Maximum Mode Shift: A VMT Reduction Study

METROPOLITAN COUNCIL

September 2023 Jonathan Ehrlich metrocouncil.org

Study Goal

Estimate the maximum mode shift possible, given existing land use patterns and travel needs.

- Help set VMT reduction & mode share targets
- Identify geographies, trip types, demographic groups where mode shift has the greatest potential
- Alternative to forecast models
- Move towards target-based planning

Project will develop open-source, reproducible tools, allowing the study to be repeated over time.

Research Questions

With land use, transportation system, and travel patterns held constant, how much travel can be shifted away from driving towards other, less carbon-intensive modes?

To what extent does the potential for, or cost of, mode shift vary across

- **geography,** e.g. community type, transit market areas, job and activity centers?
- **demographic** groups including age, gender, income, disability status, and race?
- **trip types,** such as errands or commutes?
- **time** (2018-2019 vs. 2020-2021 TBI; future years as they become available)

Research Approach

Using 500,000+ real-world trips reported by residents in the 2019 and 2021 Travel Behavior Inventory surveys:

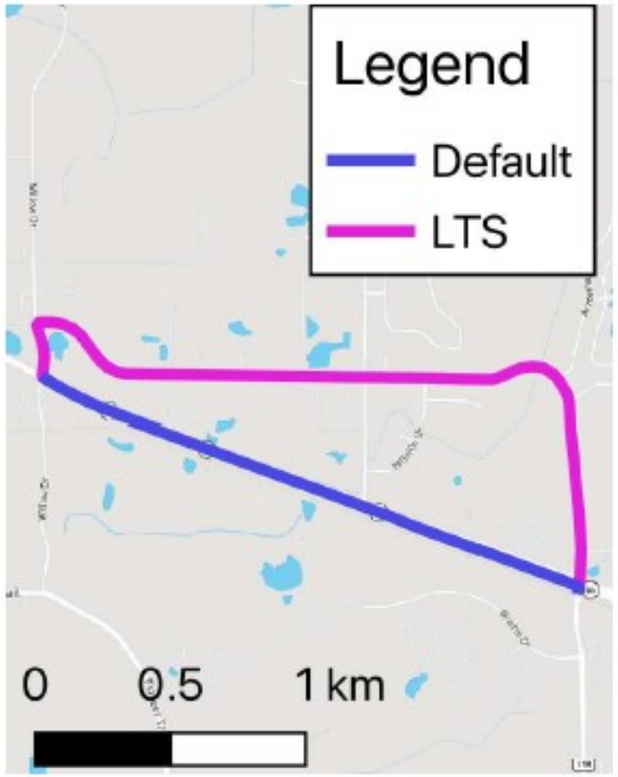
1. For each car trip, calculate the best possible walk, bike and transit paths based on the observed origin, destination and timing. Validate against observed routes and local experience.

2. Determine whether the transit, walk and bike options are feasible. An option is feasible if we observe a substantial number of people using that mode under similar circumstances.

3. For trips with one or more feasible non-car options, identify whether one or more of the non-car options has a competitive travel time. An option is competitive if its travel time is within 15 minutes of the travel time by car.

Walk Routes

Walking routes are calculated to avoid high speed & high functional class roads without sidewalks.



		With Sidewalk											
		6+ Lanes				4 Lanes				2 Lanes			
		Speed				Speed				Speed			
Functional Class		>55	41-55	31-40	<=30	>55	41-55	31-40	<=30	>55	41-55	31-40	<=30
1,2	Freeway/Major Highway												
3	Major arterial												
4	Minor arterial/collector												
5	Local												

		Without Sidewalk (or no sidewalk data available)											
		6+ Lanes				4 Lanes				2 Lanes			
		Speed				Speed				Speed			
Functional Class		>55	41-55	31-40	<=30	>55	41-55	31-40	<=30	>55	41-55	31-40	<=30
1,2	Freeway/Major Highway												
3	Major arterial												
4	Minor arterial/collector												
5	Local												

	Key			
	Prohibited	0.0	MPH	(not shown above - separate field identifies whether pedestrians prohibited or not)
	Available	1.5	MPH	
	Low	2.4	MPH	
	Medium	2.7	MPH	
	High	3.0	MPH	

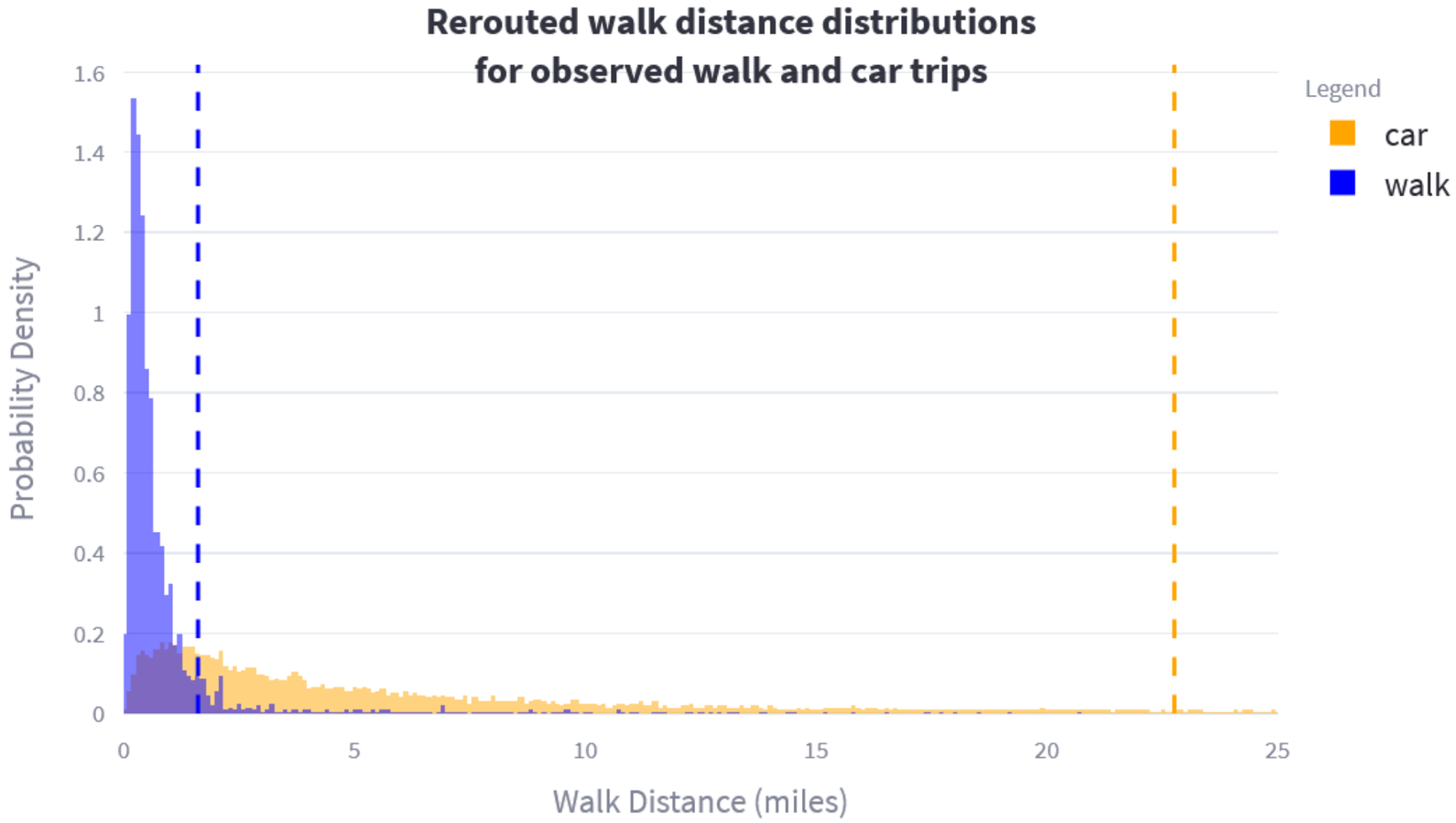
We calculate the best path based on these weightings, but report the travel time along that path assuming a 3 mph walking speed.

Walk Feasibility

Feasibility Constraints:

1. We observe that only 5% of existing walk trips are > 1.6 miles. Therefore, we assume that it is infeasible for car trips > 1.6 miles in length to switch to walk.
2. The traveler must have sufficient time to complete the trip without interfering with another work, school or pick-up/drop-off activity.

We refer to #1 as the 5% rule. If fewer than 5% of walkers do it now, it is unlikely that new walkers would.



