

PIMA ASSOCIATION OF GOVERNMENTS



REGIONAL **ACTIVE** TRANSPORTATION PLAN



COMMUNITY BENEFITS OF THE PREFERRED AT INFRASTRUCTURE INVESTMENT SCENARIO

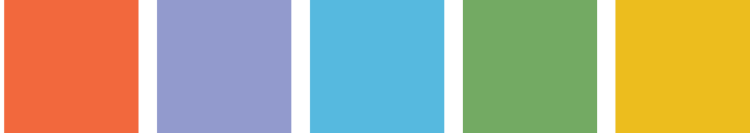
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Executive Summary

This technical memorandum details the community benefits of the preferred high-priority network package of recommended bicycle and pedestrian projects to support plan implementation as a follow on to our short trip analysis of the various scenario packages (Phase 1). The analysis estimated the number of bicycle and pedestrian trips that might take place on the proposed network using the most conservative trip conversion rate, approximated the corresponding reduction in vehicle trips and vehicle-miles traveled (VMT), and assessed the potential benefits that might accrue if the preferred high-priority network package of the proposed network was constructed.¹ Using the United States Department of Transportation guidelines to measure, in dollar terms, the analysis determined the project's net present value to society as calculated from the stream of costs and benefits that will result from implementing the plan. In total, it was estimated that the proposed facilities could generate **\$238 million in annual benefits**, or \$3.52 billion over 25 years, organized around the following categories:²

- **Safety:** The expected reduction in collisions and associated costs.
- **Public Health:** Includes the health benefits of increased physical activity and decreased healthcare costs from new users of the recommended facilities.
- **Economic Competitiveness:** Includes savings in household transportation costs and traffic congestion costs.
- **Air Quality Benefits:** Includes reductions in the following pollutants that impact air quality: NOX, VOC, PM10, PM2.5 and CO2.
- **State of Good Repair:** Includes reductions in roadway maintenance costs.

Table 1 displays the annual estimated benefits for each category. Subtotals for each category are shown in bold. The following sections provide an explanation of how each benefit was calculated and **Appendix A – Multipliers** details additional multipliers that were used for the analysis.

¹ The most conservative trip conversion rate of 15% originates from a Seattle region micromobility study (Harper et al, 2021).
² All monetary values are reported in Q1 2025 dollars, inflated using the Bureau of Economic Analysis (BEA) GDP Deflators. U.S. Bureau of Economic Analysis. (2025). GDP price deflator. <https://www.bea.gov/data/prices-inflation/gdp-price-deflator>

Table 1. Total Annual Benefits in Q1 2025 Dollars

CATEGORY	MONETARY VALUE
SAFETY BENEFITS	\$92,253,000
Pedestrian Crash Costs Reduced	\$70,323,000
Bicyclist Crash Costs Reduced	\$21,929,000
PUBLIC HEALTH BENEFITS	\$121,249,000
Mortality Costs Reduced from Induced Walk Trips	\$104,678,000
Mortality Costs Reduced from Induced Bike Trips	\$16,571,000
ECONOMIC COMPETITIVENESS BENEFITS	\$9,640,000
Congestion Costs Reduced	\$1,202,000
Household Transportation Costs Reduced	\$8,438,000
EMISSIONS REDUCTIONS BENEFITS	\$1,618,000
Carbon Dioxide Equivalents (CO _{2e}) Emission Costs Reduced	\$1,401,000
Oxides of Nitrogen (NO _x) Emission Costs Reduced	\$69,000
Fine particulate matter (PM _{2.5}) Emission Costs Reduced	\$149,000
Total Vehicle Emissions Reduced	\$6,000
STATE OF GOOD REPAIR BENEFITS	\$1,356,000
Roadway Maintenance Costs Reduced	\$1,356,000
TOTAL BENEFITS	\$238,466,000

Table 2 displays the annual estimated benefits for each category discounted at the USDOT recommended 3.1% for a horizon of 25 years. Carbon dioxide equivalent emissions are the only exception and are discounted at a 2.0% rate per 2024 USDOT guidance.³

