# Guidance on Considering CAVs in Travel Demand Models

**2025 Modeling Mobility Conference**

**Si Shi | September 2025**

SYSTEMS PLANNING & ANALYSIS

# Acknowledgements


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# Research Goals

- Investigate the consideration of Connected and Automated Vehicles (CAVs) in Travel Demand Models (TDMs) supported with case study analysis.
- Develop guidelines that NCDOT and MPOs can use to inform the modification and application of TDMs to include CAVs.

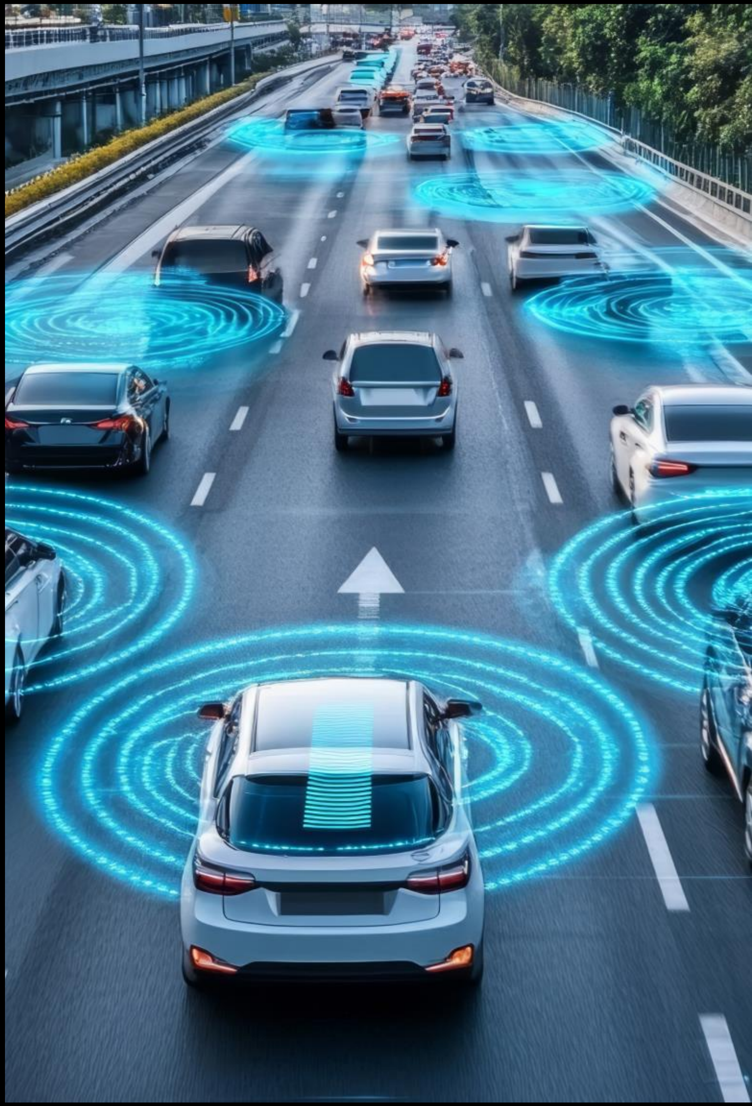
Approach