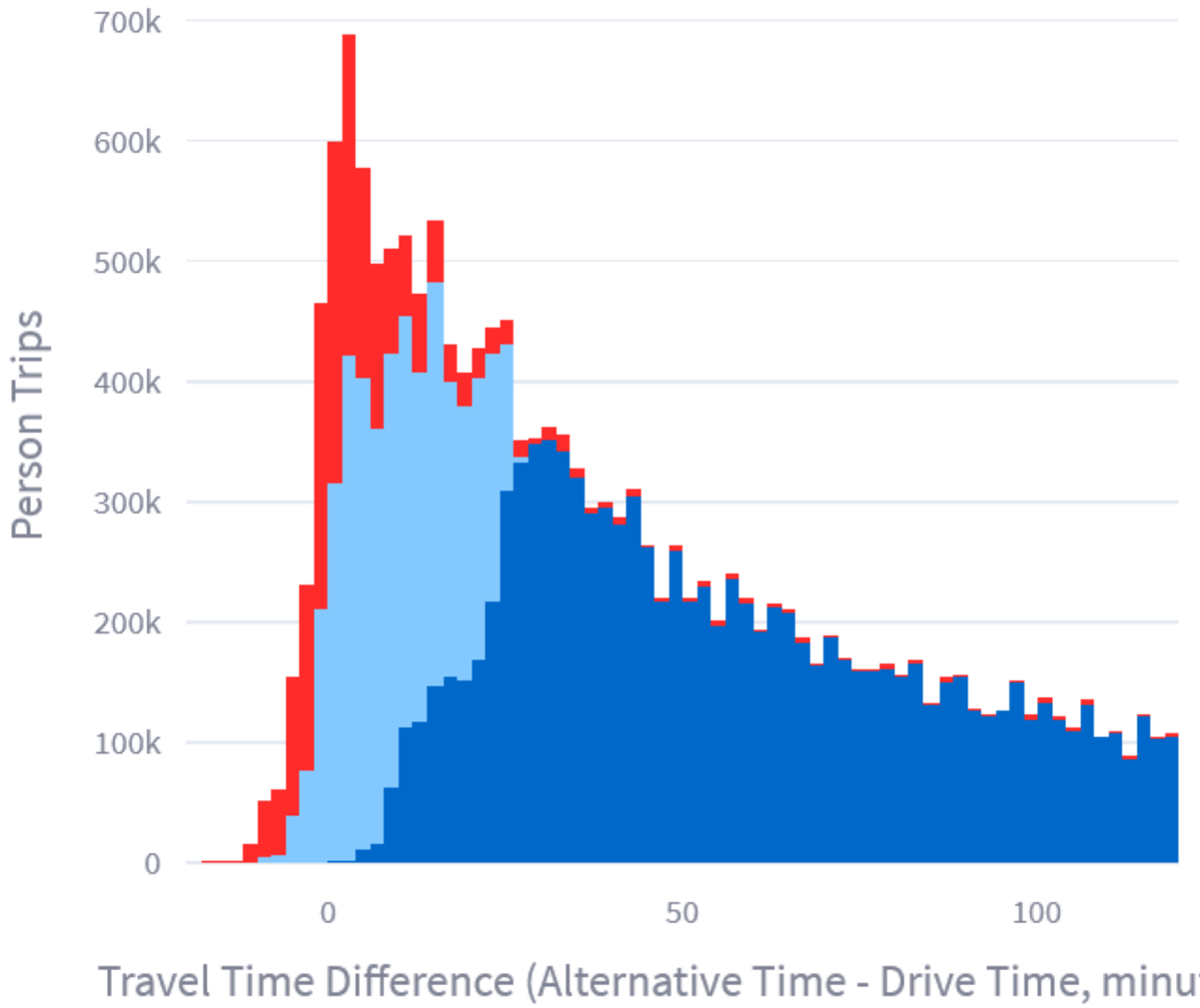
Feasible Walk Trips

Car trips that could feasibly switch to walk

	Trip is < 1.6 miles long	Sufficient Time Available to Complete Trip	Feasible Across All Criteria
% of Car Trips	22.8%	63.0%	18.0%
% of VMT	3.0%	57.0%	2.2%

Competitive Walk Trips

Travel Time Difference Between Walking and Driving

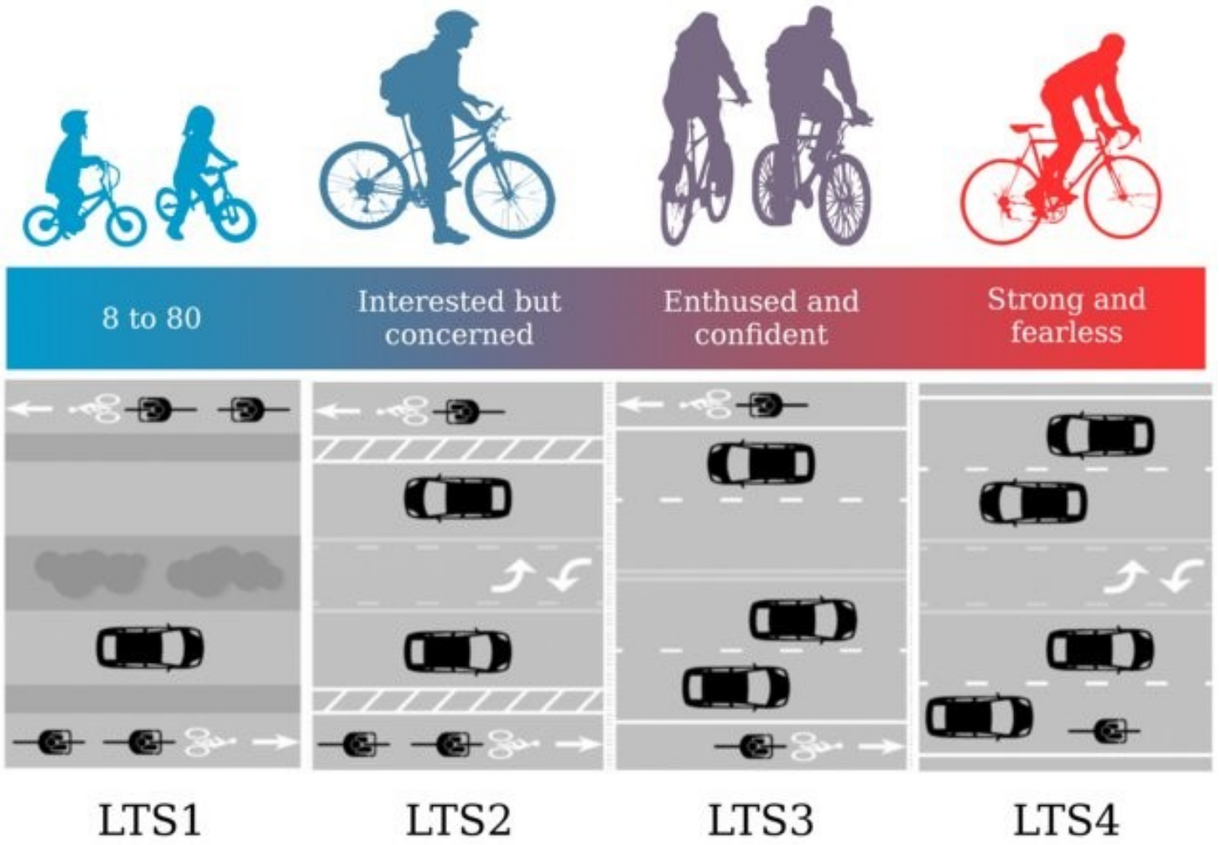


Trips that Could Feasibly Switch

	Walking is within 5 minutes of driving	Walking is within 15 minutes of driving	Walking is within 30 minutes of driving
% of Car Trips	5.5%	13.0%	18.0%
% of VMT	0.4%	1.2%	2.2%

Bike Routes

Bike routes are calculated to avoid traveling on high Level of Traffic Stress Facilities.