Table 2: Annual Benefits Discounted Over 25 Years in Q1 2025 Dollars (3.1% discount rate unless otherwise specified)

CATEGORY	MONETARY VALUE
SAFETY BENEFITS	\$1,075,108,000
PUBLIC HEALTH BENEFITS	\$2,209,250,000
ECONOMIC COMPETITIVENESS BENEFITS	\$175,656,000
EMISSIONS REDUCTIONS BENEFITS	\$38,753,000
CO _{2e} Emission Costs Reduced (2.0% Discount Rate)	\$34,479,000
NO _x and PM _{2.5} Emission Costs Reduced	\$4,273,000
STATE OF GOOD REPAIR BENEFITS	\$24,709,000
TOTAL BENEFITS	\$3,523,475,000

³ U.S. Department of Transportation. (2024). *Benefit-cost analysis guidance for discretionary grant programs*.



Methodology and Results

Short Trips Mode Shift Estimates

For this analysis, Alta evaluated all short trips (<3 miles) that are made by motor vehicles within ½ mile of the baseline network and the preferred network scenario. However, the first step was to identify a baseline network that provided sufficient low-stress connectivity based on the Level of Traffic Stress (LTS) analysis conducted in Task 4.1.

Qualifying & Package Networks

The existing facilities include both bicycle and pedestrian infrastructure that meet the following qualifications:

- **Bicycle Facilities** – All low-stress trails and bike facilities (LTS 1 or 2) that are not shared use lanes.
- **Pedestrian Facilities** – All streets with sidewalks on at least one side of the street that are low-stress facilities (LTS 1 or 2).
- **Sufficient Low-Stress Connectivity** – Facilities to be included must be in areas with some offering of low-stress connectivity. To qualify, the bicycle and pedestrian low-stress connectivity ratios of evaluated hexagons should be at least .33 for their respective facility type. This offers some assurance that people can access the facility without a vehicle and use it to get to places they need to go.

Each of the package networks were integrated into this qualifying existing network to be considered as a comprehensive package for the short trip analysis.

Short Trip Analysis

After qualifying existing facilities were identified, they were integrated into the short trip analysis. In the Replica Places platform, buffered versions of both the qualifying existing and existing + recommended networks were uploaded and used to filter trips traveling between block groups within the network. The Places model used for this analysis was the Spring 2024 model for the typical Thursday, representative of a typical weekday. This step helps define the study area for capturing potential active transportation trips. Within this area, all motor vehicle trips under three miles that both begin and end inside the ½ mile buffer were identified. These short trips represent the maximum convertible market and establish a baseline for assessing the impact of potential mode shifts.

To estimate the likelihood of these short trips shifting to active modes, we applied literature-based estimates derived from previous micromobility studies. For this analysis, Alta pulled trip conversion rates of **15%, 30%, and 44%** from the previously mentioned study of micromobility to provide low, medium, and high conversion factors for short trips (Harper et al, 2021). However, the analysis utilized only the **low conversion rate** because active trip estimates using this rate most closely matched the active trip data reported by Replica Places (Spring 2024) for the typical Thursday (weekday).⁴ We multiplied this rate by the number of short vehicle trips. The result is the number of active trips that could be expected to shift from driving; we will refer to these trips as **mode shift trips**. Using this, we can then calculate the change in the number of short trips within a ½ mile of both the existing and recommended networks, adjusted by the low conversion factor. Implicit in this calculation is an understanding that a more extensive or better-connected recommended network will naturally encompass more origins and destinations, thereby broadening its potential influence.

Estimating Total Trips

To estimate the number of total active trips on the network relevant to economic benefits, we need to use the mode shift trip estimates to calculate total estimated volumes on the network for the baseline and preferred high-priority network package. This assumes that the mode shift trips are a subset of all trips on the network, the remainder being induced trips (trips that would not have occurred at all without the new facility, including recreational trips) and route

⁴ See the **Limitations Section** for a more in-depth discussion of the choice to use the low conversion rate.



shift trips (trips that were already taken by active mode, but using a different route). This calculation therefore requires an estimate of the share of total trips that the mode shift trips comprise. The ratio for these additional trips comes from intercept survey data found in the literature.