Case Study Evaluation

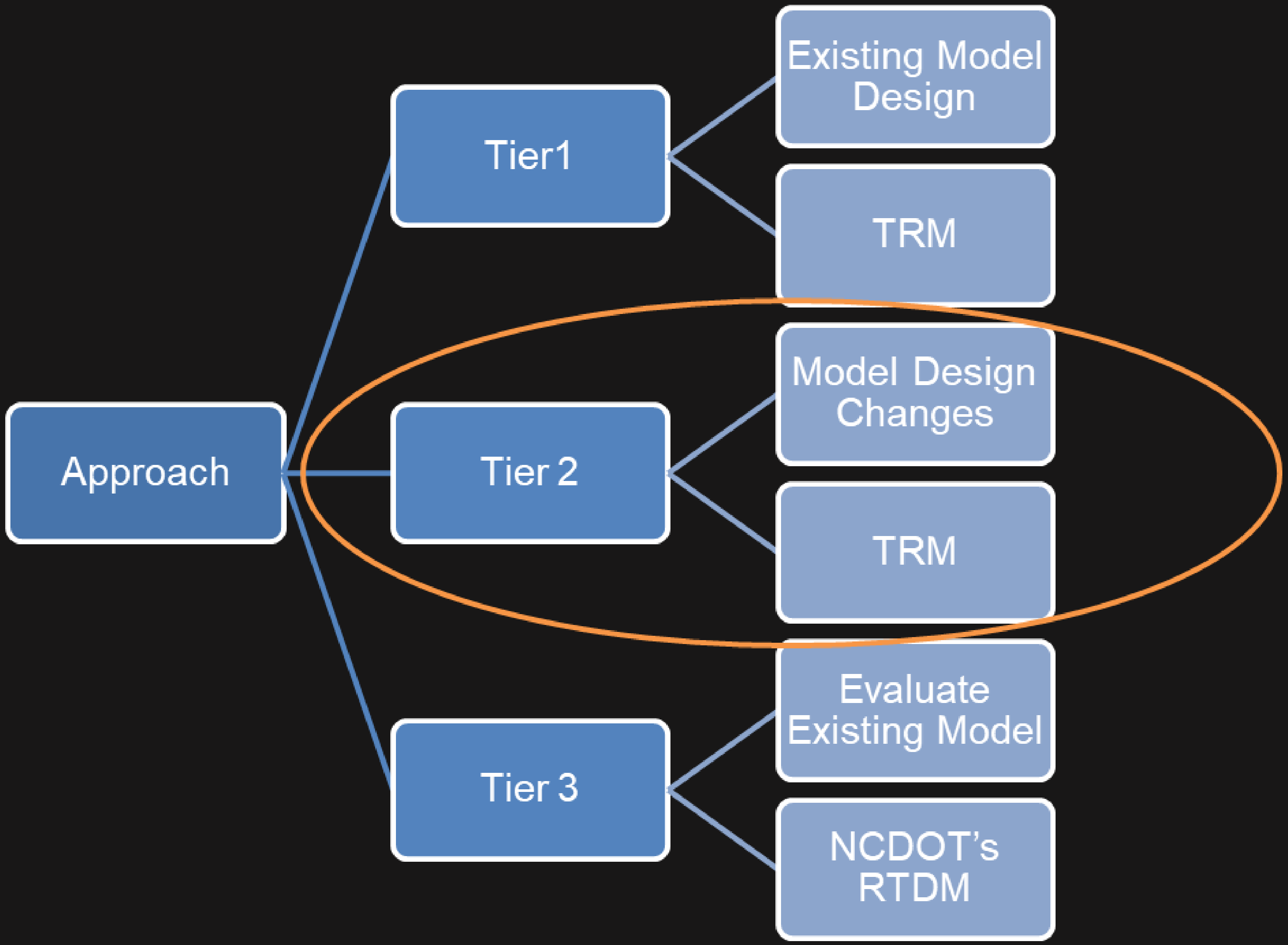
Findings & Recommendations

**Q & A**

# Agenda

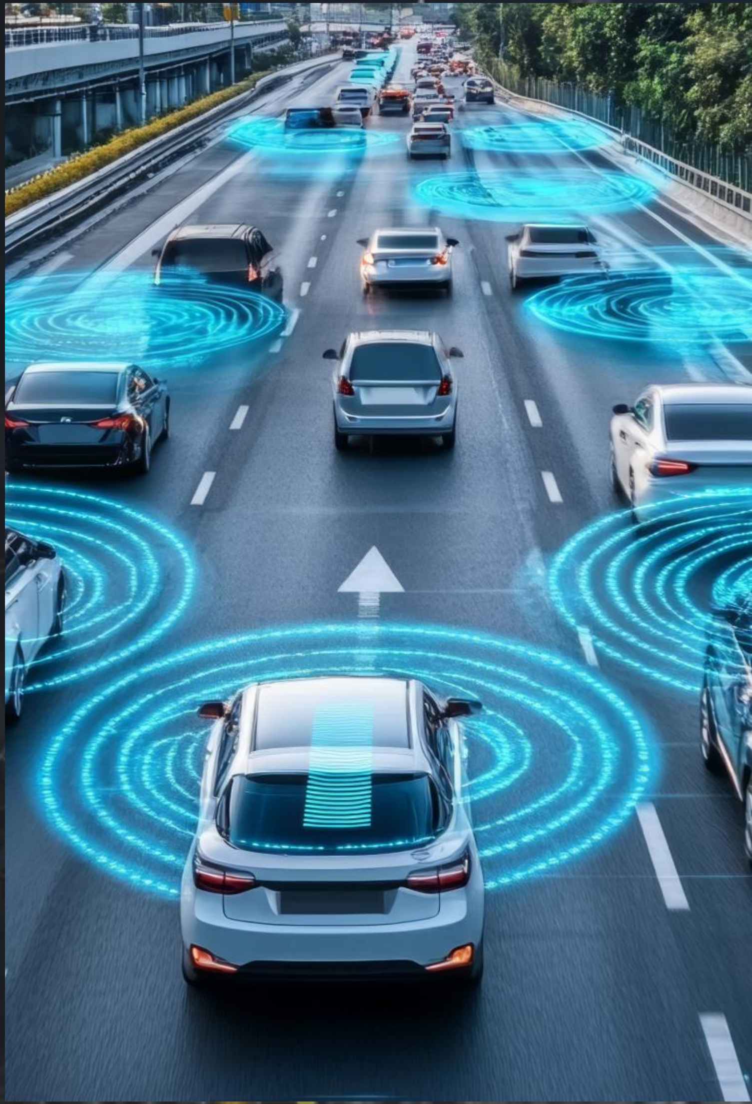


# Multi-Tiered Approach

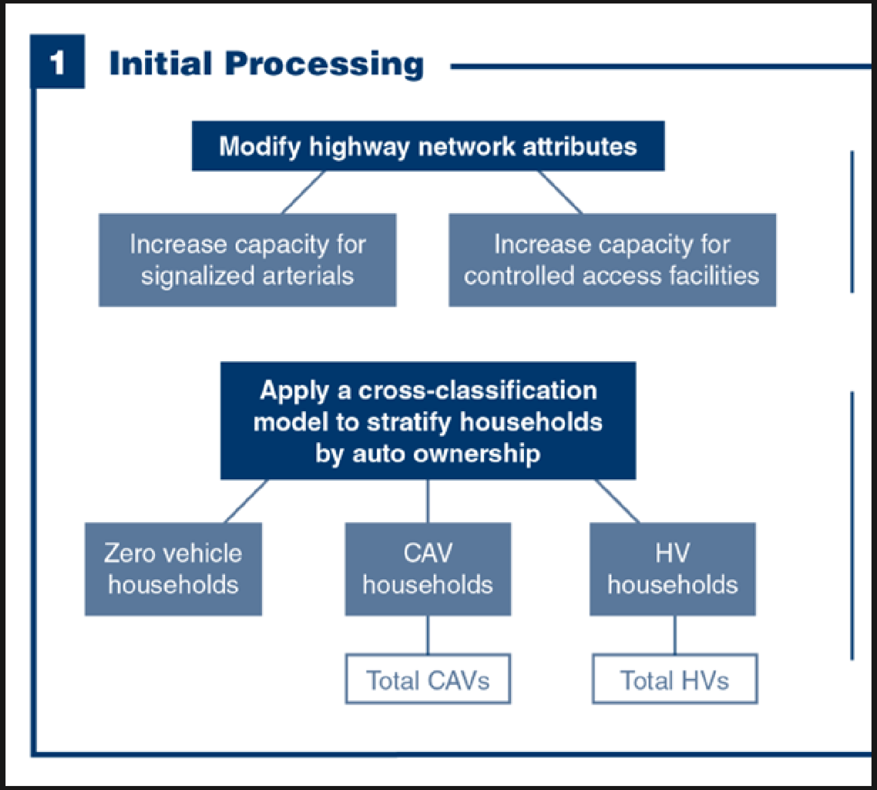


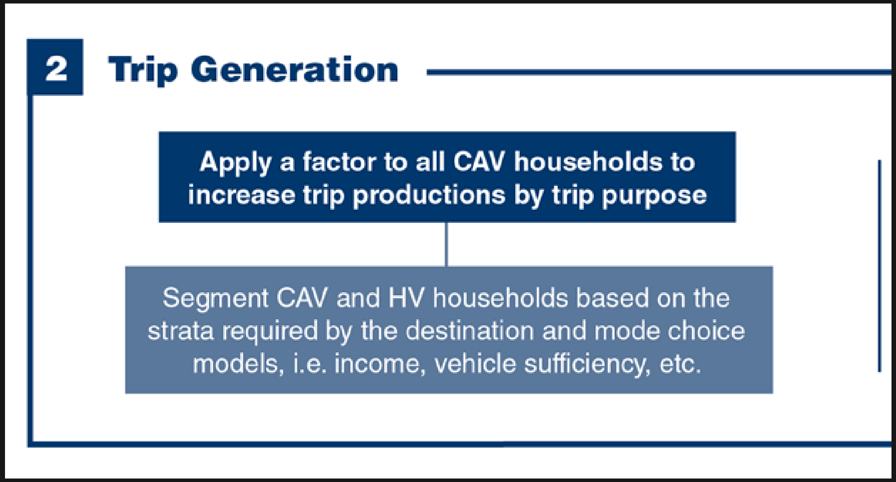
Model Design Changes

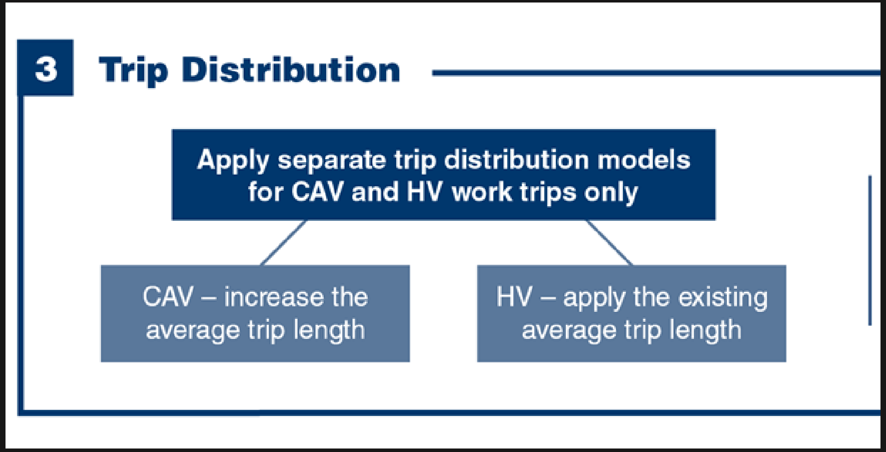
# Approach: Tier 2

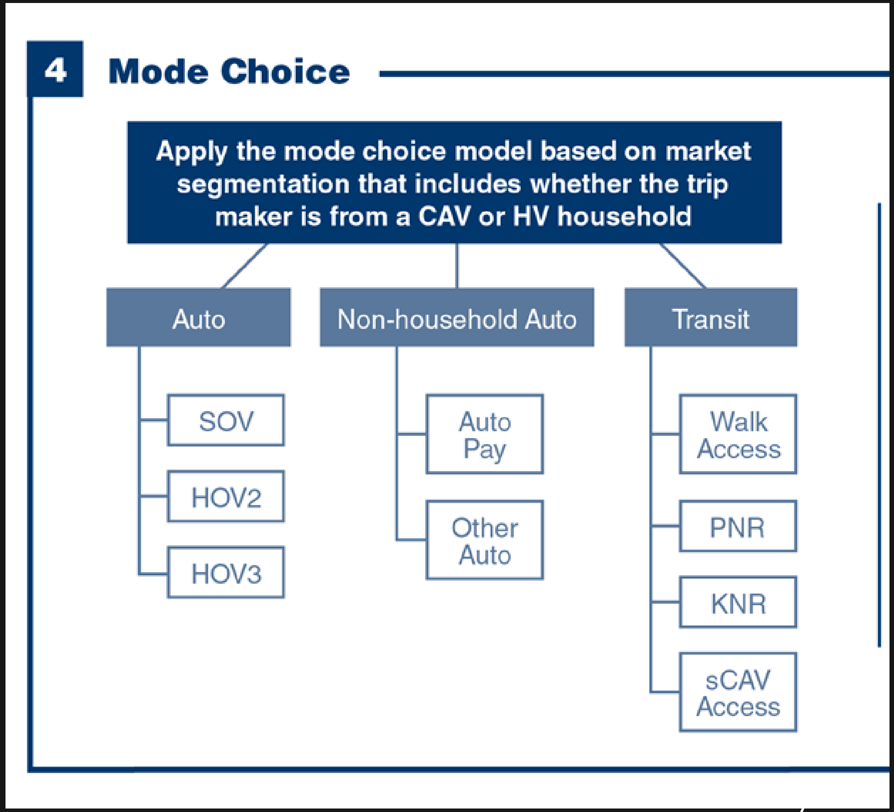


# Conceptual Framework



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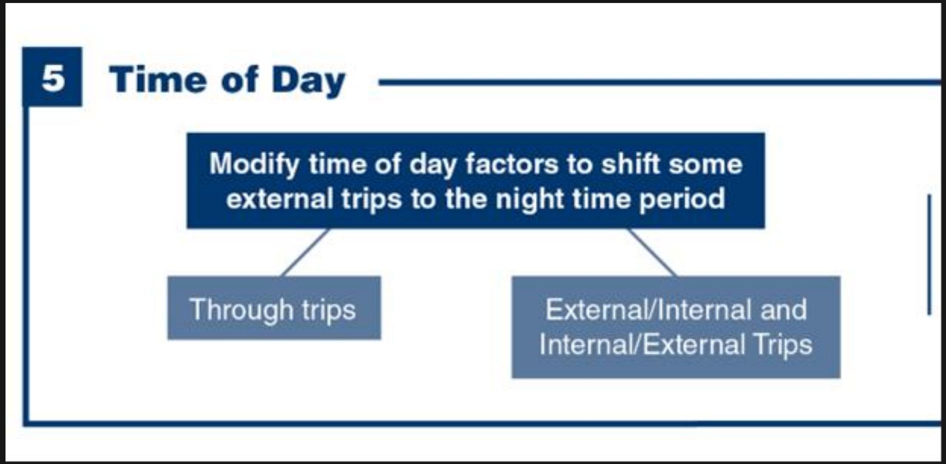
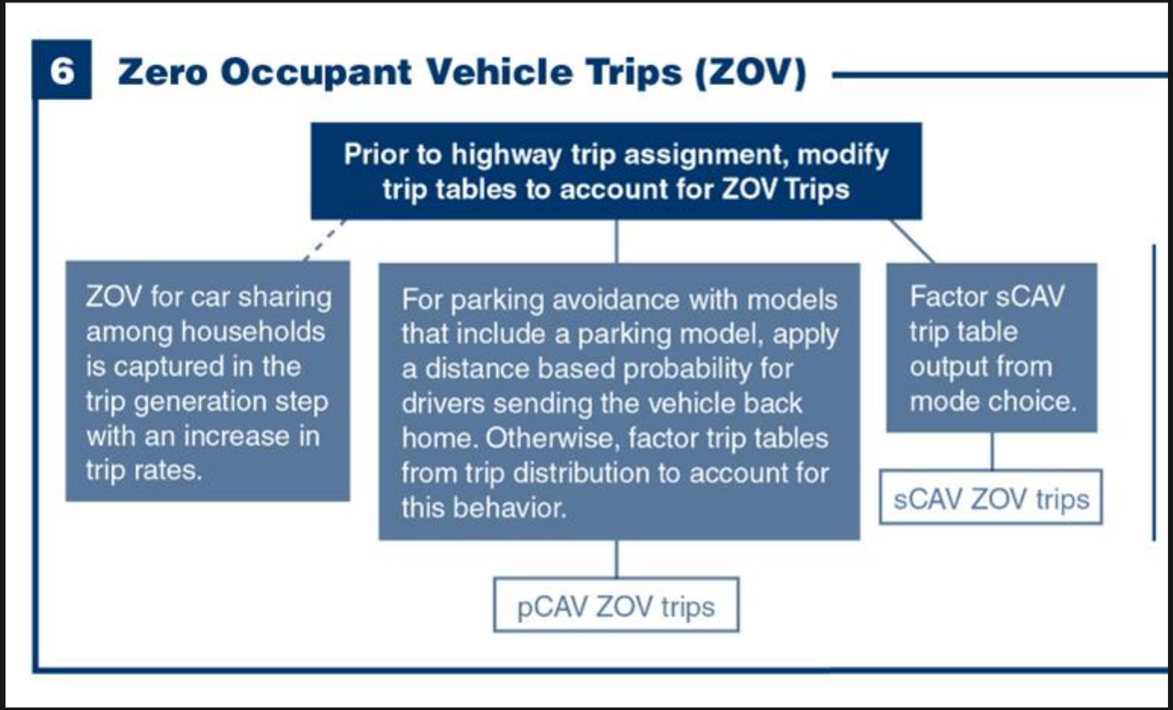