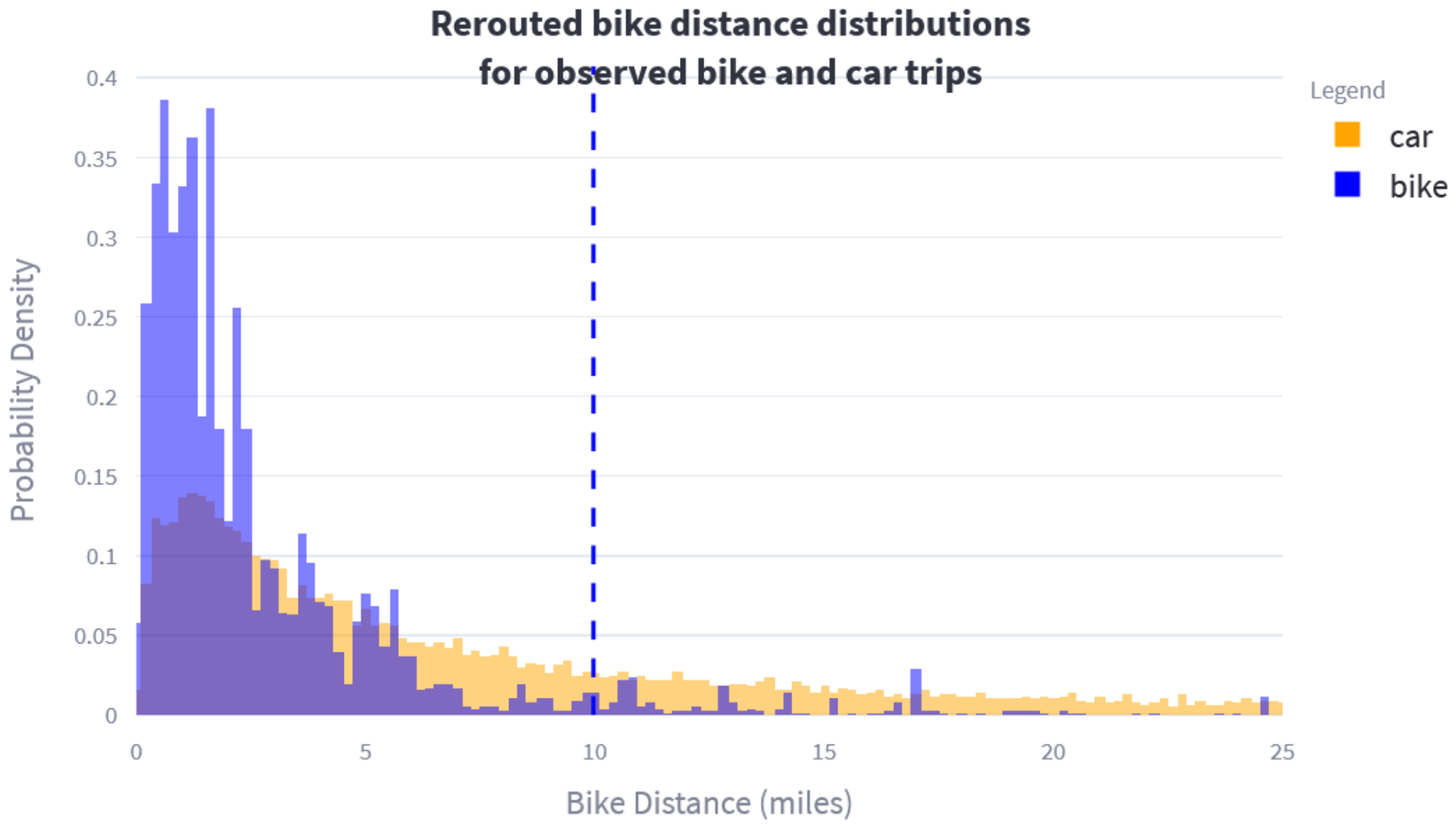


LTS 2: 10% penalty. LTS 3/4: assume cyclists will dismount.

Bike Feasibility

Feasibility Constraints:

1. We observe that only 5% of existing bike trips are > 10 miles. Therefore, we assume that it is infeasible for car trips > 10 miles in length to switch to bike.
2. We observe that <5% of existing bike trips occur when there is snow on the ground.
3. We observe that only 5% of existing bike trips have more than 15% of their distance on high LTS facilities.
4. The traveler must have sufficient time to complete the trip without interfering with another work, school or escort activity.



Another example of the 5% rule.

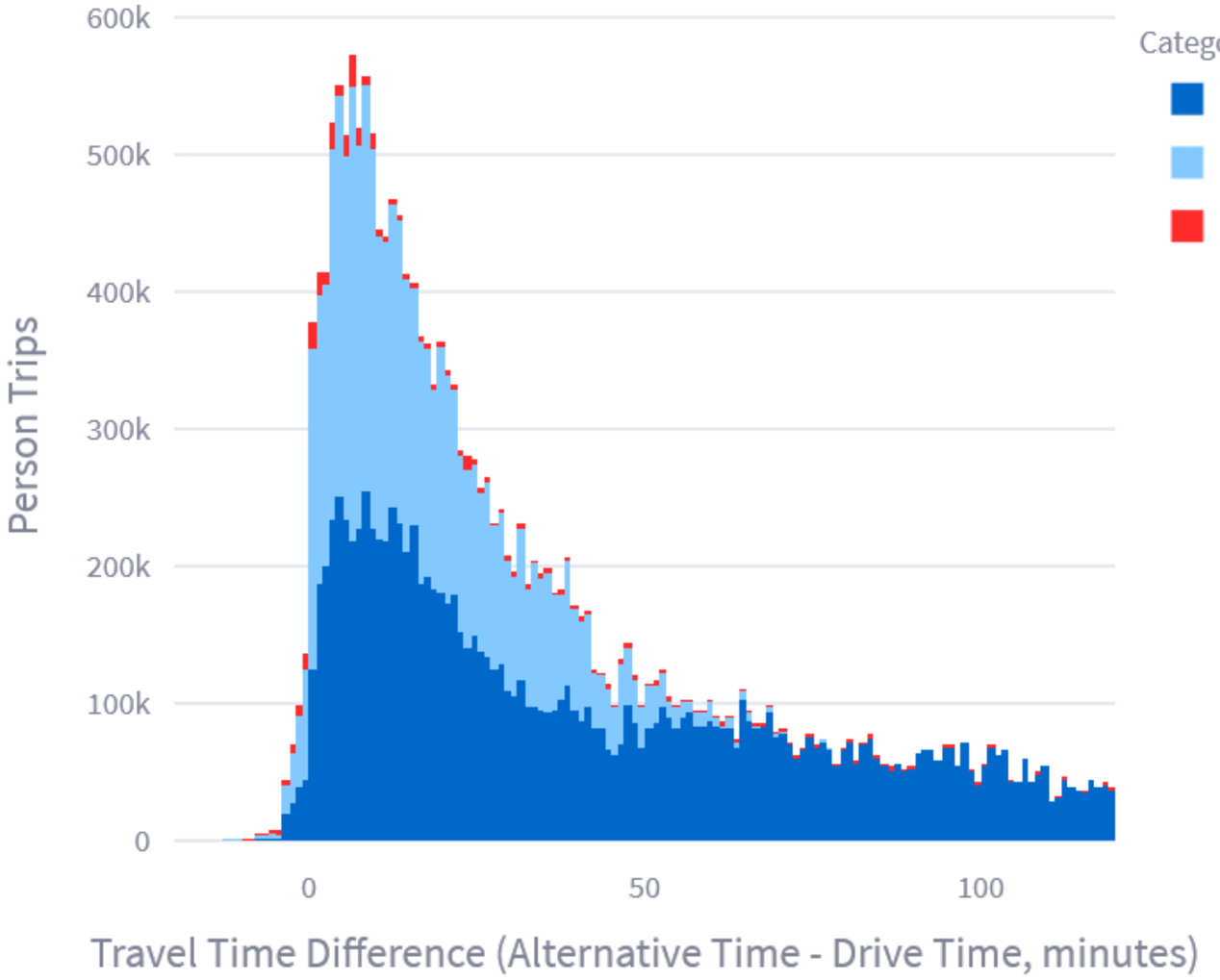
Feasible Bike Trips

Car trips that could feasibly switch to bike

	Trip is < 10.0 miles long	Not in the Snow	No more than 15% of distance on LTS 3/4 facilities	Sufficient Time Available to Complete Trip	Feasible Across All Criteria
% of Car Trips	67.3%	76.6%	86.7%	71.4%	32.5%
% of VMT	26.9%	76.4%	93.9%	63.7%	13.0%

Competitive Bike Trips

Travel Time Difference Between Biking and Driving



Trips that Could Feasibly Switch

	Biking is within 5 minutes of driving	Biking is within 15 minutes of driving	Biking is within 30 minutes of driving
% of Car Trips	5.9%	16.7%	25.6%
% of VMT	0.8%	3.4%	7.7%

Transit Routes

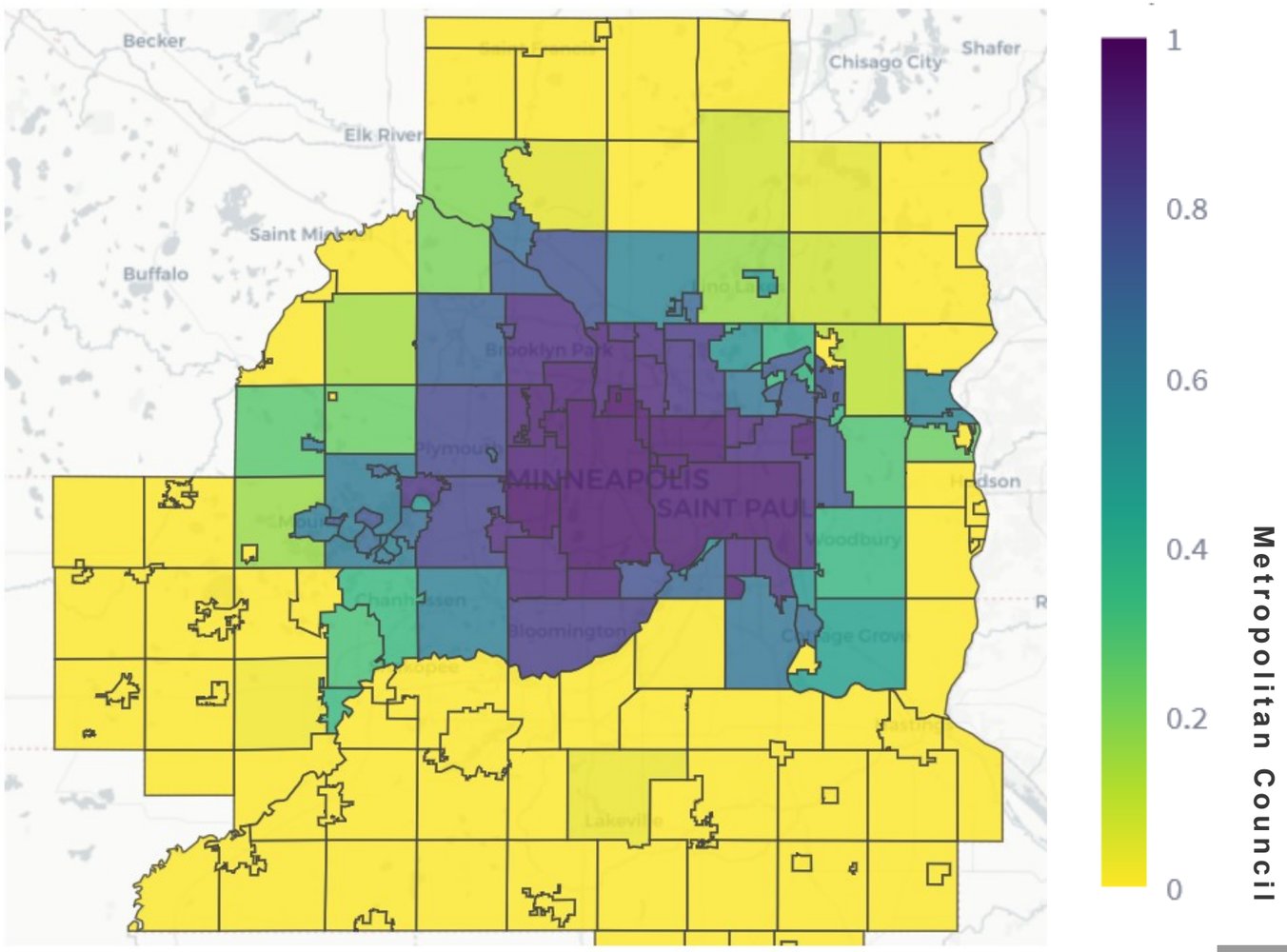
Transit routes are calculated using a method similar to what you would map in your smartphone.

