WSDOT Toll Equity Research

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Background

- WSDOT uses tolling as a key mechanism for managing demand on
  - I-405,
  - SR 167,
  - SR 99, and
  - SR 520.

- Tolls also help fund megaprojects such as SR 16 (and soon SR 509, SR 167, and I-405.)

- While tolls are excellent user fees and shift cost burden to the users of those facilities, there are concerns about their impact on vulnerable populations

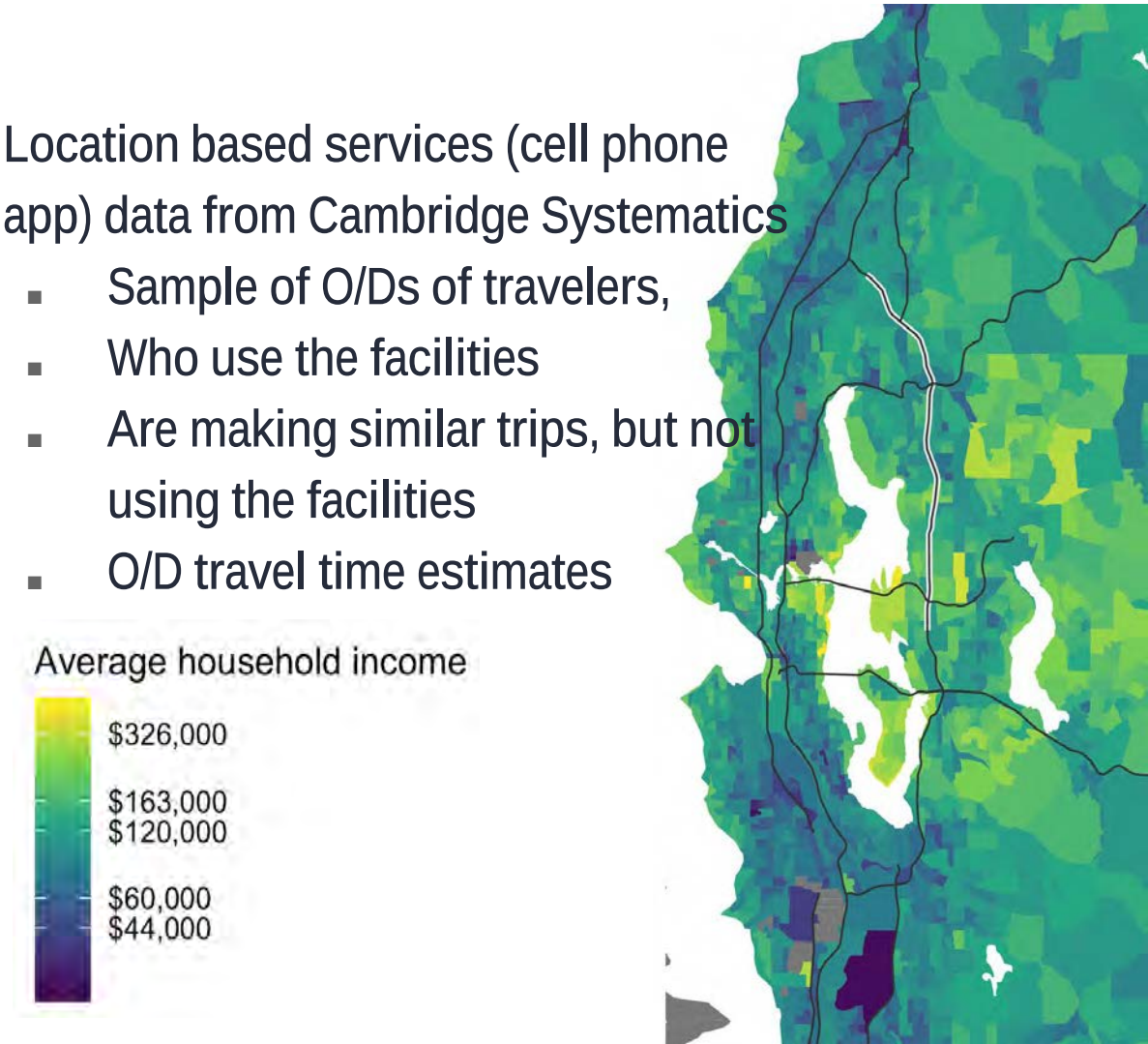
WSDOT Toll Equity Project Objectives

- Provide additional insight into the equity of WSDOT's toll facilities
  - Who is using WSDOT's toll facilities?
    - Who is NOT using the facilities?
  - How does income effect that usage?
  - Provide a baseline against which trends can be measured, given possible policy changes, such as a low-income household toll discount

We are using five major data sets

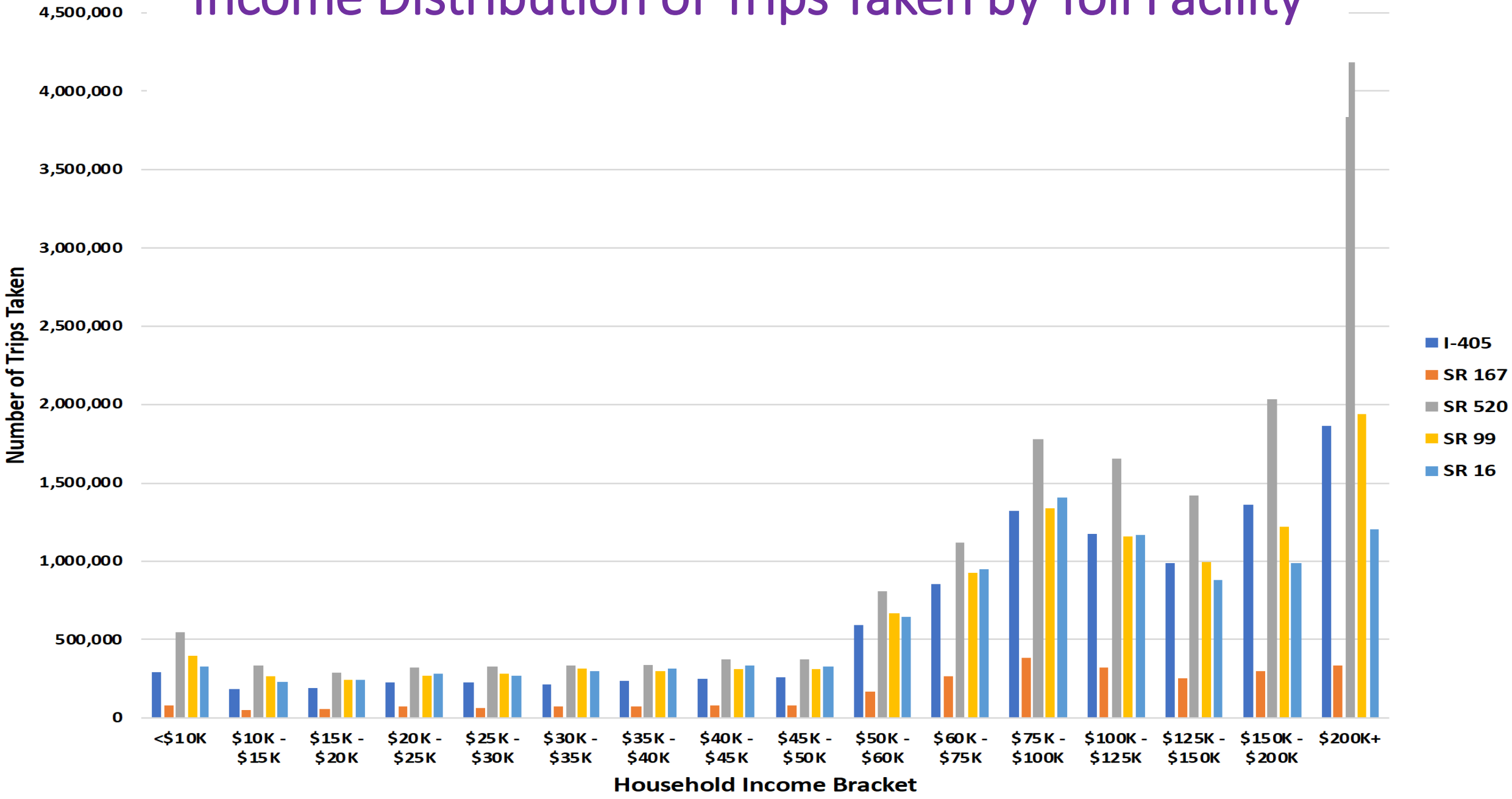
- WSDOT Toll transactions
  - Who pays, how much, for what trip, when
- WSDOT Billing information
  - Where vehicles are registered (by census block group)
- WSDOT roadway performance data
  - Travel time savings associated with HOT trips on SR 167 and I-405
- Census data
  - The demographics associated with each census block group