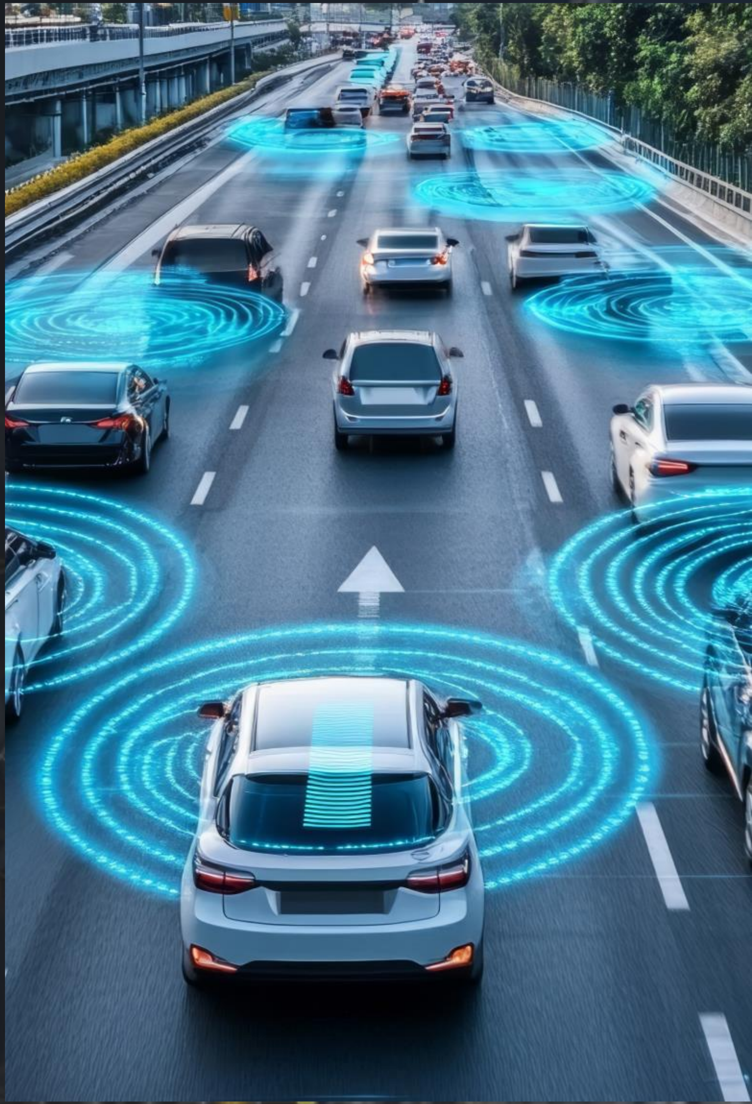



# Model Design and Scenario Development

| Model Step | Model Adjustments | | Medium High (70%) | High (95%) |
|---|---|---|---|---|
| | Category | Sub-category | | |
| Initial Processing | Higher capacity | Signalized arterial | 40% | 70% |
| | | Controlled access | 47% | 77% |
| | Add CAV ownership | Apply cross-classification model | MPR = 70% | MPR = 95% |
| Trip Generation | Increase trip rates | All purposes | 9% | 15% |
| Time of Day | More EE during night | EE - SUT/MUT | 30% | 50% |
| | | EE - Auto | 15% | 25% |
| | More IE/EI during night | IE/EI | 2% | 8% |
| ZOV Trips | Parking Avoidance | Trip distance > 20 miles | 0% | 0% |
| | | Trip distance 15 -20 miles | 10% | 10% |
| | | Trip distance 10 - 15 miles | 20% | 20% |
| | | Trip distance 5 - 10 miles | 35% | 35% |
| | | Trip distance <= 5 miles | 50% | 50% |
| | SAV empty miles | Apply growth factor to SAV trip table | 67% | 50% |
| Mode Choice | Auto pay - SAV | Discount fare coefficient | -0.40 | -60% |
| | SAV transit access | Discount coefficient for drive access | -60% | -65% |
| | Decreased VOT | Discount VOT coefficient (except K12) | -60% | -65% |
| Trip Distribution | Longer trip distance | Discount travel time for work | 31% or 11%* | 14% or 40%* |
| | | Discount travel time for social/recreational | 27% | 44% |
| Airport | Add CAV return home parking trips | Assume MPR% of airport trips will use CAV and those will go back home to park | 70% | 95% |

* *Trip purpose specific*

# Case Study Evaluation



# Performance Measures

## System Level

Average trip length by purpose

Vehicle miles traveled (total and congested)