For trips to work/school, we calculate the best route that gets you there with the same or an earlier arrival time. For other trips, we calculate the best route starting from the observed departure time.

Transit Feasibility

Feasibility Constraints:

1. We observe that only 5% of existing transit trips walk more than 0.9 miles to get to or from a stop. Therefore, consider transit infeasible if either the origin or destination walking distance is greater than 0.9 miles.
2. We observe that only 5% of existing transit trips involve waiting more than 36 minutes for the first transit vehicle, and constrain accordingly.
3. We observe that less than 5% of existing transit trips involve more than 2 transfers, and consider paths with more than 2 transfers infeasible.
4. The traveler must have sufficient time to complete the trip without interfering with another work, school or escort activity.



Share of trips for which a feasible transit path is found.

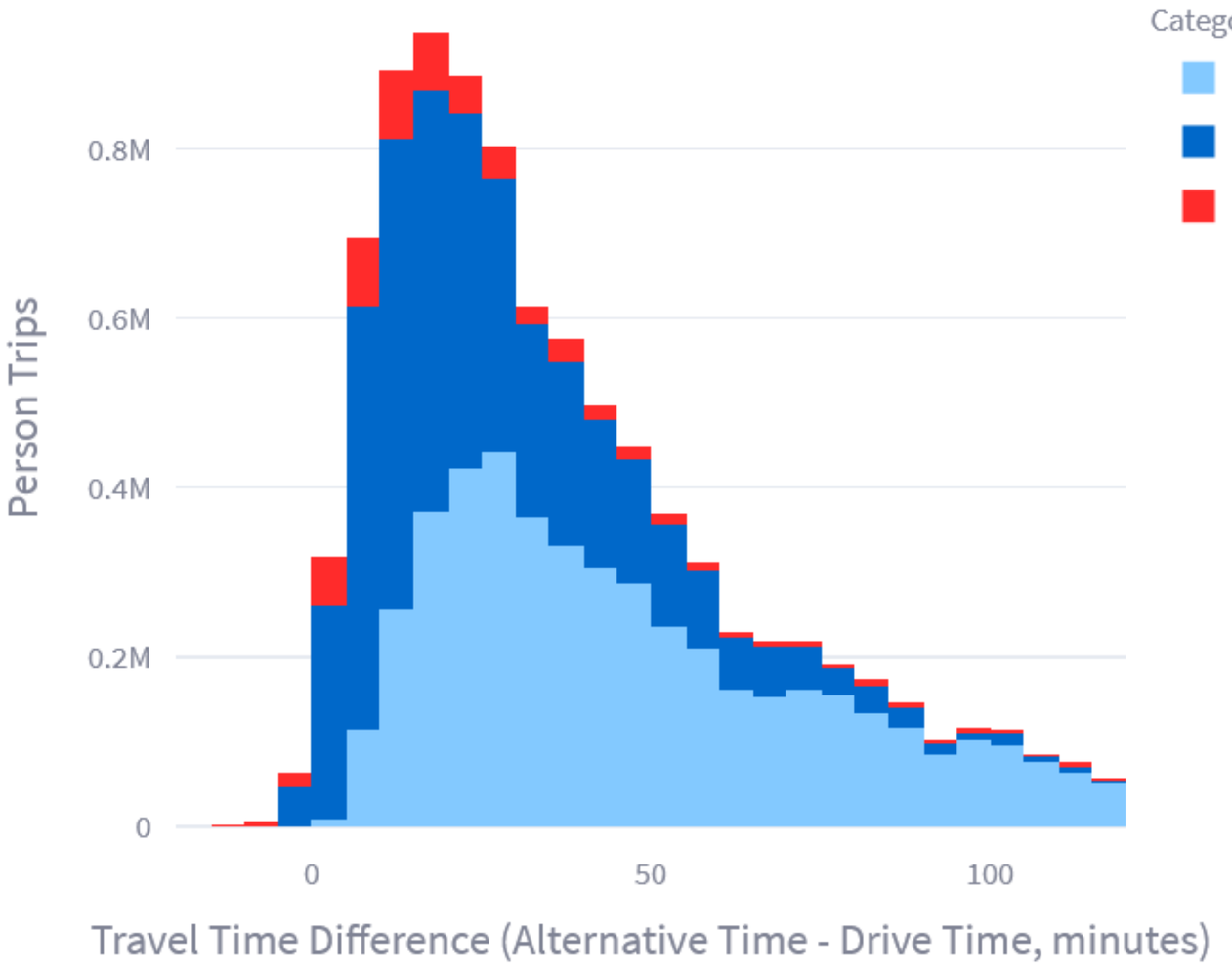
Feasible Transit Trips

Car trips that could feasibly switch to transit

	Valid Transit Path Found	Walk Access Distance < 0.9 mi	Walk Egress Distance < 0.9 mi	Waiting Time < 36 min	Sufficient Time Available to Complete Trip	Feasible Across All Criteria
% of Car Trips	53.6%	41.2%	41.4%	37.4%	30.9%	17.2%
% of VMT	40.1%	30.6%	30.2%	24.7%	22.3%	10.2%

Competitive Transit Trips

Travel Time Difference Between Transit and Driving



Trips that Could Feasibly Switch

	Transit is within 5 minutes of driving	Transit is within 15 minutes of driving	Transit is within 30 minutes of driving
% of Car Trips	1.4%	5.9%	11.2%
% of VMT	0.2%	1.2%	3.5%