- Location based services (cell phone app) data from Cambridge Systematics
  - Sample of O/Ds of travelers,
  - Who use the facilities
  - Are making similar trips, but not using the facilities
  - O/D travel time estimates

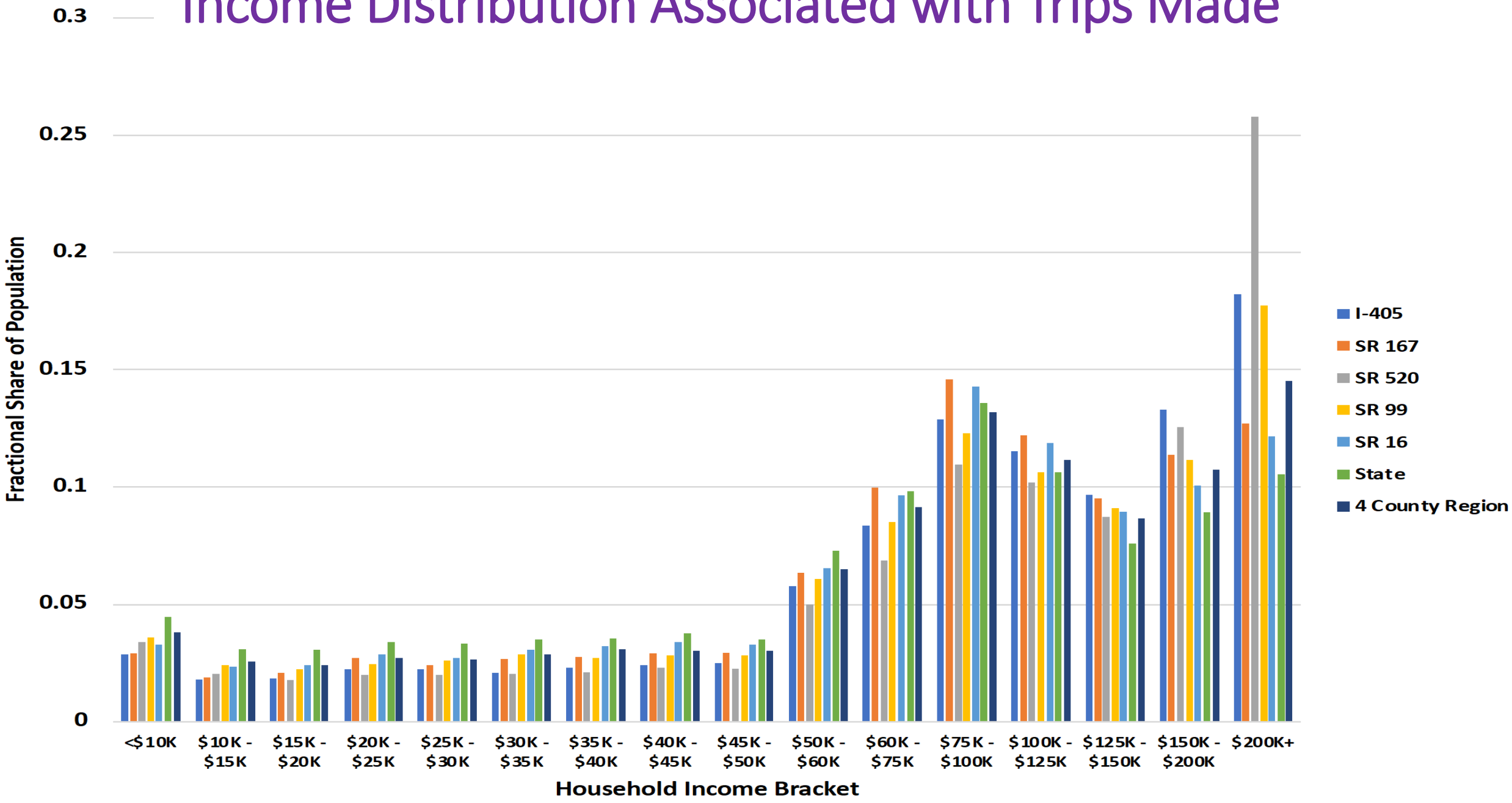


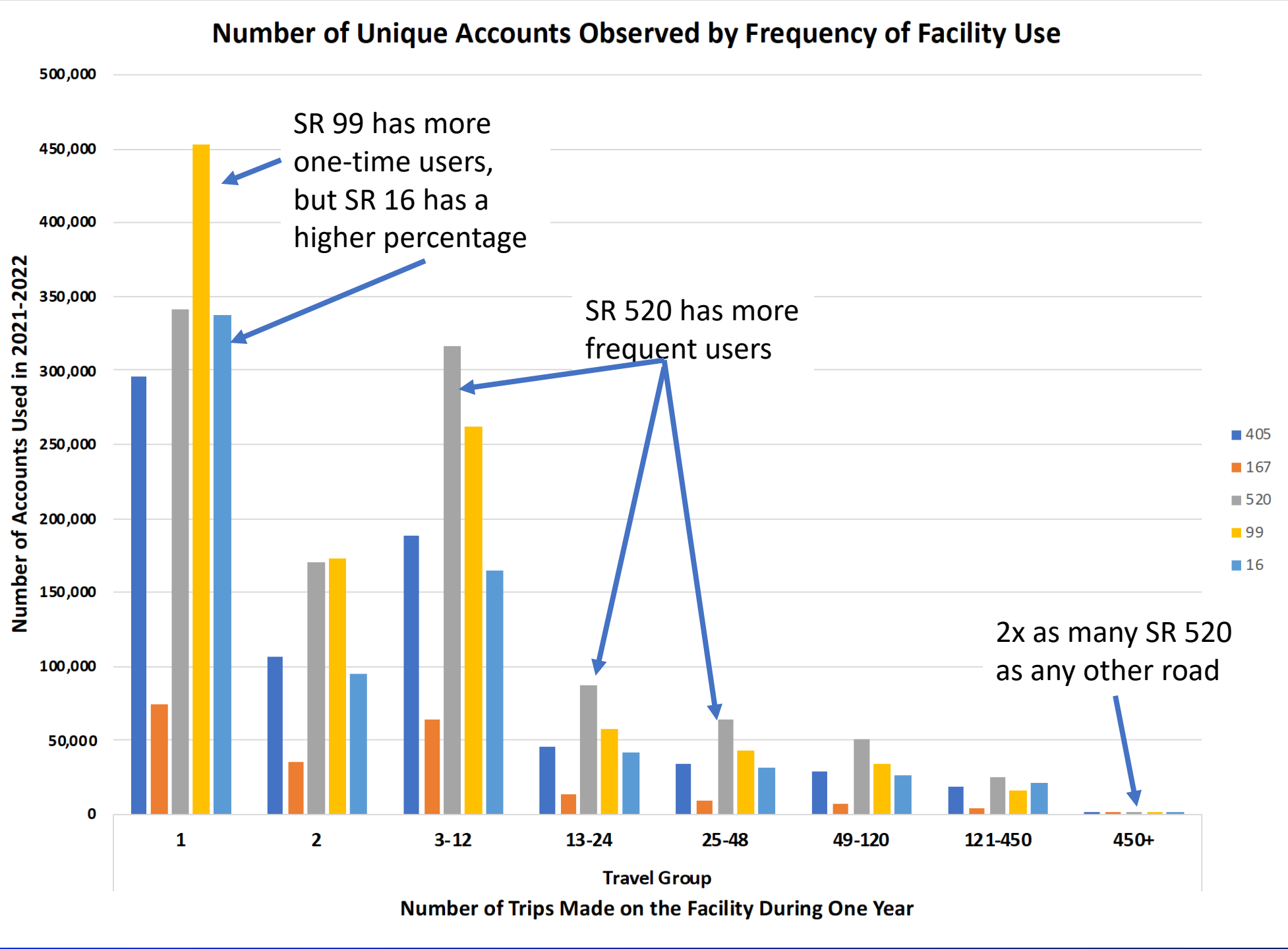
WSDOT Toll Facilities Being Studied

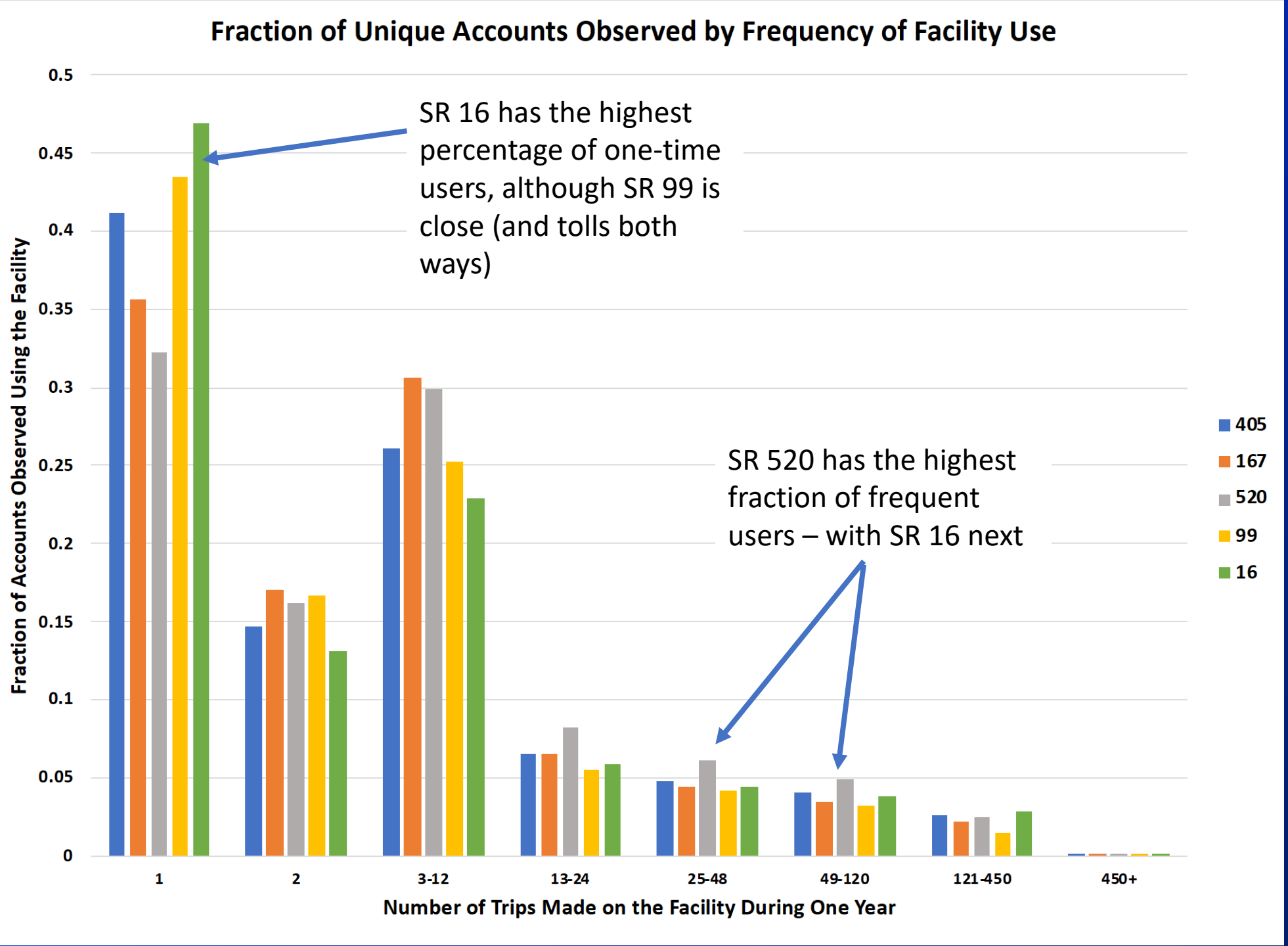
Income Distribution of Trips Taken by Toll Facility



Income Distribution Associated with Trips Made



