Transportation Options. Prepared by Wilson & Company, Inc. |
| CDOT (2021) | Analysis conducted by Cambridge Systematics for Colorado DOT in support of GHG Rule Cost-Benefit Analysis (September 2021) |
| CS (2010) | Cambridge Systematics and Sprinkle Consulting (2010). Transportation Demand Management Project Evaluation and Funding Methods in the Denver Region. Prepared for Colorado DOT. |
| CS (2021) | Cambridge Systematics (2021). Transportation Investment Strategy Tool Documentation, 2021. Prepared for Georgetown Climate Center. |
| FHWA (2018) | McGuckin, N. and A. Fucci (2018). Summary of Travel Trends: 2017 National Household Travel Survey. U.S. Department of Transportation, Federal Highway Administration, FHWA-PL-18-019. |
| ITF (2020) | International Transport Forum (ITF). (2020). "Good to Go? Assessing the Environmental Performance of New Mobility." |
| Litman (2018) | Litman, T. (2018). TDM Encyclopedia: Carsharing. Victoria Transport Policy Institute. |
| Litman (2021) | Litman, T. (2021). TDM Encyclopedia: Parking Requirement Impacts on Housing Affordability. Victoria Transport Policy Institute. |
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