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Feasible Trips by Any Mode

Car trips that could feasibly switch to walk, bike or transit

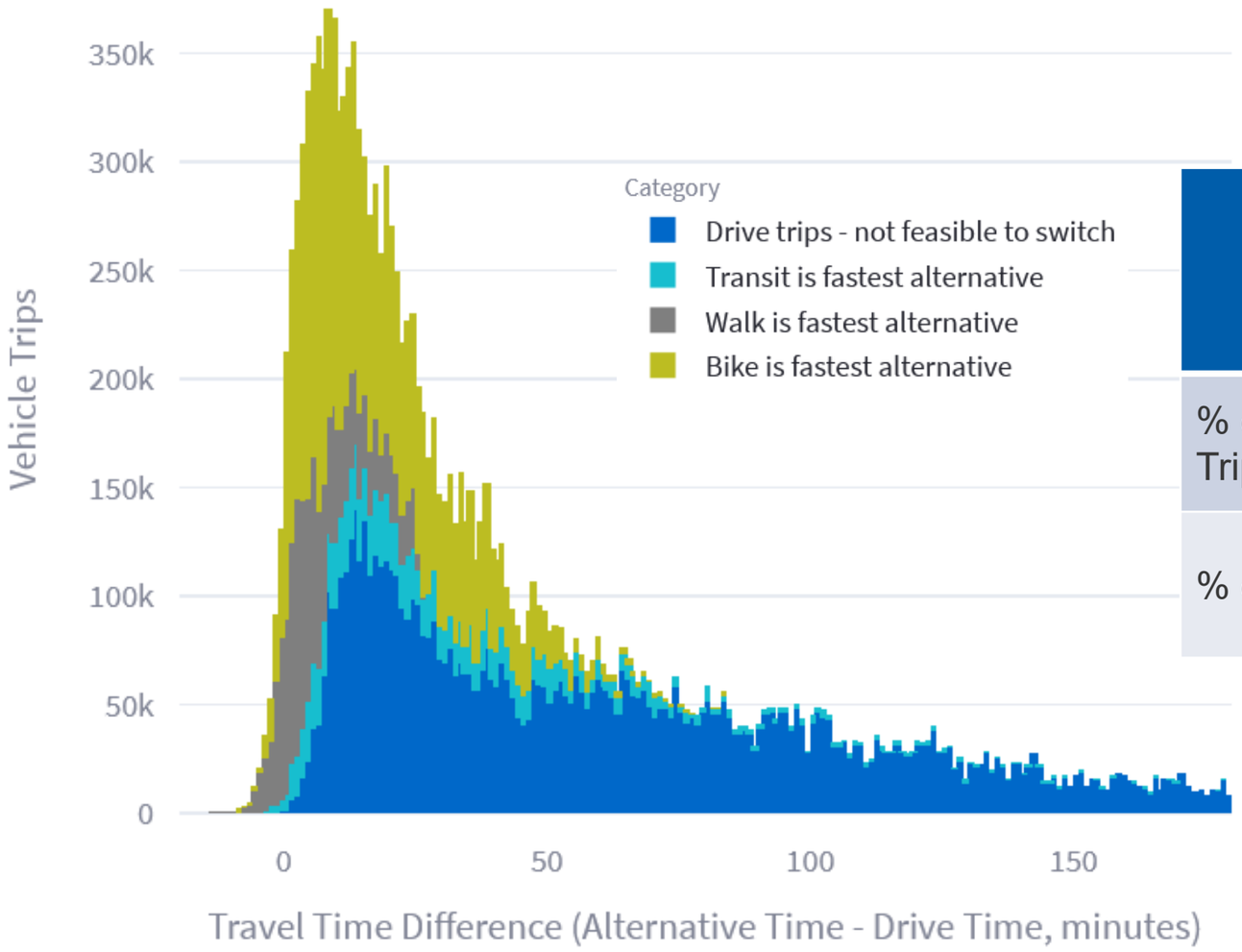
	Feasible to switch to walk	Feasible to switch to bike	Feasible to switch to transit	Feasible to switch to any non-car mode
% of Car Trips	18.0%	32.5%	17.2%	47.0%
% of VMT	2.2%	13.0%	10.2%	20.1%

Fastest Feasible Non-Car Mode

	Walk is the fastest alternative	Bike is the fastest alternative	Transit is the fastest alternative	Feasible to switch to any non-car mode
% of Car Trips	9.3%	29.5%	8.2%	47.0%
% of VMT	1.0%	11.7%	7.4%	20.1%

Competitive Trips by Any Mode

Travel Time Difference Between Non-Car Modes and Driving

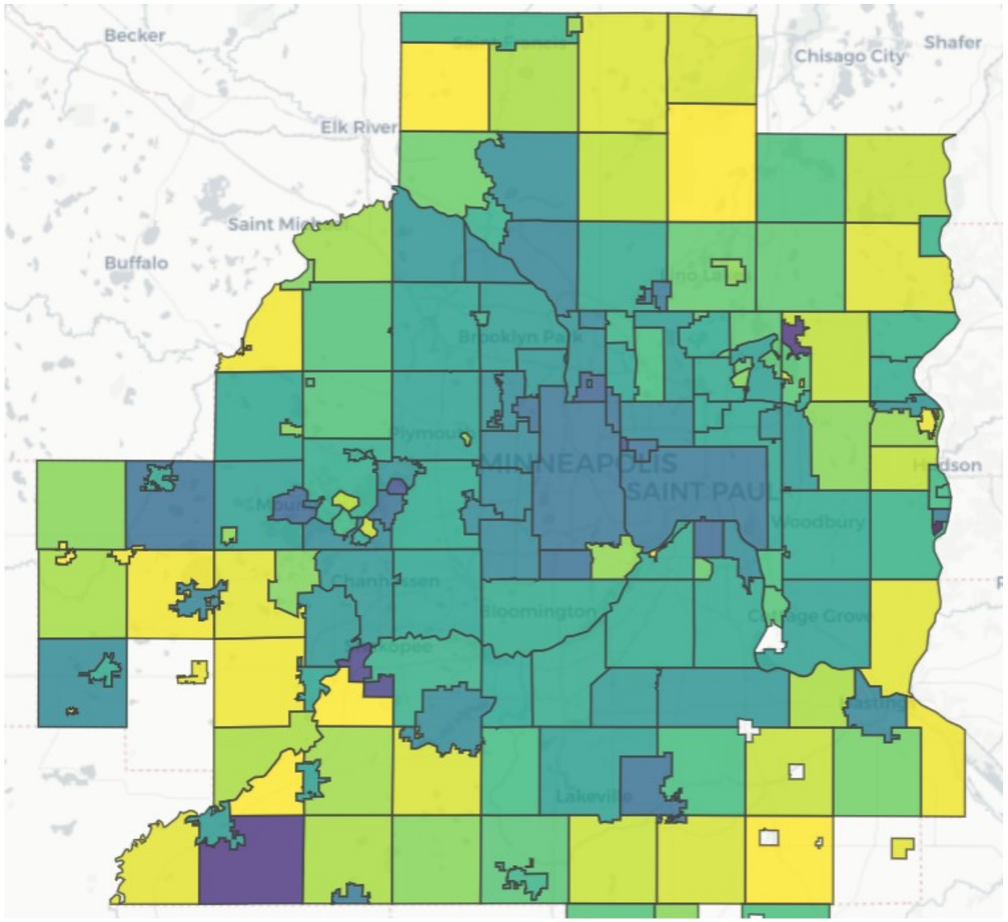


Trips that Could Feasibly Switch

	Any mode is within 5 minutes of driving	Any mode is within 15 minutes of driving	Any mode is within 30 minutes of driving
% of Car Trips	10.2%	25.2%	37.1%
% of VMT	1.1%	4.5%	10.1%

Geography

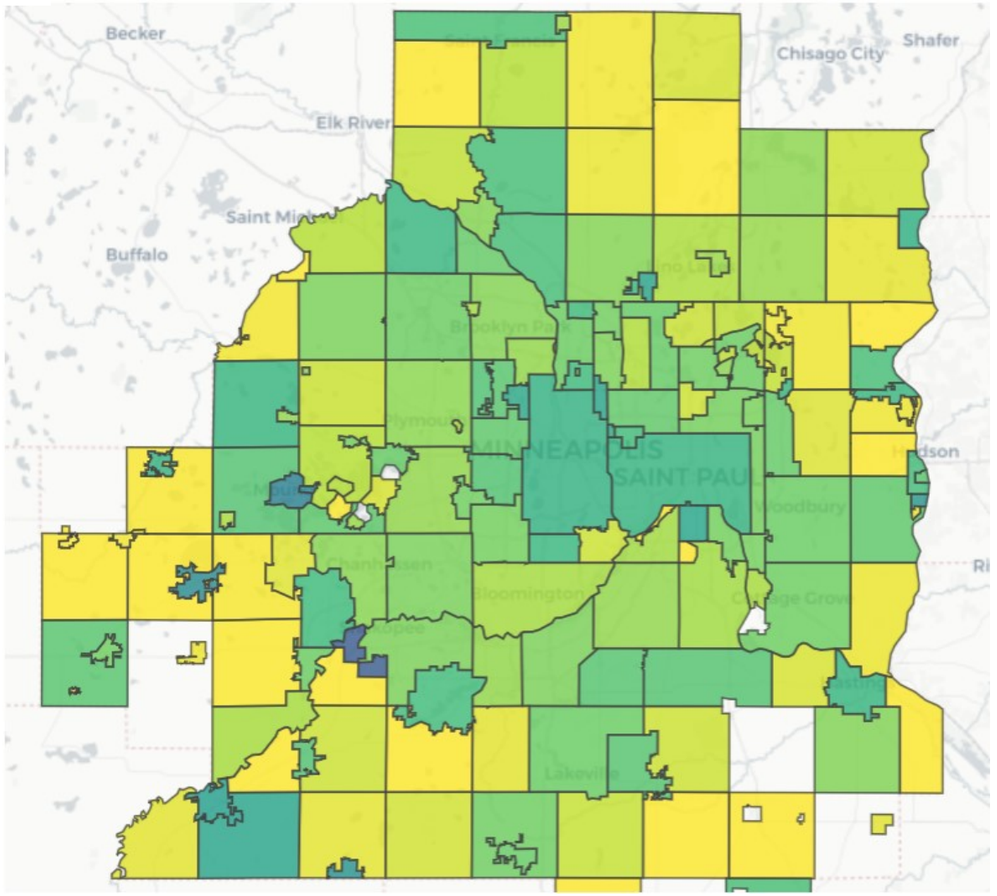
To what extent does the potential for mode shift vary across geography?



Feasible to switch.