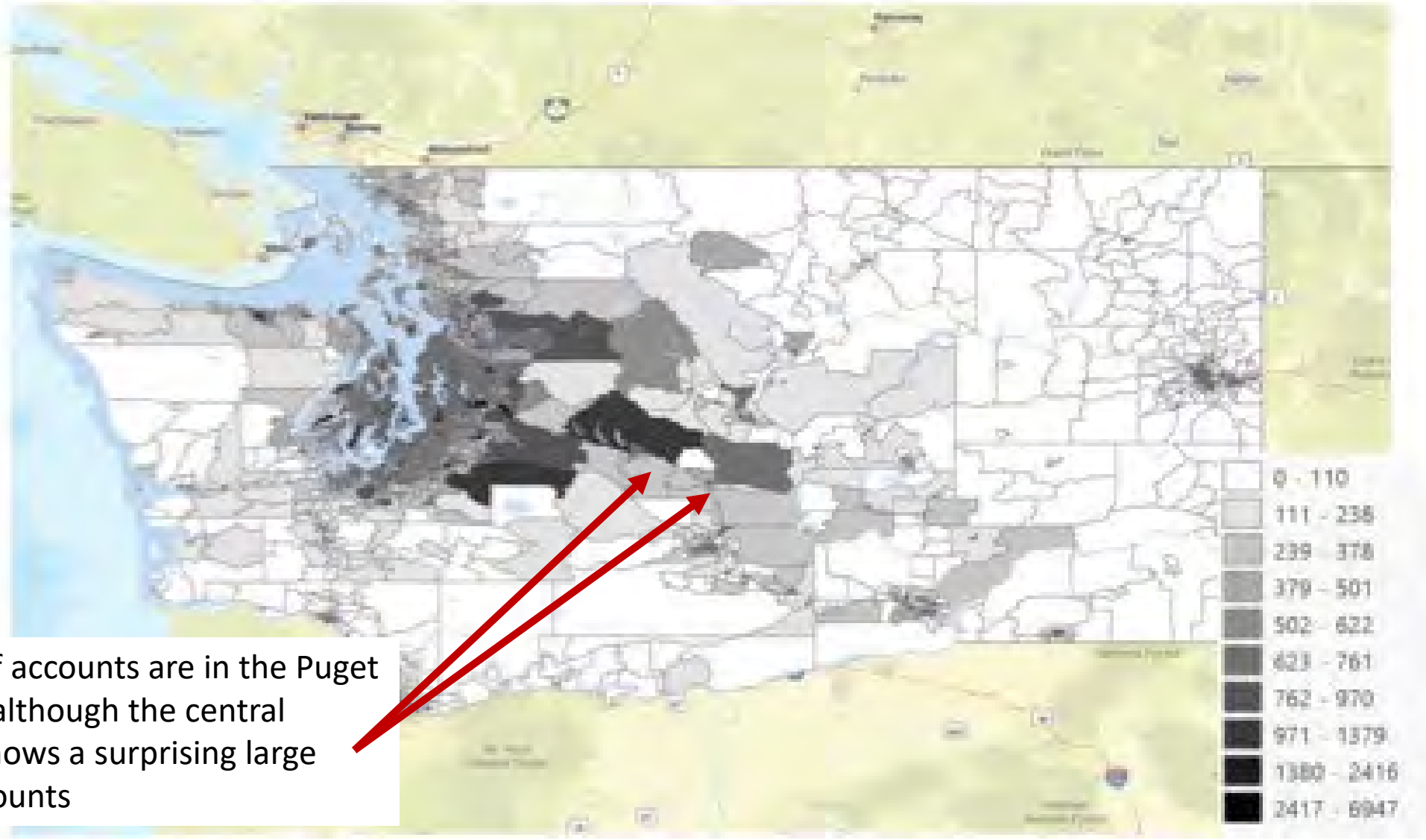

Number of Unique Accounts Observed by Frequency of Facility Use
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
Number of Accounts Used in 2021-2022
SR 99 has more one-time users, but SR 16 has a higher percentage
SR 520 has more frequent users
2x as many SR 520 as any other road
405
167
520
99
16
1
2
3-12
13-24
25-48
49-120
121-450
450+
Travel Group
Number of Trips Made on the Facility During One Year