Delay

## Project Level

Demand

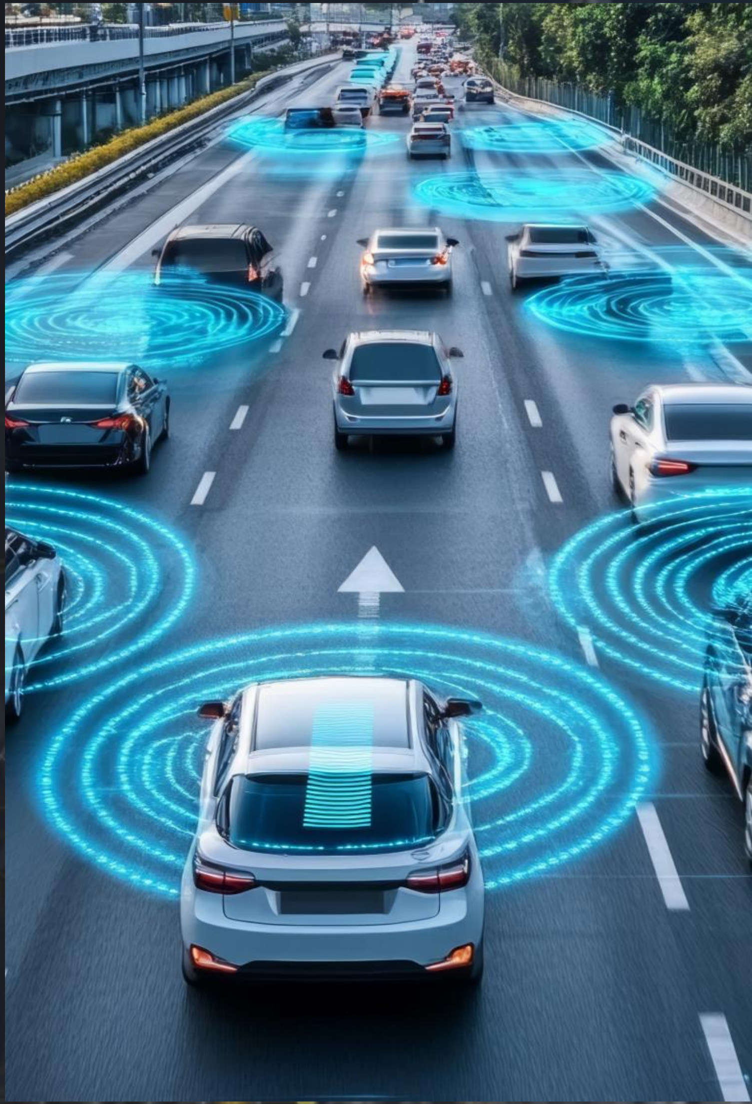
Capacity

Demand-to-capacity ratio

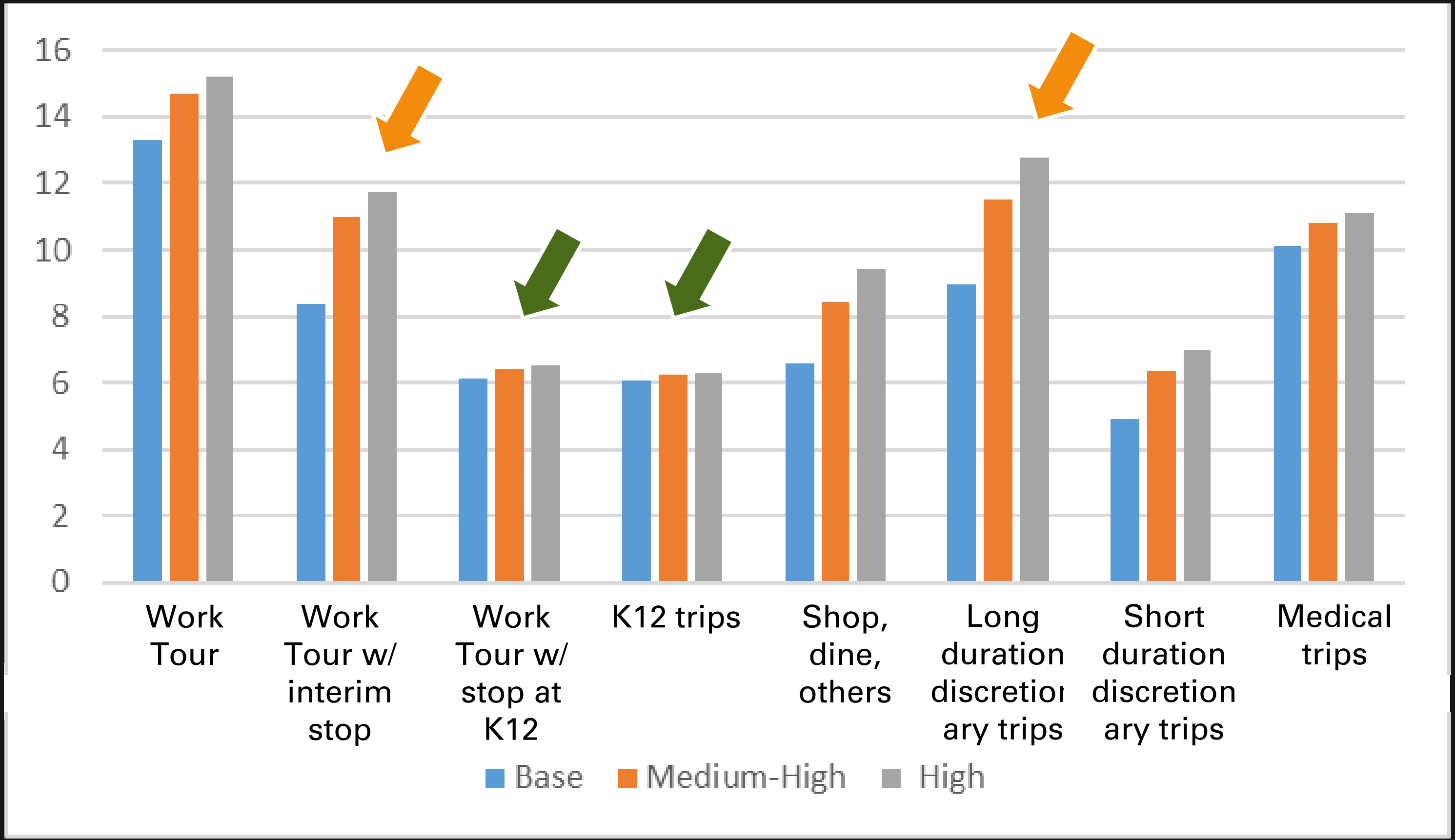
Daily delay

Daily delay per mile

# Case Study Evaluation - System Level Metrics

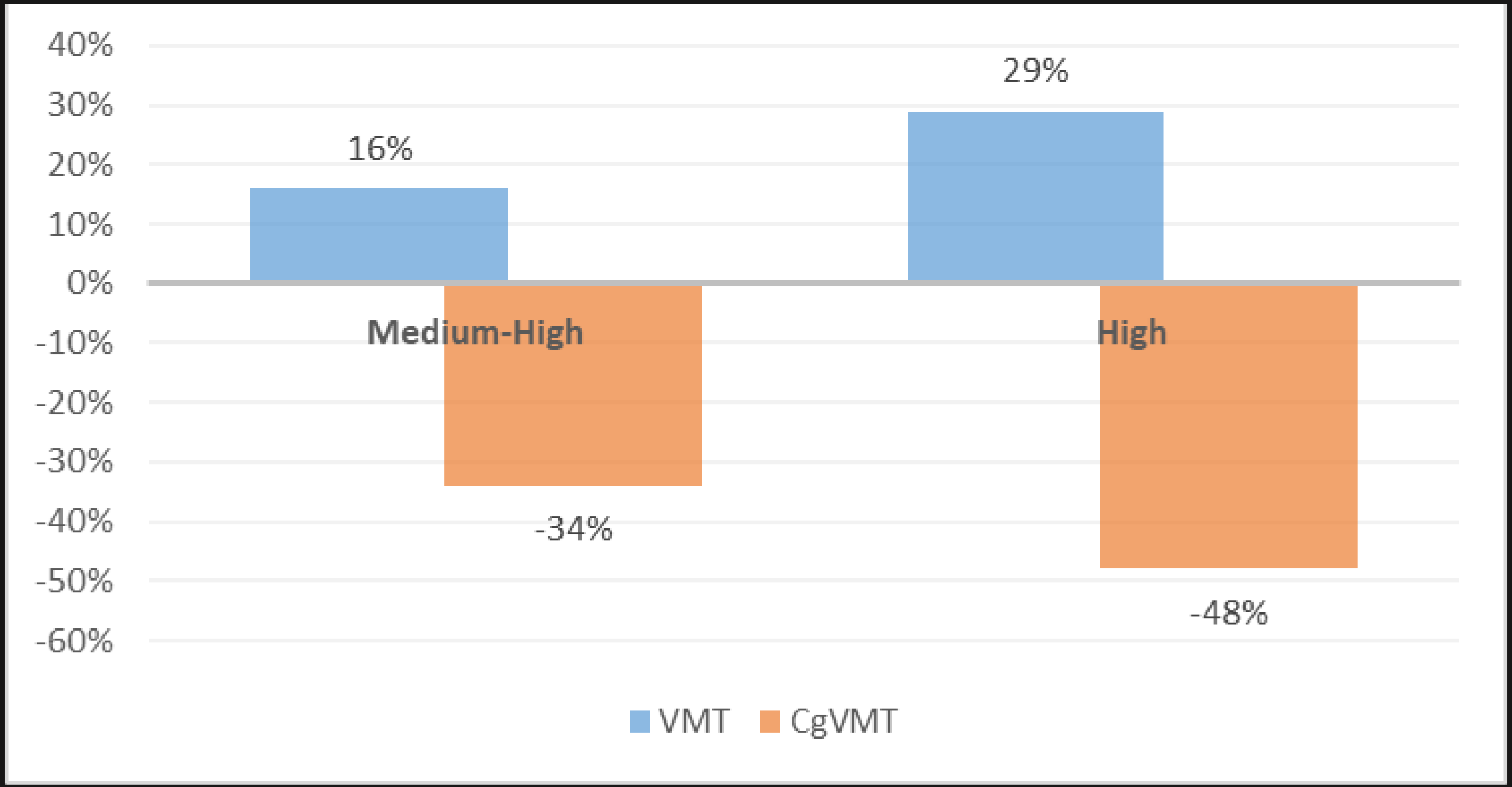


# Change in Avg. Trip Length by Purpose



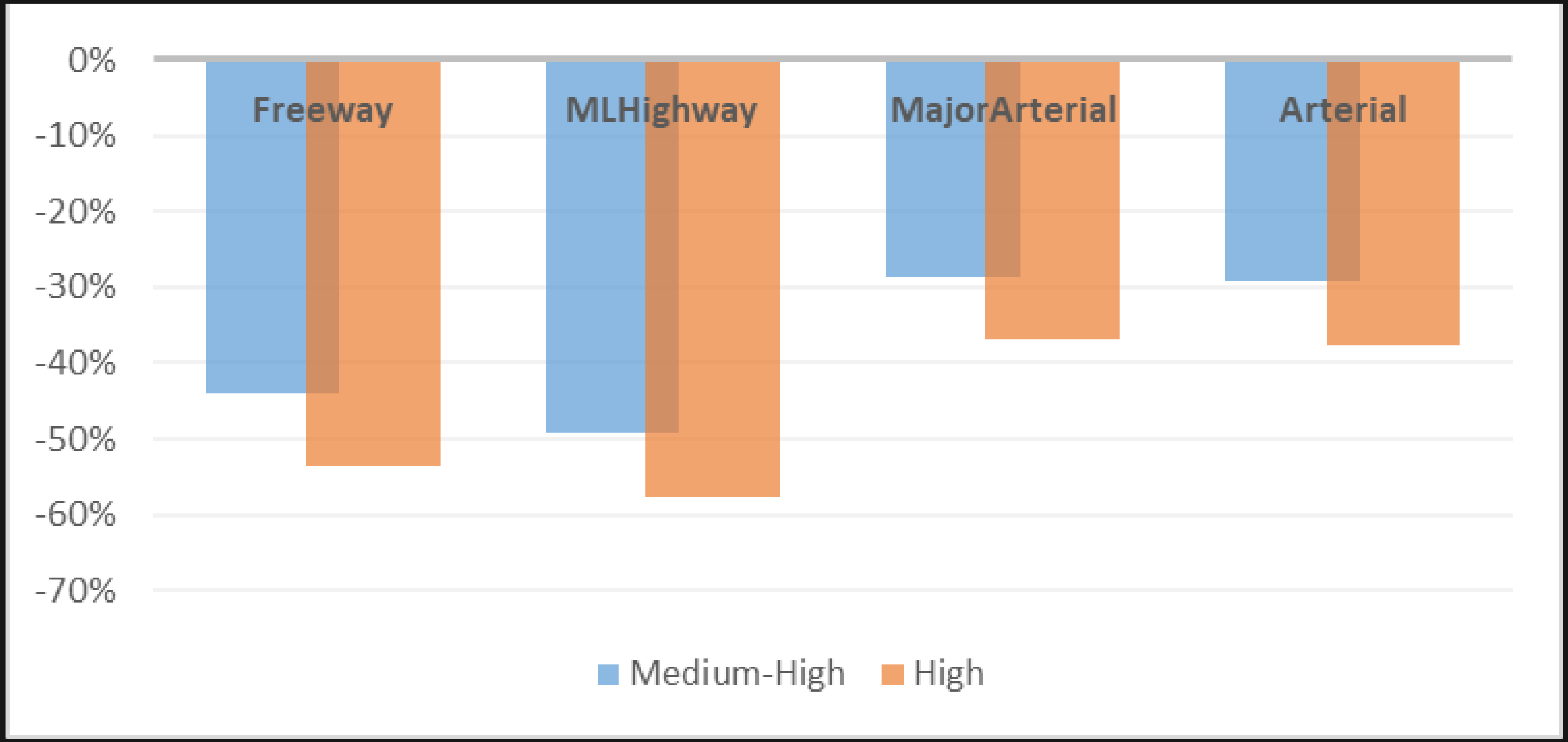

- CAVs lead to a longer average trip length (mi) for all trip purposes.
- The biggest impact is for interim stops on a work tour and long duration discretionary trips, reflecting the influence of the changes in the asserted coefficients.
- K-12 trips are least impacted by CAVs.