The share of induced and route shift trips is distinct from the trip conversion rate. Alta bases these estimates on research collected by the California Air Resources Board (CARB) looking at the percentages of mode shift, route shift, and induced trips expected by the addition of a new facility (CARB, 2019). Guided by this literature, Alta has developed a log-response regression equation that corresponds short trips rates (percentage of trips < 3 miles) to modal substitution rates. Based on this formula, Alta estimates that for all the short trips intersecting with Pima County's boundaries (about 45% of all trips), the modal substitution rate is about **16%**. This means that 16% of volumes on a new facility could be expected to have shifted from other modes.

This means we might expect total trips to match this formula:

$$\text{Total Trips} = \frac{\text{Mode Shifted Trips}}{\text{Modal Substitution Rate}}$$

Trip Stratification

From this total count of trips, we need to estimate the number of trips on these corridors that are the result of vehicle mode shift, induced trips, route shift, or substituting for other modes. For this, we refer to CARB's *Study on Quantifying VMT Reductions from New Bike Paths, Lanes, and Cycle Tracks* for a conservative estimate.⁵ We identified an intercept survey conducted in Los Angeles County that closely matches Pima County in terms of comparable climate, scale, and facility type. That intercept survey found that 10.9% of riders on new facilities shifted from vehicles, 16.8% of riders shifted from other modes, 50.4% were shifted from other routes, and 21.8% were new trips. We calculated the mode substitution rate from vehicles to be 16%, so if we proportionally shift those percentages to the other categories, we estimate that the Pima County **shift from vehicles would be 16%, other mode shift would be 15.9%, route shift would be 47.6%, and 20.6% would be new induced trips.**

Induced trips and vehicle modes shift trips were used in the Active Benefits Analysis to estimate the overall positive impact of a more robust active transportation network. The analysis only considers these trip types as they represent new active use of the proposed facilities. Alta did not consider route shift and other mode shift trips because they reflect changes in pre-existing active travel and therefore do not contribute additional benefits.

VMT Reductions & Change in Travel

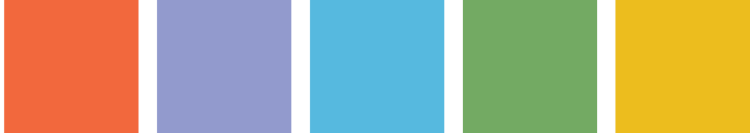
Alta converted short trip estimates from previous steps into daily Vehicle Miles Traveled reduction estimates. This calculation, shown below, multiplies the short trip estimate by the mode shift rate and average trip distance to obtain the reduced VMT. This calculation does not consider induced or route-shifted trips, as these are not reducing miles traveled by motor vehicle.

$$\text{Reduced VMT} = \text{short trips} * \text{short trip conversion rate} * \text{average trip distance}$$

Where:

- Short trips is the total number of short vehicle trips starting or ending within ½ mile of the network. This is obtained from the Replica analysis for the preferred high-priority network package.
- Short trip conversion rate is 15% (low estimate).

⁵ Alta consulted CARB's Quantifying Reductions in Vehicle Miles Traveled from New Pedestrian Facilities and found much higher modal substitution rates for Pedestrian to Auto Substitution. For example, intercept surveys in roughly similar climates in Sacramento, CA found a 27.3% auto to walk substitution rate and Davis, CA a 25% substitution rate. Given most of the short trips evaluated were > 1 mile, using the bike derived modal substitution rate provides a considerably more conservative estimate for trip stratification. Additionally, none of the intercept surveys for walk trips included any estimates of route shift which plays an important role in moderating our benefit analysis totals.



- Average trip distance is obtained from the Replica analysis for the preferred high-priority network package as **1.5 miles**.