Fraction of Unique Accounts Observed by Frequency of Facility Use
SR 16 has the highest percentage of one-time users, although SR 99 is close (and tolls both ways)
SR 520 has the highest fraction of frequent users – with SR 16 next
Fraction of Accounts Observed Using the Facility
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1
2
3-12
13-24
25-48
49-120
121-450
450+
Number of Trips Made on the Facility During One Year
405
167
520
99
16

Number of Observed Accounts

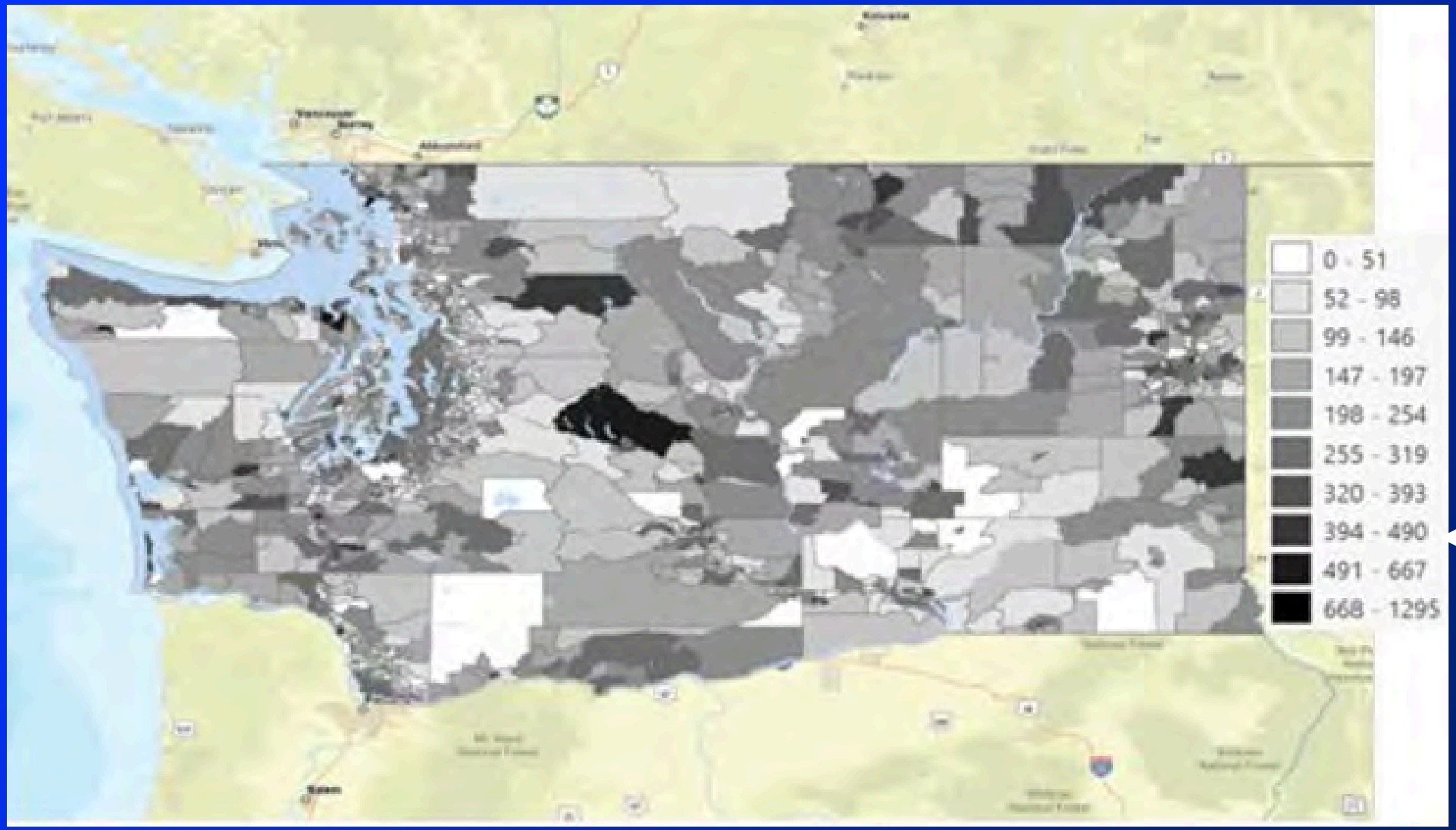
- SR 520 has the most observed accounts of the five facilities
  - But SR 99 has almost as many (1,060K vs 1,040K)
  - SR 99 has over 626K accounts the facility sees only once or twice a year.
    - More than 100K more than the next lowest road (SR 16)
- SR 520 has the largest number of accounts with very frequent use of the facility

Toll Accounts for the Entire State



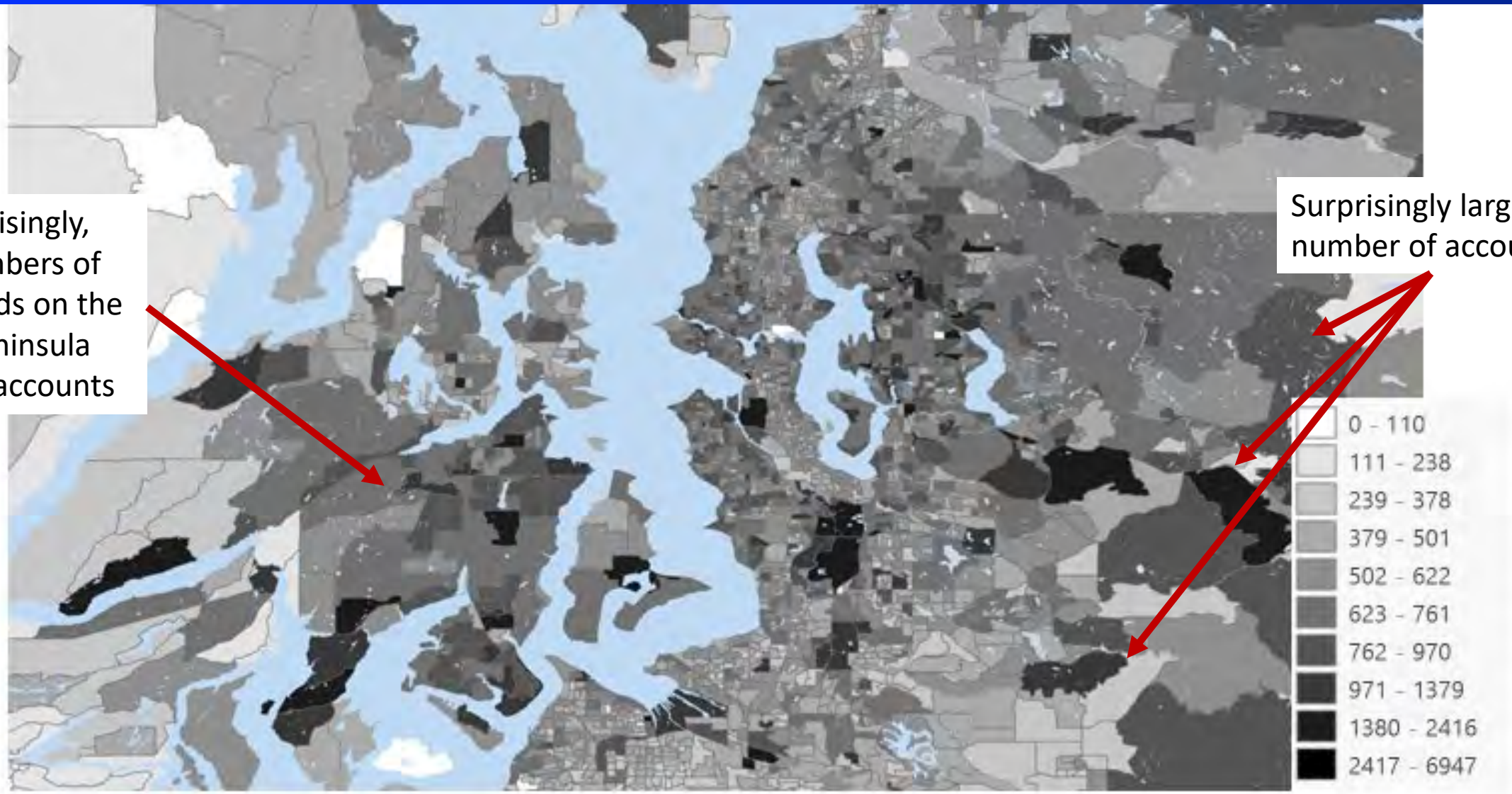
The majority of accounts are in the Puget Sound region, although the central I-90 corridor shows a surprising large number of accounts