Percent of Trips

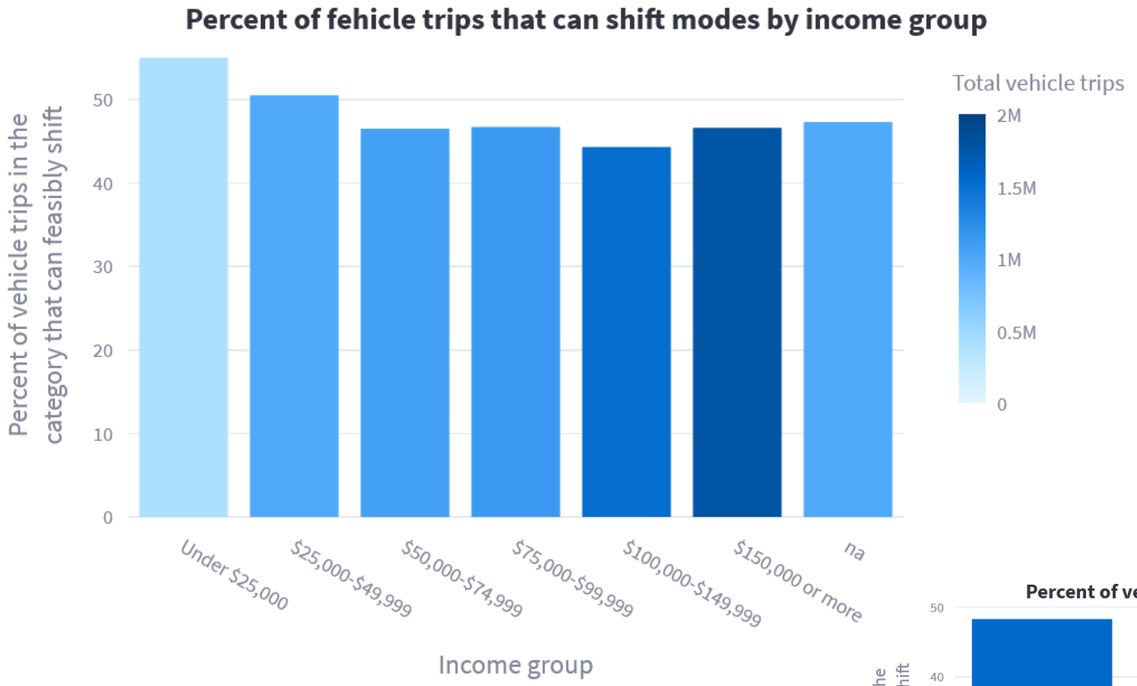
100
80
60
40
20
0

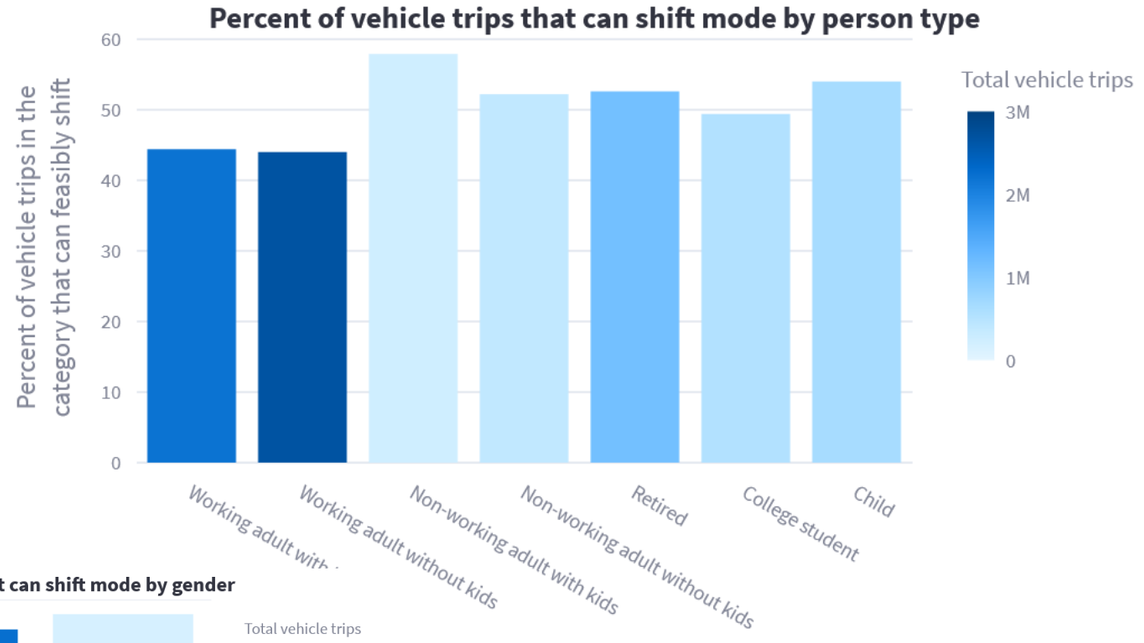


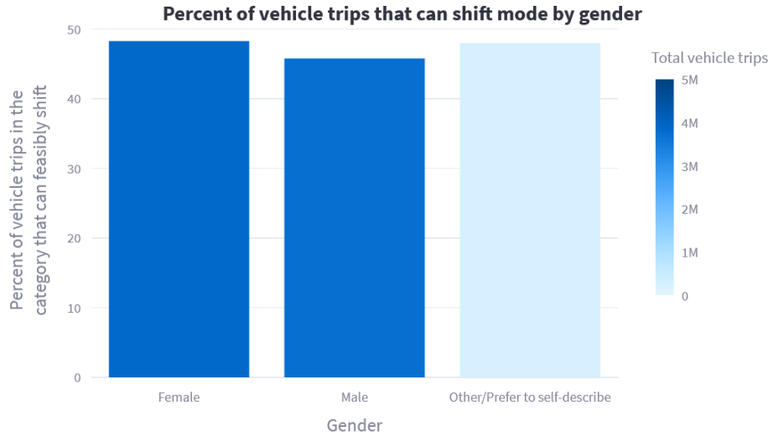
Feasible to switch & within 15 minutes of driving time.

Demographics

To what extent does the potential for mode shift vary across demographics?







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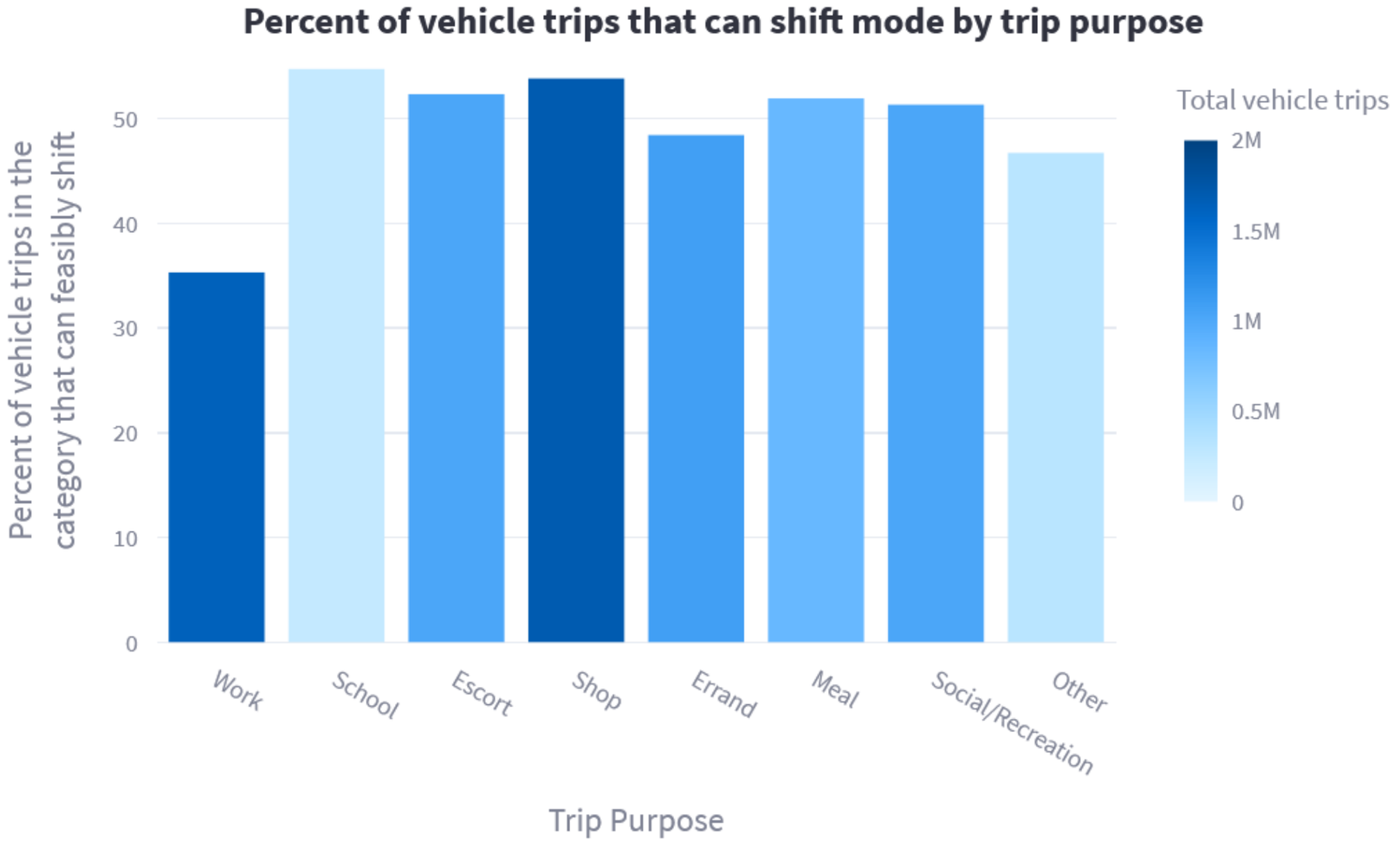
Trip Types

To what extent does the potential for mode shift vary across trip types?