Alta initially computed estimates for an average weekday in Spring 2024 using Replica data. We then annualized these numbers using a factor of 340.187 provided by PAG’s modeling team to convert daily estimates to annual estimates. **Table 3** shows the annual VMT reduction estimates from existing and new trips. VMT reduction from growth is used to calculate benefits in the Active Benefits Analysis. **Table 4** disaggregates growth by trip stratification.

Table 3. Annual Vehicle Miles Traveled Reduction Estimates (Spring 2024 Weekday)

SCENARIO	TRIP DISTANCE MILES AVERAGE	VMT REDUCTION FROM TRIPS	VMT REDUCTION FROM GROWTH
Baseline	1.44	22,221,000	0
Preferred	1.5	37,535,000	14,458,000

Table 4. Annual Total Growth by Source of Growth (Spring 2024 Weekday Annualized)

SCENARIO	TOTAL ACTIVE TRAVELER GROWTH	VEHICLE MODE SHIFT GROWTH	ROUTE SHIFT GROWTH	OTHER MODE GROWTH	INDUCED TRIP GROWTH
Baseline	0	0	0	0	0
Preferred	60,327,000	9,652,000	28,716,000	9,592,000	12,427,000

Mode Split

This analysis examined the existing mode split of trips within ½ mile of the baseline network and the preferred network scenario, finding **271,000 walking trips**, and **55,000 biking trips**, according to Replica Places data for an average weekday in spring 2024. This ratio was used to estimate the bicycle-pedestrian mode split of trips induced or shifted from vehicle modes by the proposed network.

Benefit Estimates

This section highlights both the methods used and results from the benefit calculations for Safety, Public Health Benefits, Economic Competitiveness, Emissions Reduction Benefits, and State of Good Repair Benefits.

Safety Benefits

Alta estimated safety benefits for the preferred high-priority network package of the recommended bicycle and pedestrian network. Overall, recommended facilities are expected to decrease crashes by shifting active travel from less safe existing facilities in the area to safer planned or recommended facilities, which often propose greater separation or protection for vulnerable road users, thereby decreasing conflicts with drivers. Alta used the following methodology to estimate the economic benefits from crashes reduced due to the installation of safer facilities:

Alta used the facilities identified in the preferred high-priority network package of recommended bicycle and pedestrian network – filtered to only include new or upgraded facilities – as the initial input. On segments where multiple types of facilities are planned or recommended, Alta developed a Python script to extract the facility type likely to provide the greatest safety benefit (i.e., the largest Crash Reduction Factor (CRF)) from the segment's description. In cases where multiple facility improvements might apply to different travel modes on the same facility (e.g., one for pedestrians and another for bicyclists), Alta used only the CRF with the highest magnitude of reduction. This approach assumes the highest magnitude CRF is the most significant for calculating reductions and avoids double-counting, but it makes the analysis more conservative: it likely underestimates the total safety benefits of facilities that serve multiple modes and affect different types of collisions. For example, if there are plans to construct both a separated bike lane and sidewalk along segment of the network, that segment's safety intervention is identified as the separated bike lane because it has a higher CRF the sidewalk, regardless of whether there are more bicycle or pedestrian crashes along that segment. This was a necessary simplifying assumption due to the scale of the analysis. For segments where only one type of facility is recommended, Alta used this value as the relevant safety intervention.

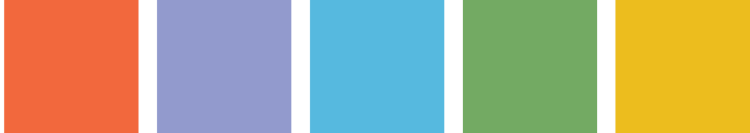
Alta used collision data covering a five-year period (2018-2022) provided by the Pima Association of Governments (PAG) and further processed to identify the involvement of bicyclists or pedestrians.

Alta summarized the number of collisions involving bicyclists and pedestrians by severity within 250 feet to each facility. Alta ensured that the zones within which collisions were summarized were exclusive to one another by removing any overlap between them. This guaranteed that collisions were not related to more than one facility and therefore would not be double counted when calculating benefits. Alta analyzed collisions within 250 feet because it is a conservative assumption that *at least* collisions within this distance of the recommended facility would be reduced had the recommended facility already existed. For some types of facilities, it is likely that the area of influence is much larger.