Low-Income Households for the Entire State



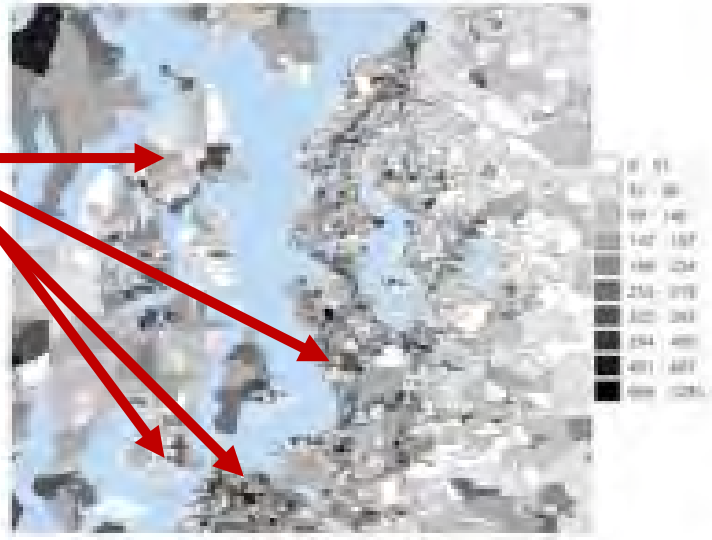
Note Change in scale from previous slide