# Change in Peak Hour VMT




- CAVs increase VMT with greater increases for the high scenario.
- Overall VMT increases, but congested VMT decreases.
- This is a direct reflection of the capacity benefits resulting from CAVs.

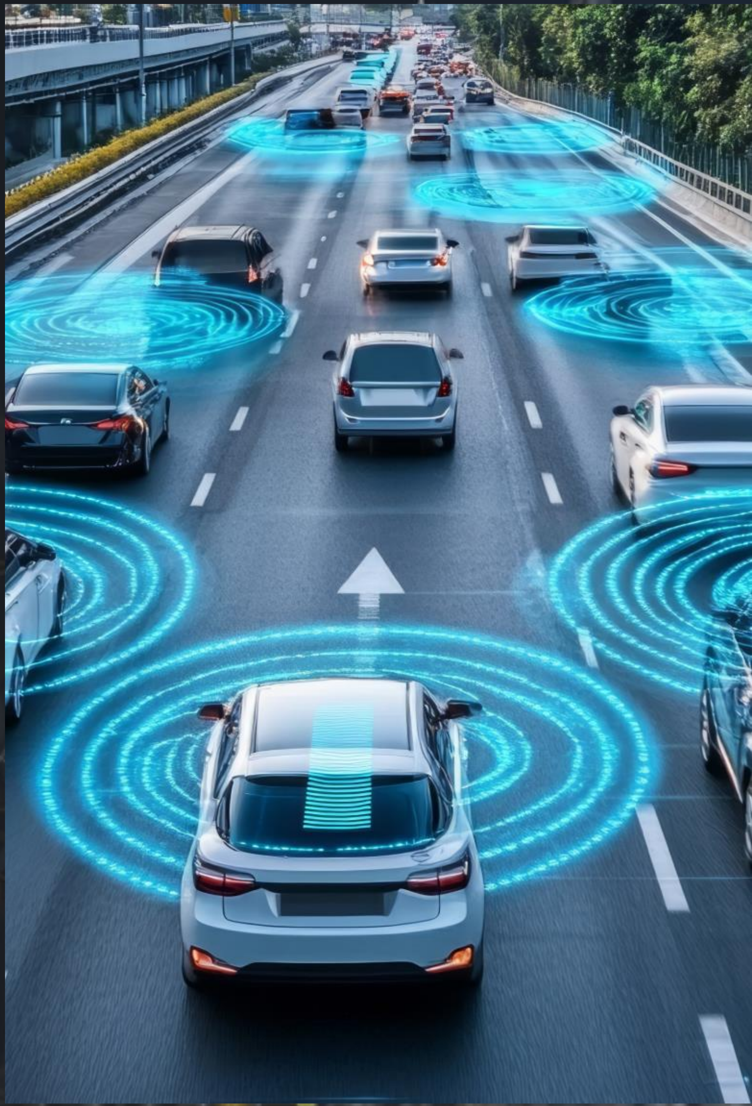
# Change in Daily Delay by Facility Type




- Delay decreases for all facility types, with the largest reductions in delay for freeways and multilane highways.
- This is a direct reflection of the capacity benefits resulting from CAVs.

# Case Study Evaluation – Project Level Metrics

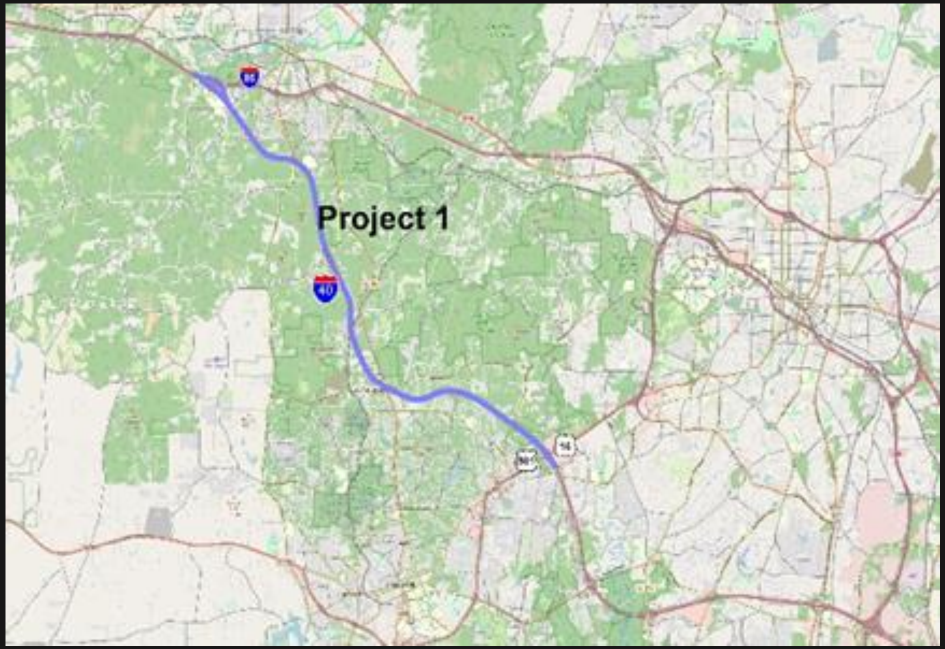
Assumption: Level 5 automation



# I-40 Widening

| | Build No CAV | Build MH CAV | No Build MH CAV |
|---|---|---|---|
| Capacity | 12,329 | 18,124 | 12,083 |
| Demand (peak hour) | 8,473 | 10,165 | 9,891 |
| D/C | 0.69 | 0.56 | 0.82 |

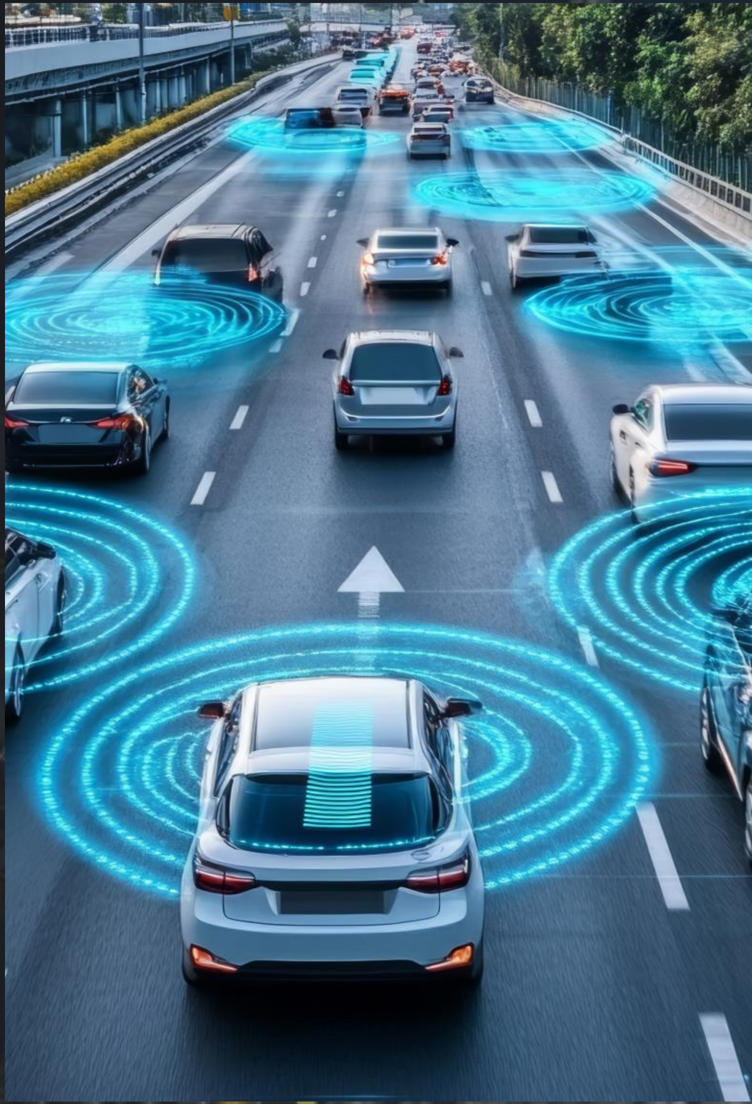
| | | |
|---|---|---|
| Cost of delay per mile with project but no CAVs | $ | 114 |
| Cost of delay per mile with project and CAVs | $ | 31 |
| Savings | $ | 82 |
| Cost of delay per mile with CAVs but no project | $ | 139 |
| Loss | $ | (26) |