Alta grouped together the recommended facility types and summed the collisions involving bicyclists and pedestrians by severity, matching crash type to facility type. For example, we summarized pedestrian collisions to recommended sidewalk facilities but not separated bike lane facilities. From the crashes summarized by facility type, Alta calculated the average annual crashes of each severity level occurring at locations of each recommended facility type, applied a Crash Reduction Factor (CRF) based on the recommended facility type, and multiplied the result by the crash damage costs⁶ based on severity level, inflated to 2025 dollars⁷. This resulted in an estimate of the expected crash damage costs avoided annually by installing each type of recommended facility, across the preferred high-priority network package (**Table 5**).

⁶ U.S. Department of Transportation. (2025). *Benefit-cost analysis guidance for discretionary grant programs*. <https://www.transportation.gov/office-policy/transportation-policy/benefit-cost-analysis-guidance>

⁷ U.S. Bureau of Economic Analysis. (2025). GDP price deflator. <https://www.bea.gov/data/prices-inflation/gdp-price-deflator>



Alta summed these estimates to create an overall estimate of the annual safety benefits associated with the preferred high-priority network package, and then calculated the benefits over 25 years, using a discount rate of 0.031.

Alta’s estimate of annual safety benefits from constructing recommended facilities in the preferred high-priority network package is \$92,252,595 with benefits accumulating to \$1,075,107,695 over 25 years (**Table 6**).

Table 5. Annual safety benefits by facility type, sorted by highest to lowest Crash Reduction Factor (CRF) used. Where multiple facility types are proposed on a segment, benefits are estimated using only the facility type with the highest CRF.

FACILITY TYPE	CRASH REDUCTION FACTOR	MONETARY VALUE
Bicycle Boulevard	0.630	\$15,917,000
Cycle Track	0.502	\$33,000
Separated Bike Lane	0.502	\$710,000
Sidewalk	0.402	\$42,293,000
Crosswalk	0.370	\$9,758,000
Shared Use Path	0.250	\$23,529,000
Widen Shoulder	0.070	\$13,000
TOTAL ANNUAL SAFETY BENEFITS		\$92,253,000

Note: This approach prioritizes the most impactful intervention but does not account for segment-specific crash patterns (e.g., frequency of pedestrian vs. bicycle crashes), nor does it reflect the cumulative effect of multiple recommended facilities.

Table 6. Annual and 25-year safety benefits of constructing recommended facilities in the preferred high-priority network package.

CATEGORY	MONETARY VALUE
TOTAL ANNUAL SAFETY BENEFITS	\$92,253,000
Annual Pedestrian Crash Costs Reduced	\$70,323,000
Annual Bicyclist Crash Costs Reduced	\$21,929,000
25-YEAR SAFETY BENEFITS (DISCOUNTED)	\$1,075,108,000

Public Health Benefits

The estimated increase in active trips from the installation of the proposed facilities is associated with improvements in cardiovascular health and other positive health outcomes for participants. However, the change in activity towards more travel via active modes will not affect all demographics equally; in particular, 2025 USDOT guidance suggests that these benefits will primarily be experienced by those aged 20-74 for walking and 20-64 for cycling. The analysis applied the national average population in these age ranges to determine the proportion of potential users, displayed in **Table 7**.

Alta used the existing active mode split pulled from Replica Places Spring 2024 data for an average weekday, shown in **Table 8**, to estimate the bicycle-pedestrian division of induced trips and mode shifted trips. Next, combining that mode split with the proportion of potentially affected populations and the dollar benefit assigned by USDOT for each active trip, Alta calculated the cumulative health benefits of walk and bike trips induced or mode shifted by the proposed network.

Table 9 shows the annual public health benefits of additional biking and walking trips as well as the benefits accrued over 25 years, discounted at a rate of 3.1%.