Toll Accounts for Central Puget Sound Region

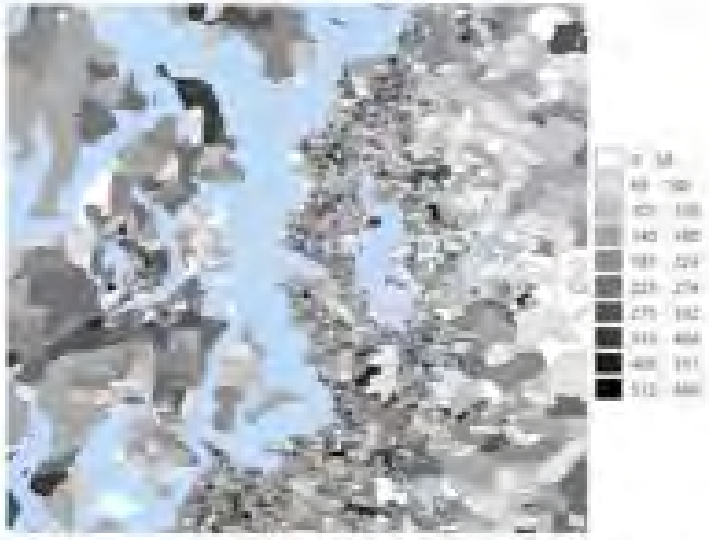


Income Levels of Central Puget Sound Region

Pockets of low-income users exist in all portions of the region

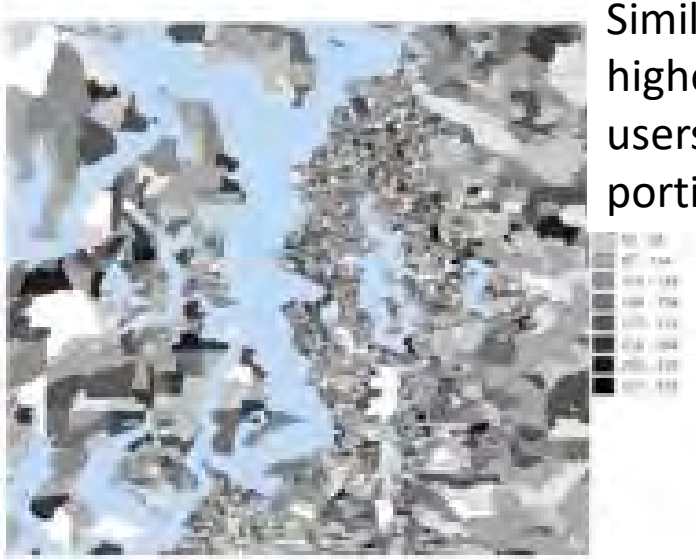


A) Number of Households with Income up to $49,999

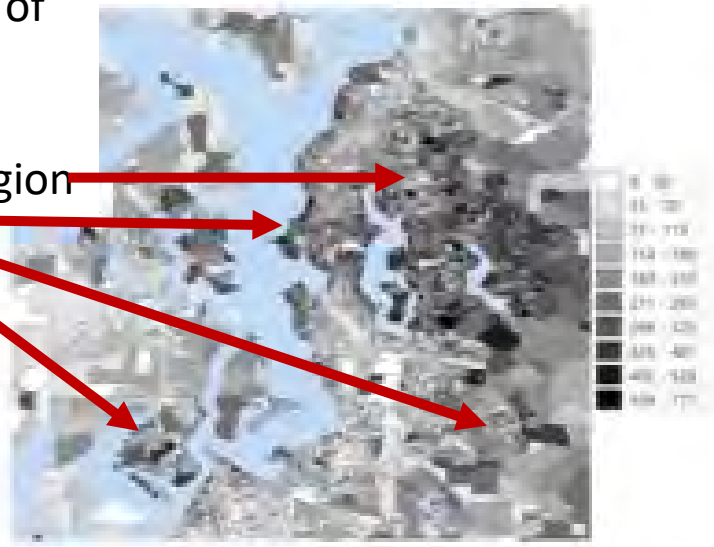


B) Number of Households with Income from $50,000 to $99,999

Similarly, pockets of higher-income users exist in all portions of the region



C) Number of Households with Income from $100,000 to $149,999



D) Number of Households with Income Above $150,000

Let’s Examine Patterns of Use by Facility

I-405

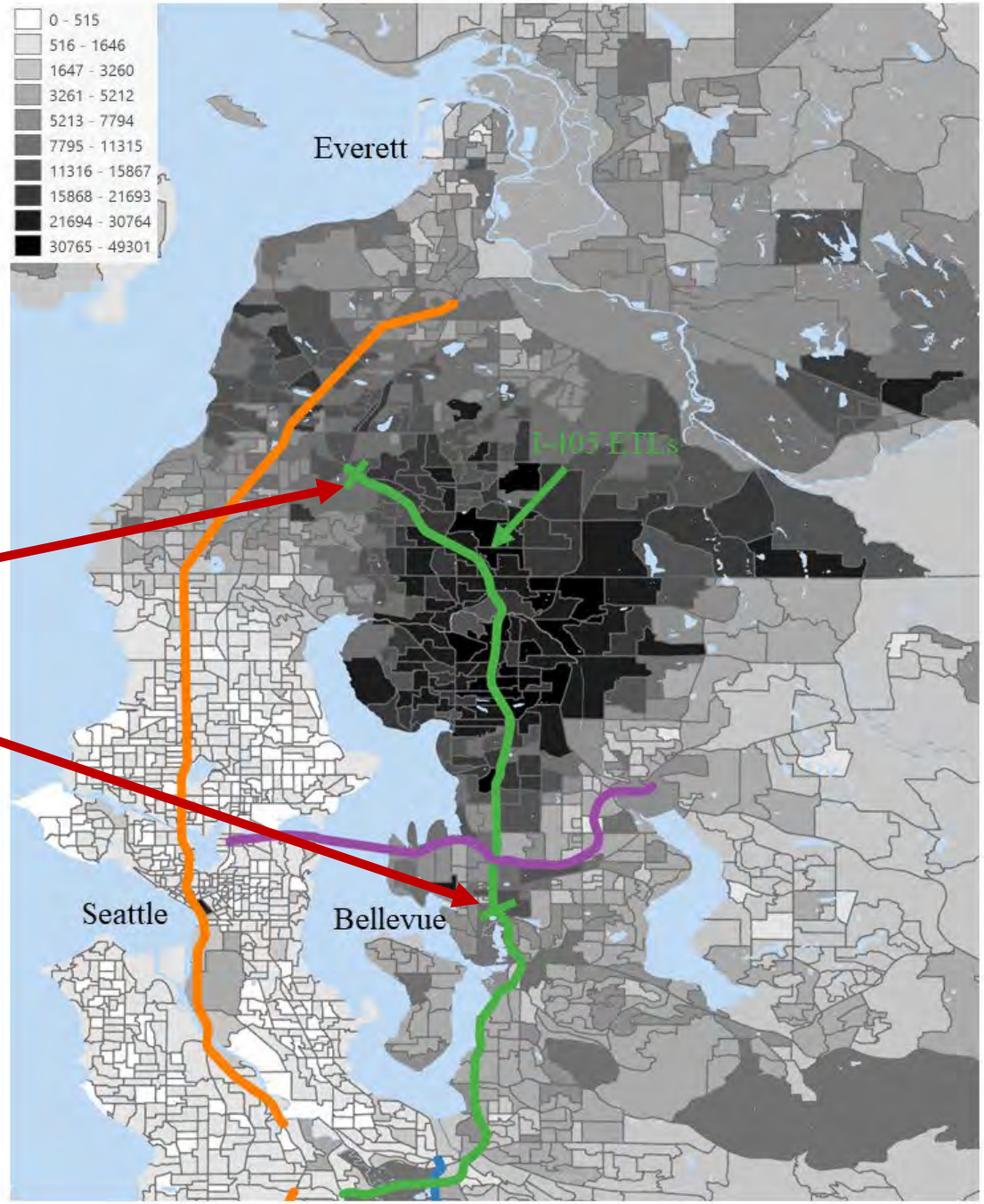
SR 167

SR 520

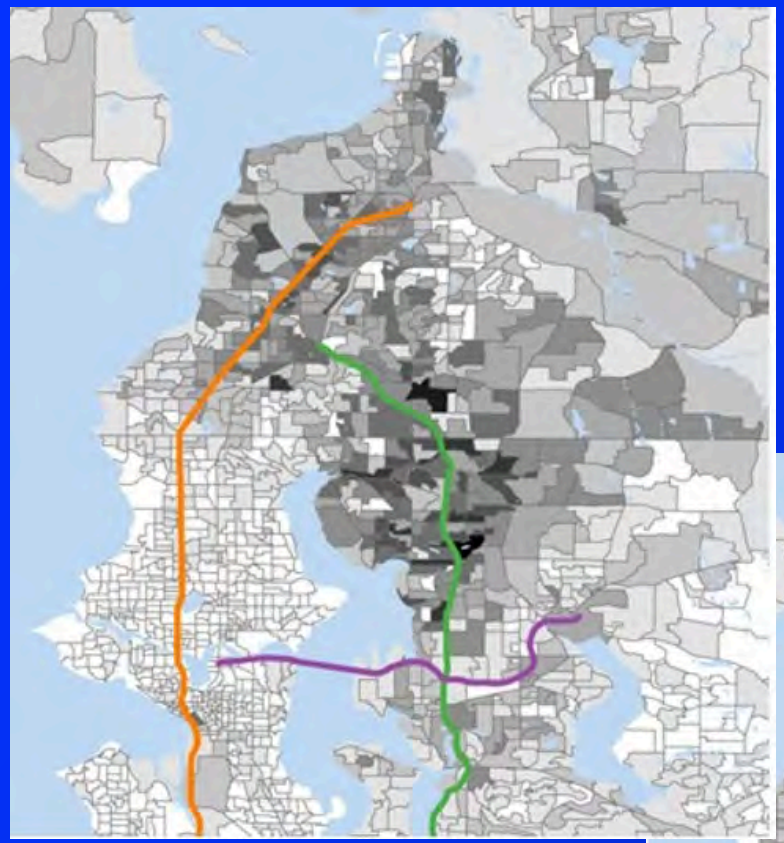
SR 99

SR 16

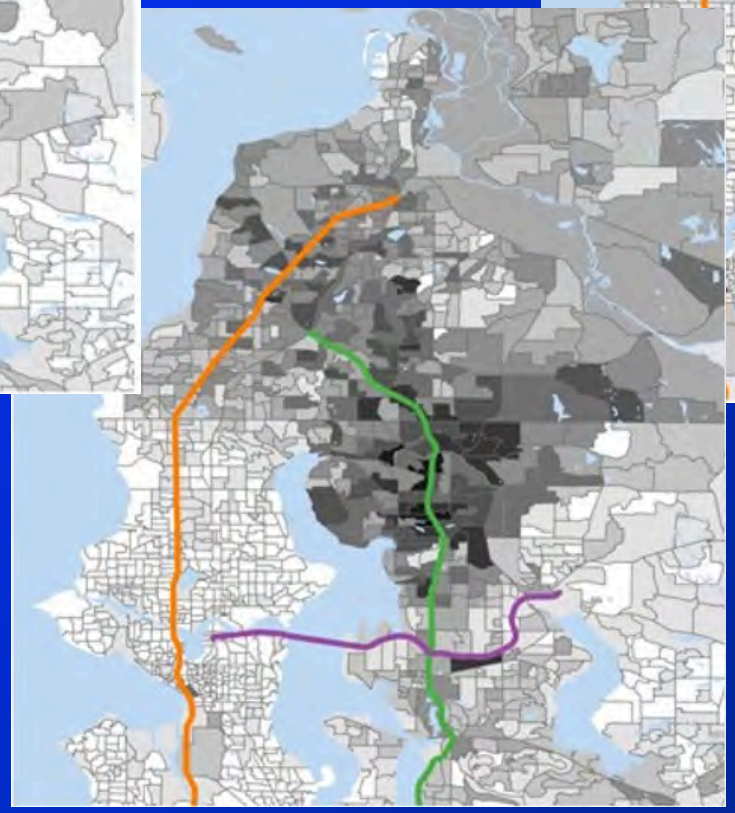
Trip Making on I-405 and the I-405 Express Toll Lanes



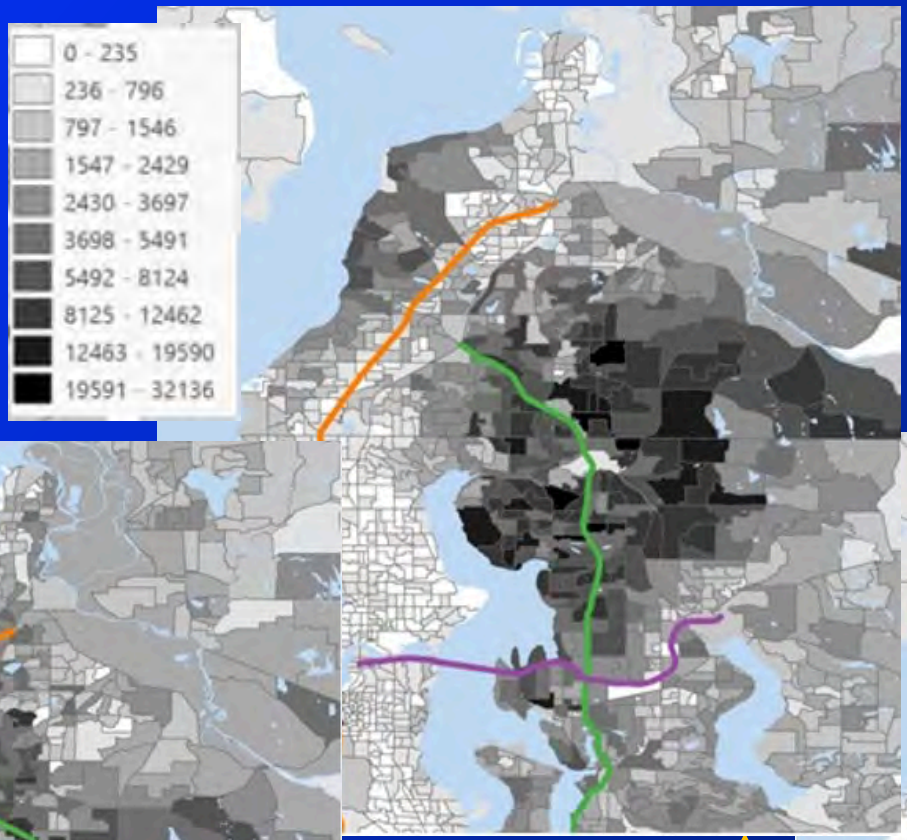
Income Levels and Geographic Location of I-405 ETL Users