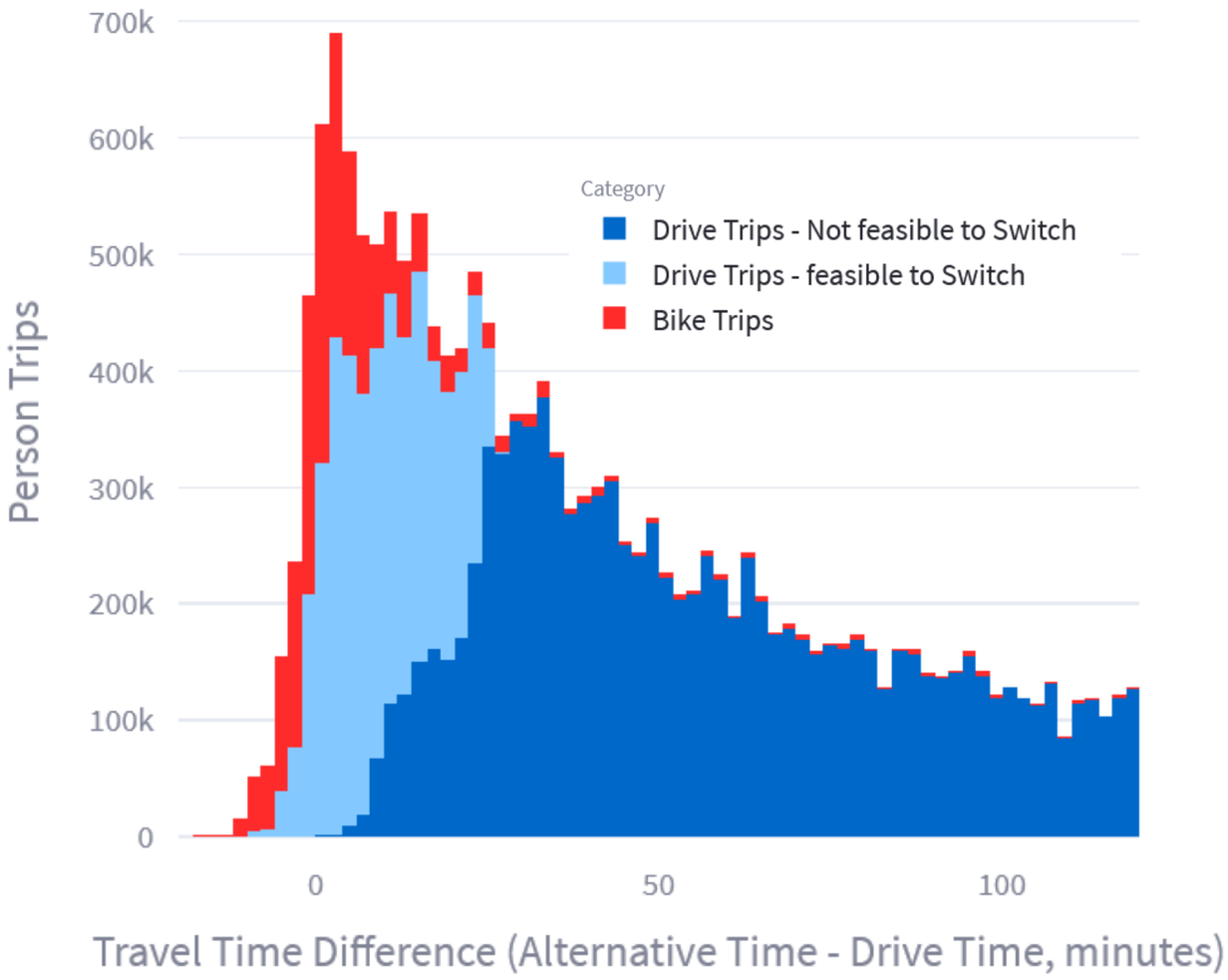
Scenario Analysis- PRELIMINARY

Considered very broad scenarios:

- **Walk infrastructure**
- **Bike Infrastructure**
- E-bikes
- **Transit frequency**
- Transit time
- Land use proxy
- Highway speed

Walk Scenario: All Streets Operate at Best Pedestrian Quality of Service

Travel Time Difference Between Biking and Driving



BASE: Trips that Could Feasibly Switch

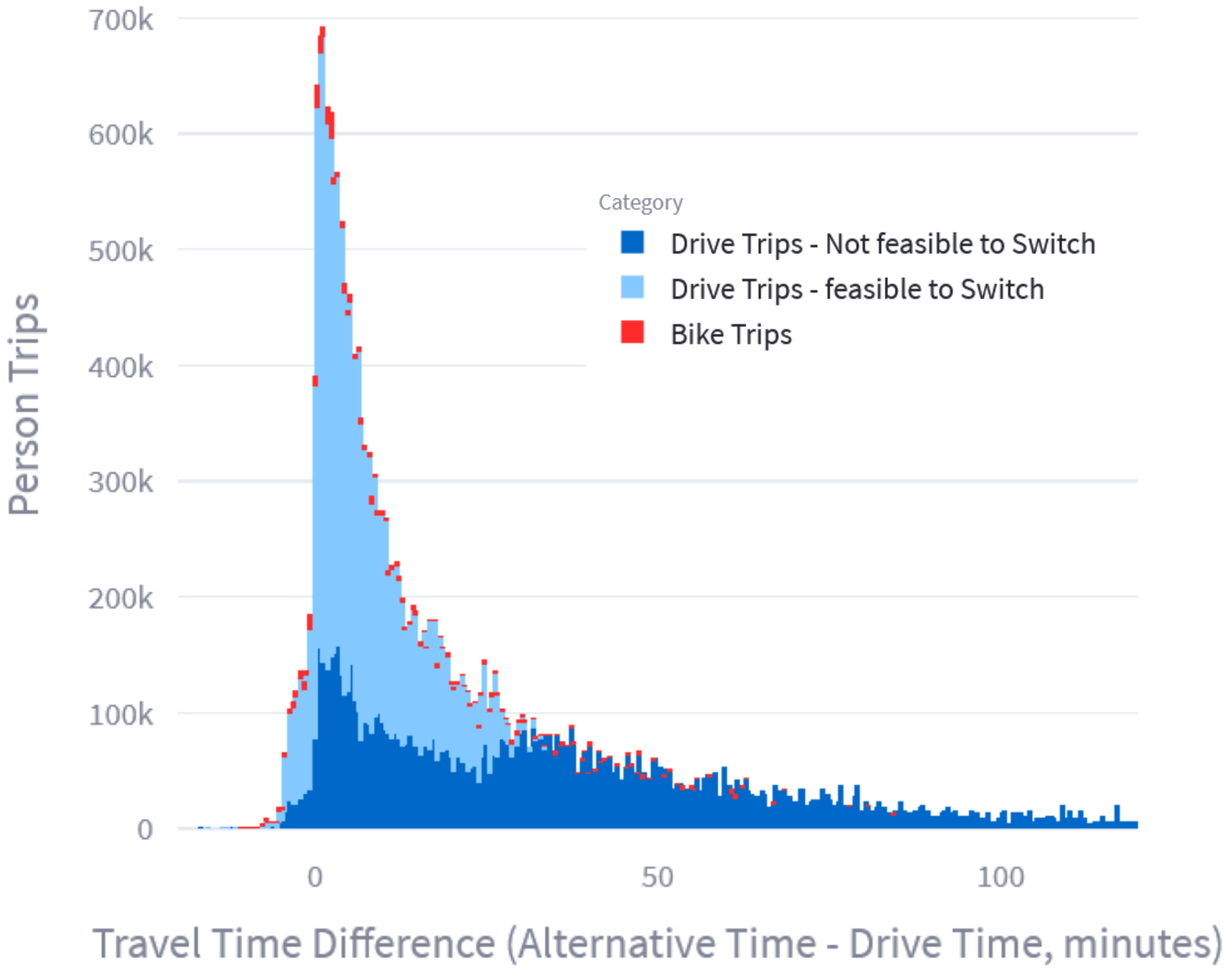
	Walking is within 5 minutes of driving	Walking is within 15 minutes of driving	Walking is within 30 minutes of driving
% of Car Trips	5.5%	13.0%	18.0%
% of VMT	0.4%	1.2%	2.2%

SCENARIO: Trips that Could Feasibly Switch

	Walking is within 5 minutes of driving	Walking is within 15 minutes of driving	Walking is within 30 minutes of driving
% of Car Trips	5.7%	13.4%	18.2%
% of VMT	0.4%	1.3%	2.2%