- CAVs offer benefits in both the build and no build scenario.
- The benefits of CAVs are like those seen when we build the project. Depending on the target D/C ratio, this could suggest delaying the project, but the presence of CAVs do not overcome the need for the project at MH adoption levels.

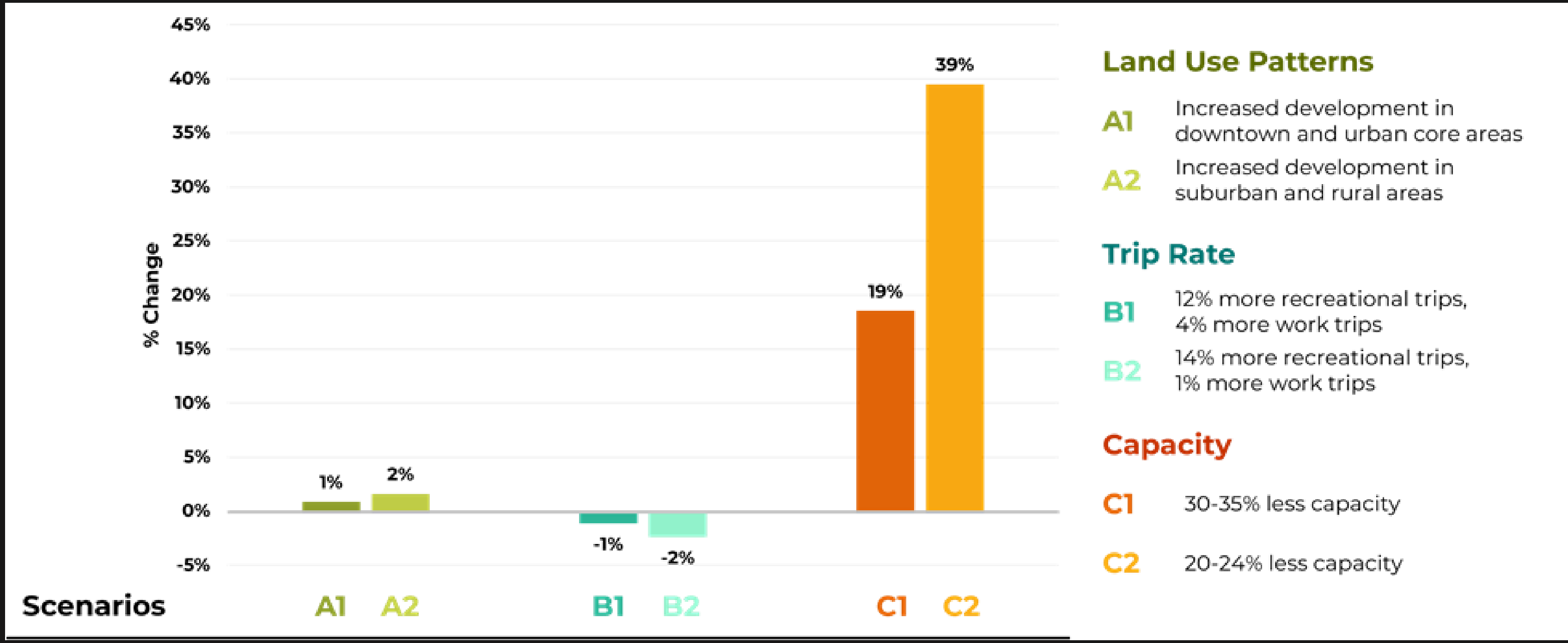
# Case Study Evaluation

Sensitivity Testing



# I-40 Widening

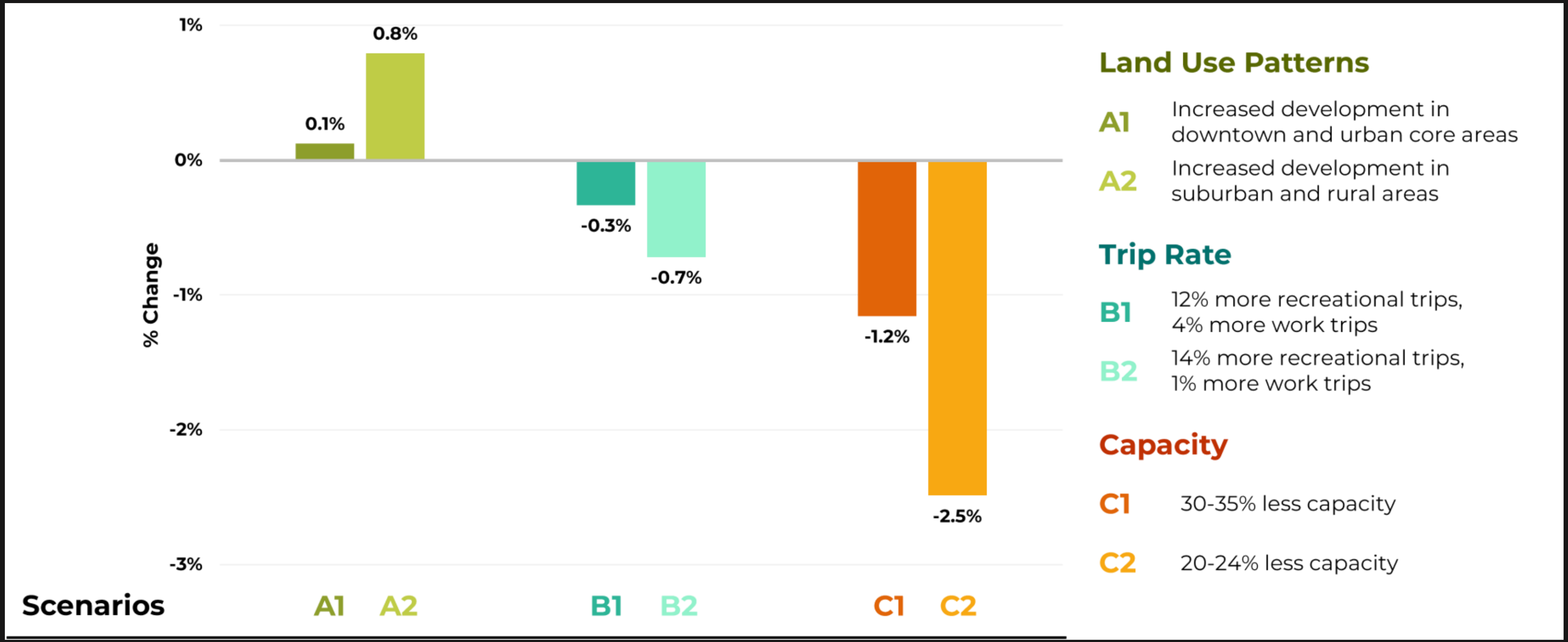
## Range of Uncertainty as Measured by Delay




- The effect on system-level delay to changes in land use patterns and trip making is very small.
- The capacity variable shows a higher degree of risk with a 40% higher measure of systems delay for the cautious capacity values.