HH Income <$50K

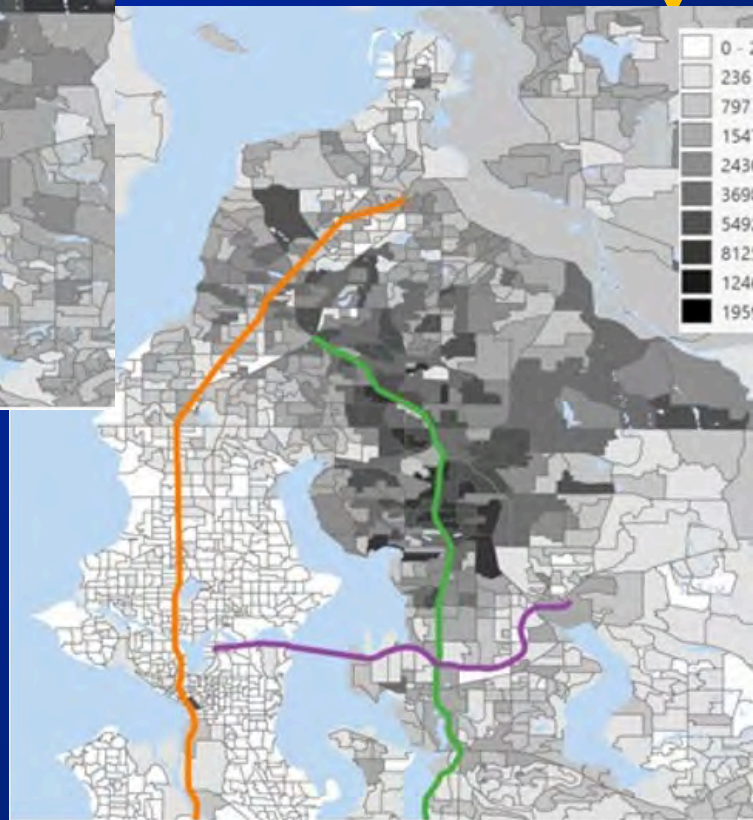


HH Income
$50K - $100K



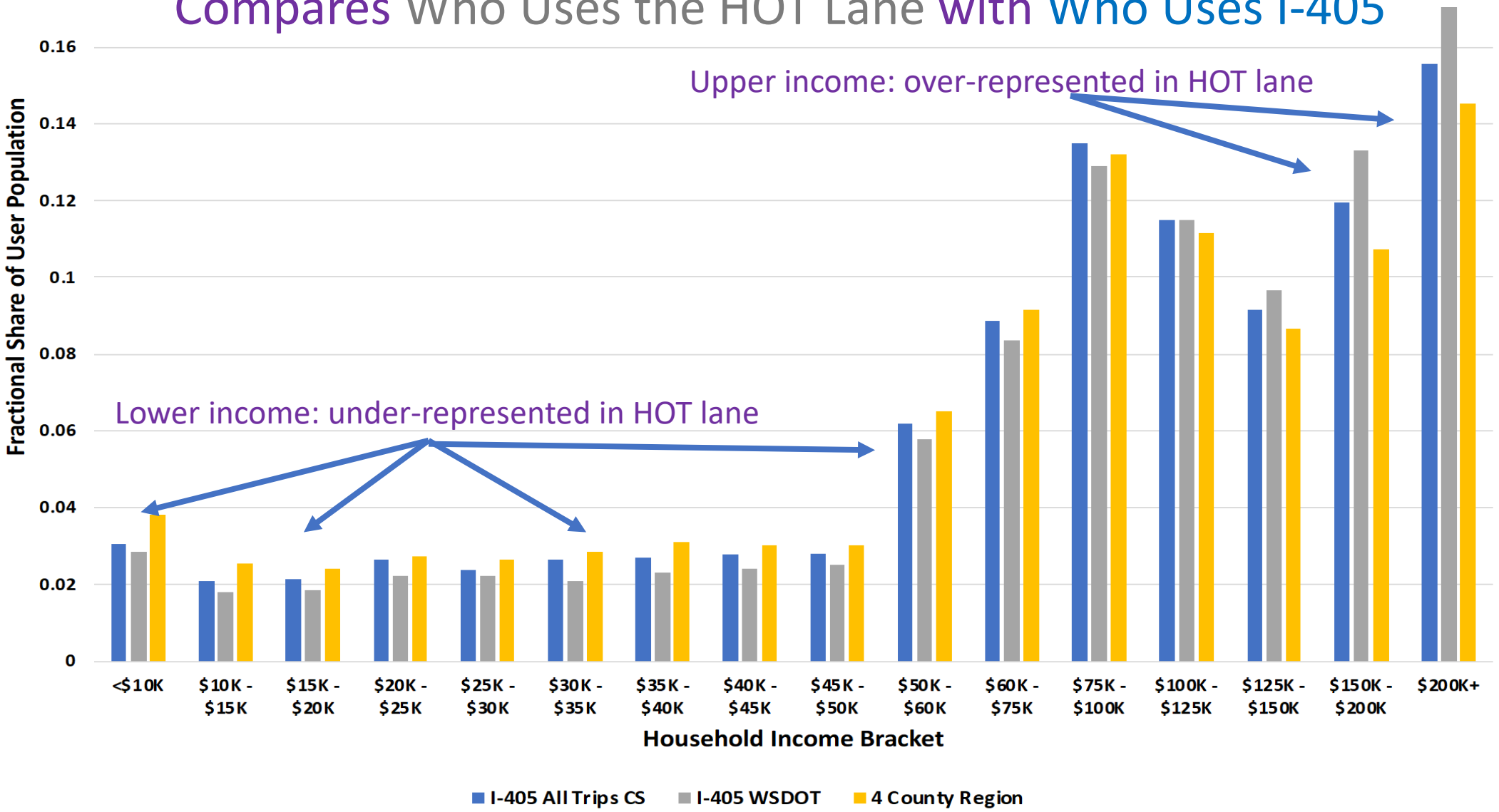
HH Income
$100K - $150K

HH Income >$150,000



I-405 Demographic Profile

Compares Who Uses the HOT Lane with Who Uses I-405



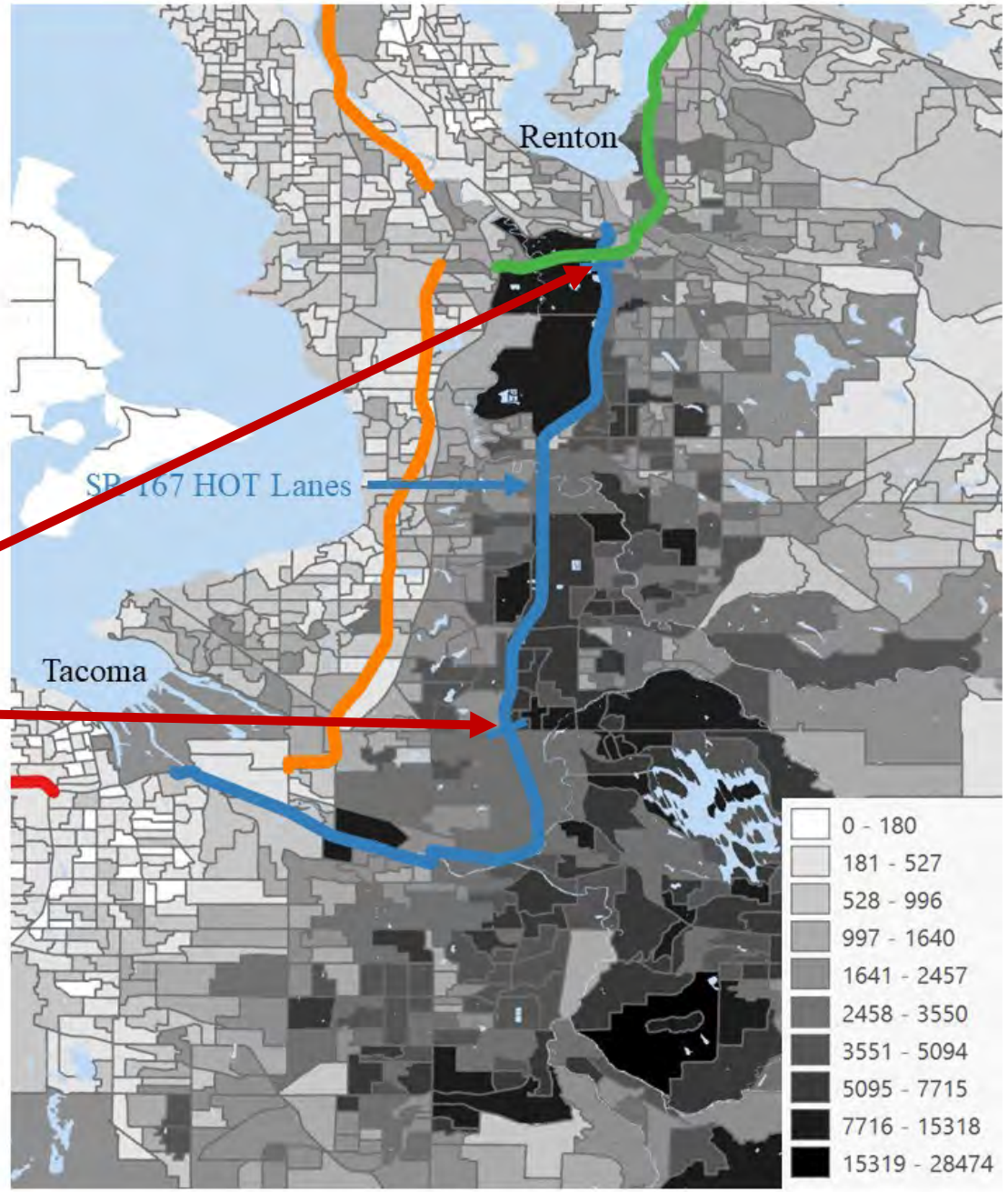
Demographics of Use on I-405

- Demographics (the distribution of facility users by household incomes) follow the same basic curve as the region

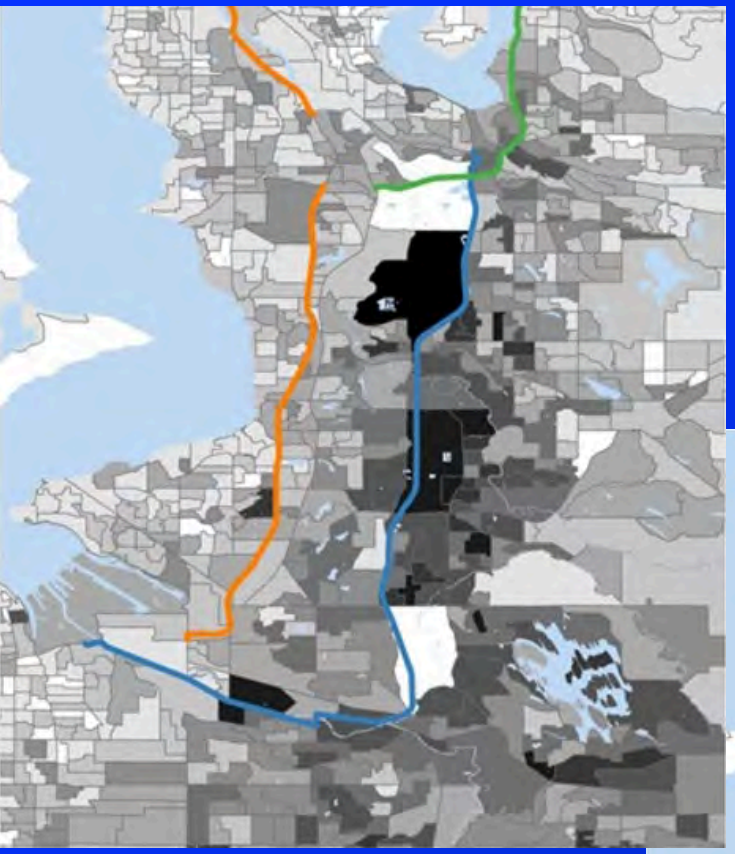
