

DRAFT
4/14/22

COLORADO DEPARTMENT OF TRANSPORTATION		<input checked="" type="checkbox"/> POLICY DIRECTIVE <input type="checkbox"/> PROCEDURAL DIRECTIVE
Subject Greenhouse Gas Mitigation Measures		XXX
Effective 5/01/22	Supersedes New	Originating Office 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: <ul style="list-style-type: none"> ● The nexus with the transportation sector ● Description of what the strategy implements ● Identification of how the strategy reduces CO₂e emissions ● 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 CO ₂ e emissions reductions from the strategy <ul style="list-style-type: none"> ● Base methodology on empirical evidence supported by verifiable data sources ● Clearly document all assumptions, sources of data, and calculations
Challenges and Constraints	<ul style="list-style-type: none"> ● 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
4. Adjustment for effectiveness over time, and
5. A total expected lifetime of each measure

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.

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

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.

Herman Stockinger
Transportation Commission Secretary

Date of Approval

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

APPENDIX A.

Table of Contents

- [Table 1. GHG Mitigation Measures and their points/metric in each compliance year.](#)
- [Table 2. GHG Point Estimate Calculation Methodologies - Pedestrian and Bicycle Strategies](#)
- [Table 3. GHG Point Estimate Calculation Methodologies - Transit Strategies](#)
- [Table 4. GHG Point Estimate Calculation Methodologies - Parking Strategies](#)
- [Table 5. GHG Point Estimate Calculation Methodologies - Travel Demand Management Strategies](#)
- [Table 6. GHG Point Estimate Calculation Methodologies - Traffic Operation Strategies](#)
- [Table 7. GHG Point Estimate Calculation Methodologies - Sources](#)

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

Project Type	Metric	Project Lifetime (Years)	Points/Metric ¹	Points/Metric	Points/Metric	Points/Metric	Additional Multipliers
			Now - 2024 ²	2025-2030	2031-2040	2041-2050	
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.

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

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
“Complete Streets” reconstruction - suburban			4	3	1	1	1.5 – within mixed-use district or ½ mi of transit station or school
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.

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

New/increased fixed-route transit service - urban/suburban - electric/diesel fleet average			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	1	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.

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

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.

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

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:

Subject GHG Mitigation Measures Policy Directive	Number XXX
--	---------------

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.

Legend:

- need to verify
- output (points)
- future years copied from base year

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						

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

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			

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

	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	

Subject

GHG Mitigation Measures Policy Directive

Number

XXX

	“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	

Subject GHG Mitigation Measures Policy Directive	Number XXX
--	---------------

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						

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

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	

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

	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	

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

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	

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

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)

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

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	-0.4				Litman (2021)

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

	cost					
	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

Subject GHG Mitigation Measures Policy Directive	Number XXX
--	---------------

Points per DU	648	546	254	97
---------------	-----	-----	-----	----

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

TRAVEL DEMAND MANAGEMENT STRATEGIES						
Ref	Parameter	Value 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

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

Points per program \$1,000	30	26	12	5	
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 circuitry 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	= circuitry 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

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

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	313	256	119	46	CDOT (2021) - high EV scenario

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

	(auto)					
	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	-75.7	-63.3	-35.7	-21.8	Calculation

Subject	Number
GHG Mitigation Measures Policy Directive	XXX

	signal					
	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.

<p>Subject</p> <p>GHG Mitigation Measures Policy Directive</p>	<p>Number</p> <p>XXX</p>
---	--------------------------

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.
MacArthur (2018)	MacArthur, J., C. Cherry, M. Harpool and D. Scheppke. (2018). A North American Survey of Electric Bicycle Owners. NITC-RR-1041. Portland, OR: Transportation Research and Education Center (TREC). https://dx.doi.org/10.15760/trec.197
Mobility Lab (2019)	Mobility Lab, Arlington County Commuter Services (ACCS). (2019). Arlington County Shared Mobility (SMD) Pilot Evaluation Report.
MWCOCG (2009)	LDA Consulting et al for Metro Washington Council of Governments (2009). Transportation Emission Reduction Analysis Report, FY 2006–2008.

Subject GHG Mitigation Measures Policy Directive	Number XXX
--	----------------------

NABSA (2020)	North American Bikeshare Association (NABSA). (2020). 1st Annual Micromobility State of the Industry Report. https://doi.org/10.7922/G2057D6B
NACTO (2018)	National Association of City Transportation Officials (NACTO). (2018). Shared Micromobility in the U.S.: 2018.
NTD (2019)	2019 National Transit Database (data analysis by Cambridge Systematics)
NYT (2021)	Buckley, Cara, "These Americans Are Just Going Around in Circles", New York Times, Nov. 20, 2021.
PBOT (2020)	Portland Bureau of Transportation (2020). E-Scooter Findings Report. https://www.portlandoregon.gov/transportation/article/709719
Ramboll (2020)	Ramboll. (2020). Achieving Sustainable Micro-mobility. < https://ramboll.com/-/media/files/rgr/documents/markets/transport/m/ramboll_micro-mobility_greenpaper_a4_0320_lo_wres_v.pdf?la=en >
San Diego County (no date)	San Diego County. "Modern Roundabouts: Reduce Congestion and Improve Safety on Main Roads"
Small and van Dender (2007)	Small, K. and K. Van Dender (2007). Fuel Efficiency and Motor Vehicle Travel: The Declining Rebound Effect. The Energy Journal, 28:1.
TCRP Report 95 Chapter 12	McCollom, B.E., and R. H. Pratt, et al (2004). TCRP Report 95, Traveler Response to Transportation System Changes. Chapter 12: Transit Pricing and Fares. Transportation Research Board, Washington, D.C.
TCRP Report 95 Chapter 5	Evans, J.E., and R. H. Pratt, et al (2005). TCRP Report 95, Traveler Response to Transportation System Changes. Chapter 5: Vanpools and Buspools. Transportation Research Board, Washington, D.C.
TTI (2021)	Texas A&M Transportation Institute (2021). Urban Mobility Report. As analyzed in Cambridge Systematics (2021).
U.S. EPA (2016)	U.S. Environmental Protection Agency (EPA) (2016). Population and Activity of On-road Vehicles in MOVES2014. EPA-420-R-16-003.

Subject GHG Mitigation Measures Policy Directive	Number XXX
--	---------------

USDOT (2010)	U.S. Department of Transportation (2010). Transportation's Role in Reducing U.S. Greenhouse Gas Emissions.
WSCTRB (2017)	Washington State Commute Trip Reduction Board (2017). 2017 Report to the Legislature.

DRAFT