Table 7. Proportion of Potential Pedestrians and Cyclists based on Population Age Ranges

CATEGORY	PERCENTAGE
Potential Induced Pedestrians (Ages 20-74)	68%
Potential Induced Cyclists (Ages 20-64)	59%

Table 8. Existing Active Trip Mode Split Within ½ Mile of Proposed Network

CATEGORY	PERCENTAGE
Existing Share of Bike Trips	17%
Existing Share of Walking Trips	83%

Table 9. Annual Public Health Benefits and 25-Year Net Present Value in Q1 2025 Dollars

CATEGORY	MONETARY VALUE
ANNUAL TOTAL PUBLIC HEALTH BENEFITS	\$121,249,000
Annual Mortality Costs Reduced from Induced Walk Trips	\$104,678,000
Annual Mortality Costs Reduced from Induced Bike Trips	\$16,571,000
25-YEAR NET PRESENT VALUE OF PUBLIC HEALTH BENEFITS	\$2,209,250,000

Economic Competitiveness Benefits

The installation of the proposed network is expected to reduce vehicle traffic congestion and lower average household transportation costs by decreasing VMT. Less congestion translates to fuel and time savings for drivers, while households are likely to benefit financially as more travelers choose lower-cost modes such as walking and biking. The economic competitiveness benefits accrued from reduced congestion and transportation costs are shown in **Table 10**.

Alta calculated the monetary value of congestion costs per VMT using several factors: the cost of crashes, the ratio of crash costs to congestion costs, the per-person costs of crashes and congestion⁸—all reported by AAA—and the average VMT per person as reported by FHWA⁹.

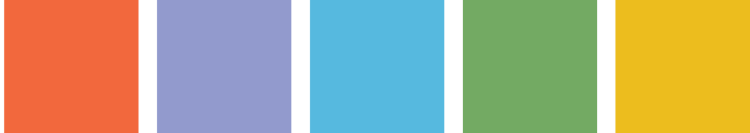
Alta based the household transportation cost per VMT on the light duty vehicle operating and ownership costs per mile published by the 2025 USDOT guidance.

Table 10. Annual Economic Competitiveness Benefits and 25-Year Net Present Value in Q1 2025 Dollars

CATEGORY	MONETARY VALUE
ANNUAL ECONOMIC COMPETITIVENESS BENEFITS	\$9,640,000
Congestion Costs Reduced	\$1,202,000
Household Transportation Costs Reduced	\$8,438,000
25-YEAR NET PRESENT VALUE OF ECONOMIC COMPETITIVENESS BENEFITS	\$175,656,000

⁸ The American Automobile Association (AAA). (2011). *Crashes vs. Congestion: What's the Cost to Society?*
<https://exchange.aaa.com/wp-content/uploads/2012/07/AAA-Crashes-vs-Congestion-2011.pdf>

⁹ Federal Highway Administration (FHWA). (2022). *Average Annual Miles per Driver by Age Group*.
<https://www.fhwa.dot.gov/ohim/onh00/bar8.htm>



Emissions Reductions Benefits

Based on the estimated reduction in VMT of 14,458,000 miles per year due to the installation of the proposed bicycle and pedestrian facilities in the preferred high-priority network package, the analysis determined the reduction in emissions in metric tons and the resultant economic benefit. PAG provided emissions reduction estimates per VMT from the EPA MOVES4 model in the 2023 *Travel Reduction Program (TRP) Air Pollutant Benefits and Method Summary* for volatile organic compounds (VOC), oxides of nitrogen (NOx), coarse particulate matter (PM10), fine particulate matter (PM2.5), and carbon dioxide equivalents (CO2e). Alta used these numbers to estimate the metric tons per year of emissions avoided by use of the proposed network, as shown in **Table 11**.

USDOT reports the monetary value of damages per metric ton of emitted NOx and PM2.5 in the 2025 guidance and damages costs for emitted CO2 in the 2024 guidance. Damages from these pollutants stem from the detrimental effects on human health and the environment. Because USDOT does not provide damage costs for VOC and PM10 emissions, Alta only calculated the metric tons of avoided emissions for these pollutants, outlined in **Table 12**.