Bike Scenario: All Streets Operate at LTS 1

Travel Time Difference Between Biking and Driving



BASE: Trips that Could Feasibly Switch

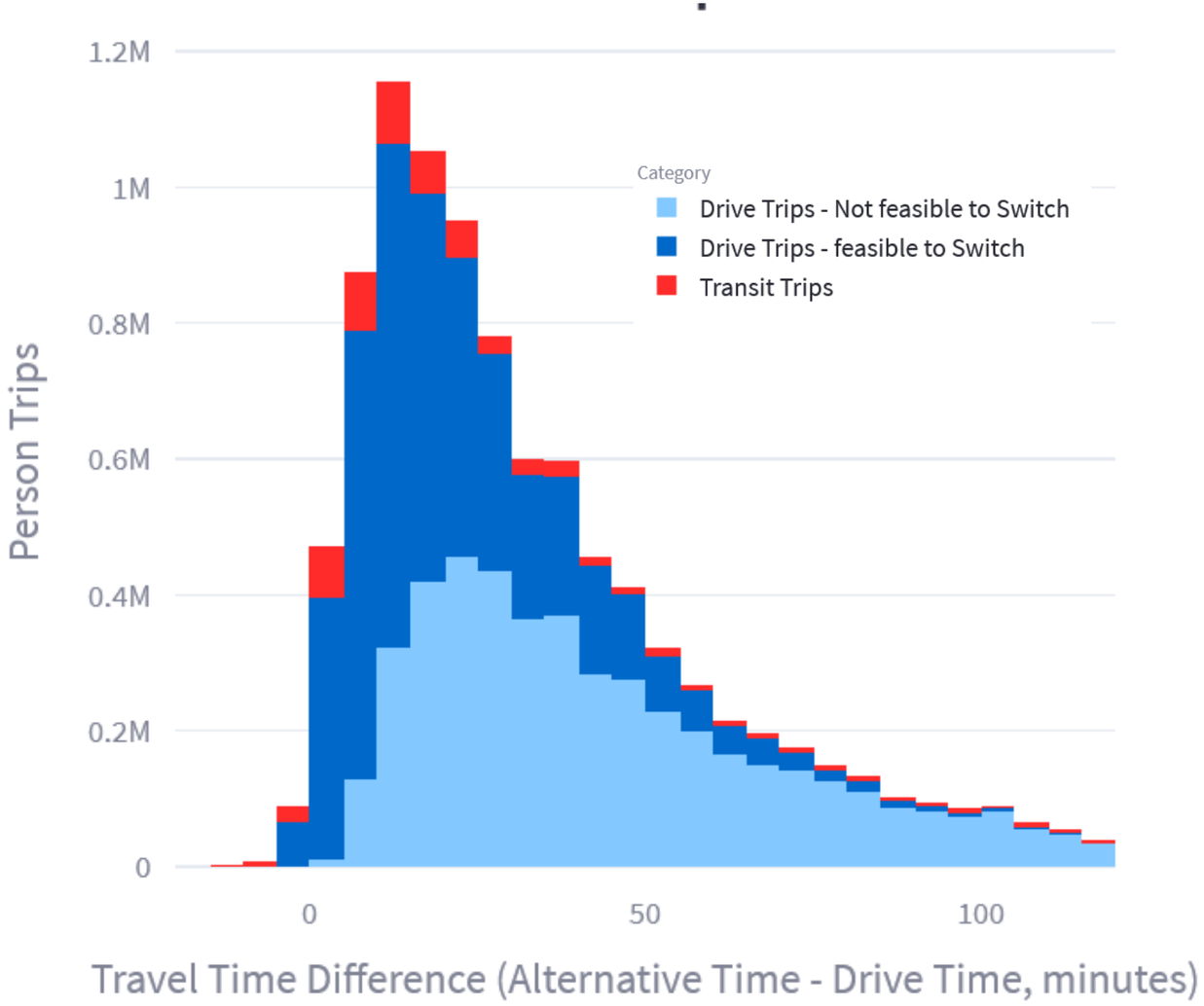
	Biking is within 5 minutes of driving	Biking is within 15 minutes of driving	Biking is within 30 minutes of driving
% of Car Trips	5.9%	16.7%	25.6%
% of VMT	0.8%	3.4%	7.7%

SCENARIO: Trips that Could Feasibly Switch

	Biking is within 5 minutes of driving	Biking is within 15 minutes of driving	Biking is within 30 minutes of driving
% of Car Trips	23.0%	38.9%	46.7%
% of VMT	4.0%	11.0%	17.4%

Transit Scenario: Double Frequency of All Routes

Travel Time Difference Between Transit and Driving



BASE: Trips that Could Feasibly Switch

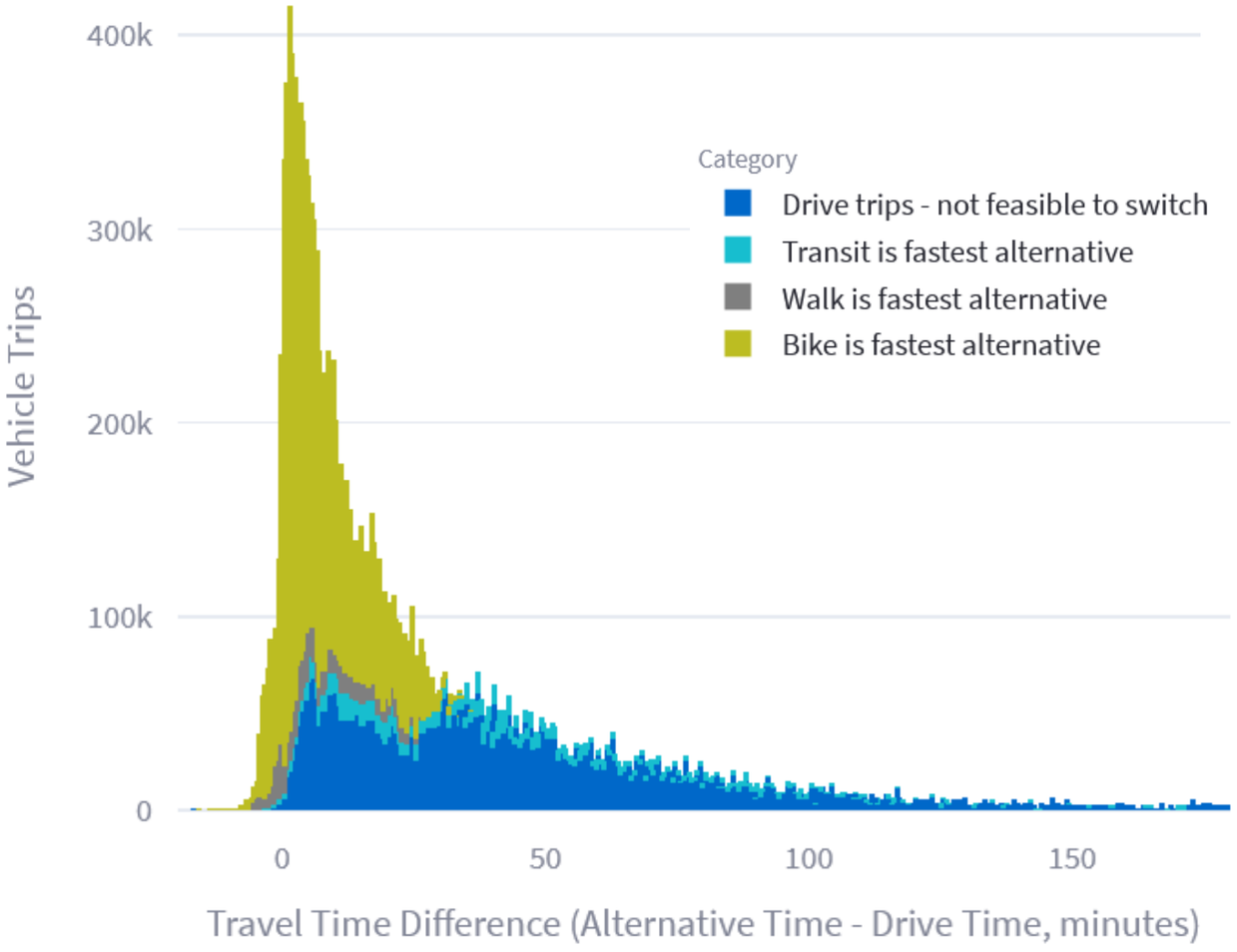
	Transit is within 5 minutes of driving	Transit is within 15 minutes of driving	Transit is within 30 minutes of driving
% of Car Trips	1.4%	5.9%	11.2%
% of VMT	0.2%	1.2%	3.5%

SCENARIO: Trips that Could Feasibly Switch

	Transit is within 5 minutes of driving	Transit is within 15 minutes of driving	Transit is within 30 minutes of driving
% of Car Trips	2.1%	8.1%	13.7%
% of VMT	0.3%	1.8%	4.7%

Scenario: All of the Above

Travel Time Difference Between Alternative and Driving



BASE: Trips that Could Feasibly Switch

	Alternatve is within 5 minutes of driving	Alternatve is within 15 minutes of driving	Alternatve is within 30 minutes of driving
% of Car Trips	10.2%	25.2%	37.1%
% of VMT	1.1%	4.5%	10.1%

SCENARIO: Trips that Could Feasibly Switch

	Alternative is within 5 minutes of driving	Alternative is within 15 minutes of driving	Alternative is within 30 minutes of driving
% of Car Trips	25.0%	43.3%	53.4%
% of VMT	4.2%	11.8%	19.4%

Questions?

Jonathan Ehrlich
Jonathan.Ehrlich@metc.state.mn.us