# I-40 Widening

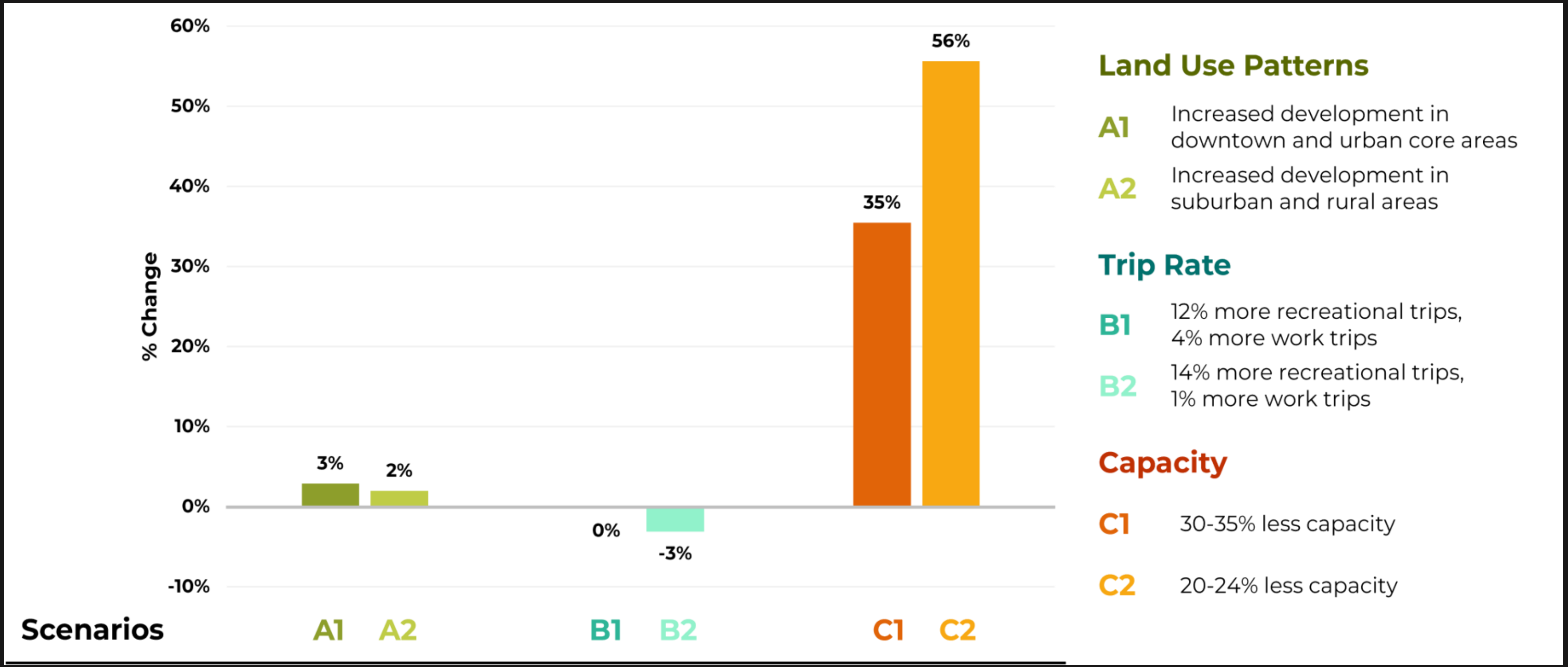
## Range of Uncertainty as Measured by Peak VMT




- The effect on system level peak period VMT to changes in all variables is very small, suggesting lower levels of risk in the asserted values of these variables through the lens of systems level VMT.

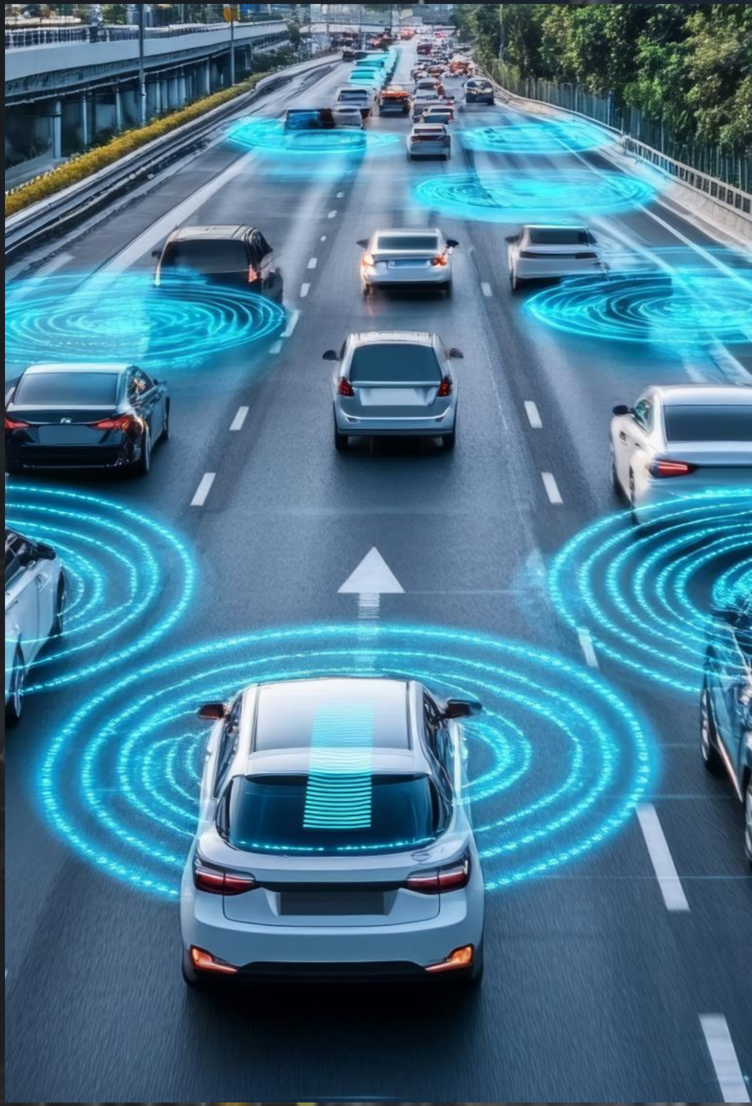
# I-40 Widening

## Range of Uncertainty as Measured by Congested VMT




- Peak period congested VMT shows a similar pattern as the daily delay.
- Land use patterns and trip making having a small impact on congested VMT.
- The degree of risk for the capacity variable is much higher.

# Findings and Recommendations



# Findings

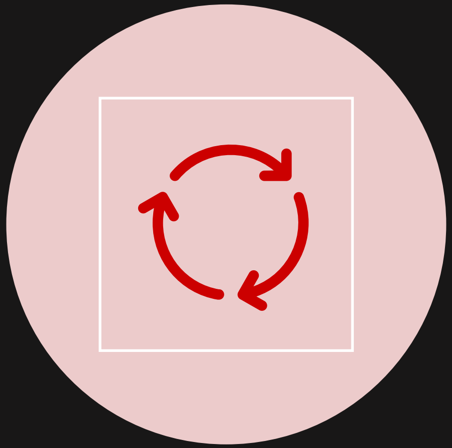
Significant contribution to the use of travel models in a strategic scenario planning context to better understand the potential effects of CAVs.

The tiered approach lays a solid groundwork for changes that could be implemented immediately as well as those that require more time and effort but offer more behavioral realism.

This work informed the development of guidelines that can be used to incorporate findings into the models to better capture the effects of CAVs on long range transportation plans, project prioritization and project level traffic forecasts.

# Recommendations

Immediately incorporate the consideration of CAVs in traffic forecasts and long-range transportation plans.



Incorporate model design changes for CAVs in future model development efforts.

Implement a regular practice of risk and uncertainty analysis.

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DEPARTMENT OF TRANSPORTATION

ITRE
Institute for Transportation
Research and Education

Caliper

# Thank You!