Carbon dioxide and its equivalents, in particular, are noted by USDOT in the 2024 guidance for their long-lasting effects, and are therefore benefits from the reduction of carbon emissions are discounted at a lower rate than other benefits.¹⁰ The discount rate is used to determine the net present value of benefits after a 25-year horizon, and does not affect the annual benefits calculations. See **Table 13** for the net present value of emissions reductions benefits.

Table 11. Annual Emissions Reductions in Metric Tons

CATEGORY	METRIC TONS
Volatile organic compounds (VOC)	4.58
Oxides of nitrogen (NOx)	3.14
Coarse Particulate Matter (PM10)	0.57
Fine particulate matter (PM2.5)	0.14
Carbon dioxide equivalents (CO2e)	5,462.97
All Non-CO2e Emissions	8.28
TOTAL EMISSIONS REDUCED	5,471.26

Table 12. Annual Emissions Reduction Benefits in Q1 2025 Dollars

CATEGORY	MONETARY VALUE
Volatile organic compounds (VOC)	-
Oxides of nitrogen (NOx)	\$69,000
Coarse Particulate Matter (PM10)	-
Fine particulate matter (PM2.5)	\$149,000
Carbon dioxide equivalents (CO2e)	\$1,401,000
All Non-CO2e Emission Reduction Benefits	\$218,000
TOTAL EMISSIONS REDUCTION BENEFIT	\$1,618,000

¹⁰ Carbon emissions are discounted at a rate of 2.0% rather than the 3.1% rate that applies to other economic benefits.



Table 13. Net Present Value of Emissions Reduction Benefits over 25-Year Horizon in Q1 2025 dollars

CATEGORY	MONETARY VALUE
CO2e Emission Costs Reduced (2.0% Discount Rate)	\$34,479,000
NOx and PM2.5 Emission Costs Reduced (3.1% Discount Rate)	\$4,273,000
TOTAL EMISSIONS REDUCTION BENEFIT	\$387,527,000

State of Good Repair Benefits

By reducing VMT, PAG can expect lower roadway maintenance expenses for “street repair and resurfacing, police, emergency response, transportation planning, legal costs for traffic-related incidents, lighting, and parking enforcement,” according to the San Francisco Bay Area Planning and Urban Research Association (SPUR).¹¹ SPUR also reports a roadway maintenance cost per VMT in San Francisco, which Alta has used to estimate the state of good repair benefits resulting from the proposed facility implementation, illustrated in **Table 14**.

Table 14. Annual State of Good Repair Benefits and 25-Year Net Present Value in Q1 2025 Dollars

CATEGORY	MONETARY VALUE
ANNUAL STATE OF GOOD REPAIR BENEFITS	\$1,356,000
25-YEAR NET PRESENT VALUE OF GOOD REPAIR BENEFITS	\$24,709,000

¹¹ San Francisco Bay Area Planning and Urban Research Association (SPUR). (2005). *Estimating the External Costs of Driving in San Francisco*.

<https://www.spur.org/publications/urbanist-article/2005-09-01/estimating-external-costs-driving-san-francisco>

Limitations

The primary purpose of the analysis is to enable a more informed policy discussion on the benefits of investing in the proposed bicycle and pedestrian facilities. Even with extensive primary and secondary research incorporated into the impact analysis model, it is impossible to accurately predict the exact impacts of various factors. Accordingly, all estimated benefit values are rounded and should be considered order of magnitude estimates, rather than exact amounts.

Alta's analysis has the following limitations that should be considered:

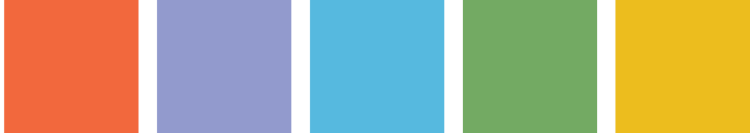
- There is not a strong literature base for how to estimate mode shift entirely from short trip estimates, and we have chosen the most conservative estimate based on the low active trip conversion rate from the Seattle Area Micromobility Study so that it aligns with realistic outcomes from plan implementation (Harper et al, 2021). Using the low conversion rate to convert the total short trips in the baseline study area to active modes most closely resembled the net active trips reported by Replica Places within the study area, less the other mode shift trips and the induced trips.
- The 2025 BCA Guidance does not report the social cost of carbon (SCC) values alongside damage costs from NOx and PM2.5. Therefore, Alta pulled values from the 2024 BCA Guidance and inflated to Q1 2025 dollars. These values are sourced from the EPA's 2023 "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances,"¹² in 2020 dollars, as they were also reported in the Microtransit Study provided by PAG.¹³
- All monetary values were inflated to Q1 2025 dollars to represent the most up-to-date benefit amounts. Typical practice from USDOT involves inflating using annual GDP values rather than quarterly, but Q1 2025 is the most recent GDP deflator value published by the BEA.
- Some emissions classes such as coarse particulate matter (PM10) did not have monetary values associated with them from the established sources Alta trusted for this analysis. However, these emissions are likely to have some benefit associated with their reduction, even if no established resources have documented it.
- The safety analysis only considers the maximum CRF to be the most significant and supported by the evidence in relevant literature when multiple overlapping countermeasures are in place. This applies even if the applicable share of one mode type of collisions might be higher for one counter measures versus another. This makes the safety analysis intrinsically conservative where there are multiple overlapping counter measures.
- The type of infrastructure considered was not factored into trip estimates and mode shift directly. The estimates assume the core network identified would improve conditions for bicycles and pedestrians to build a connected backbone network for these modes of transportation. The degree to which each mode sees increased use activity thus is not proportional to the mileage of each type of network improvement recommended, but the existing mode split between walking and biking as estimated by Replica's activity-based model.

¹² Environmental Protection Agency (EPA). (2023). *Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances*.

https://www.epa.gov/system/files/documents/2023-12/epa_scghg_2023_report_final.pdf

¹³ Pima Association of Governments (PAG). (2025). Dial-a-Ride and Microtransit Service Analysis.

<https://pagregion.com/microtransit/>



Appendix A – Multipliers

This section displays additional multipliers that were used to calculate the benefits throughout this analysis that were not presented in the body of the analysis results.

For every vehicle-mile reduced, there is an assumed decrease in greenhouse gases and criteria pollutants. **Table 15** lists the reduction in greenhouse gases and criteria pollutants by vehicle-mile traveled¹⁴, along with the cost to mitigate or clean-up those pollutants in 2025¹⁵.

Table 15. Environmental Protection Multipliers in Q1 2025 Dollars

COMPOUND	Value (Metric Tons/VMT) ¹⁴	VALUE (\$USD/METRIC TON) ¹⁵
VOLITILE ORGANIC COMPOUNDS (VOC)	0.0000003165	-
Oxides of nitrogen (NOx)	0.0000002172	\$21,990
COARSE PARTICULATE MATTER (PM10)	0.0000000391	-
Fine particulate matter (PM2.5)	0.0000000098	\$1,053,736
Carbon dioxide equivalents (CO2e)	0.0003778448	\$256

Additional walking and biking trips are associated with improved health and reduced mortality. Based on these health improvements, USDOT published dollar benefits per walk and bike trip taken in the 2025 BCA guidance, shown in **Table 16**.

Table 16. Public Health Multipliers in Q1 2025 Dollars

TRIP TYPE	Value (\$USD/ Trip) ¹⁶
Walk Benefit per Trip	\$8.40
Bike Benefit per Trip	\$7.48

¹⁴ Pollutant emissions per VMT in U.S. pounds are sourced from the EPA MOVES4 Study 2023 Travel Reduction Program (TRP) Air Pollutant Benefits and Method Summary provided by PAG and converted to metric tons.
¹⁵ PM2.5 and NOx damage costs per metric ton are sourced from the USDOT 2025 BCA Guidance. Carbon damage costs are sourced from the USDOT 2024 BCA Guidance.
¹⁶ Walk and bike trip benefits are sourced from the USDOT 2025 BCA Guidance.