- Not surprisingly:
  - Overall use of I-405 skews modestly towards higher income households

  - I-405 Express Lanes Use skews even more towards higher income users
    - Especially above $125,000 annual income

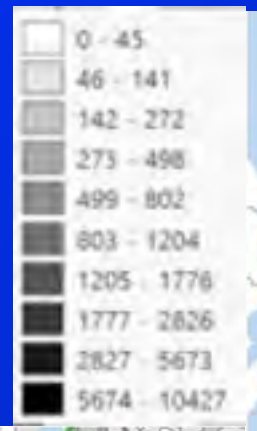
Trip Making on the SR 167 HOT Lanes

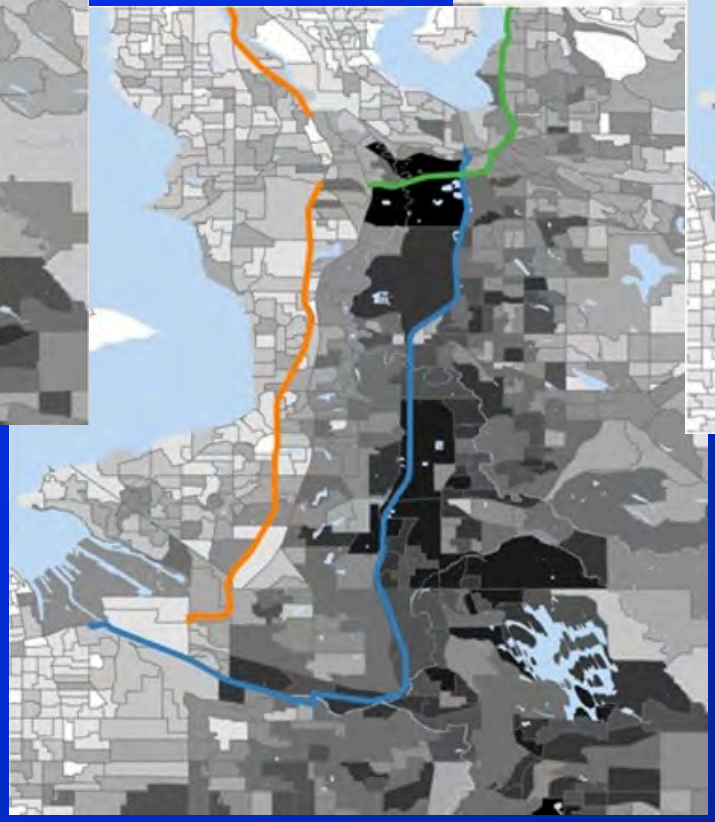


Income Levels and Geographic Location of SR 167 HOT Users

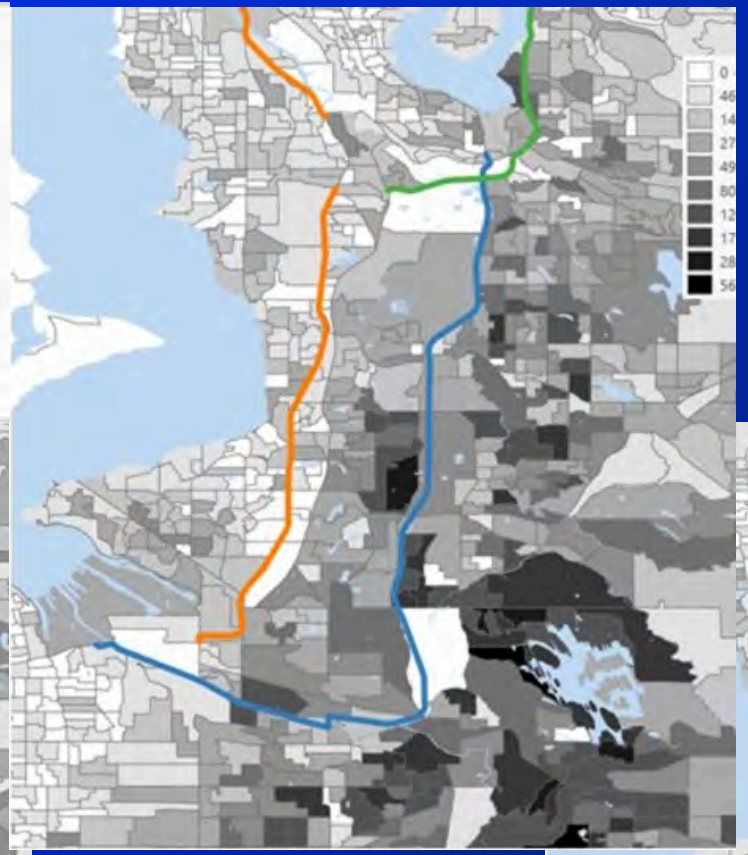


HH Income <$50K



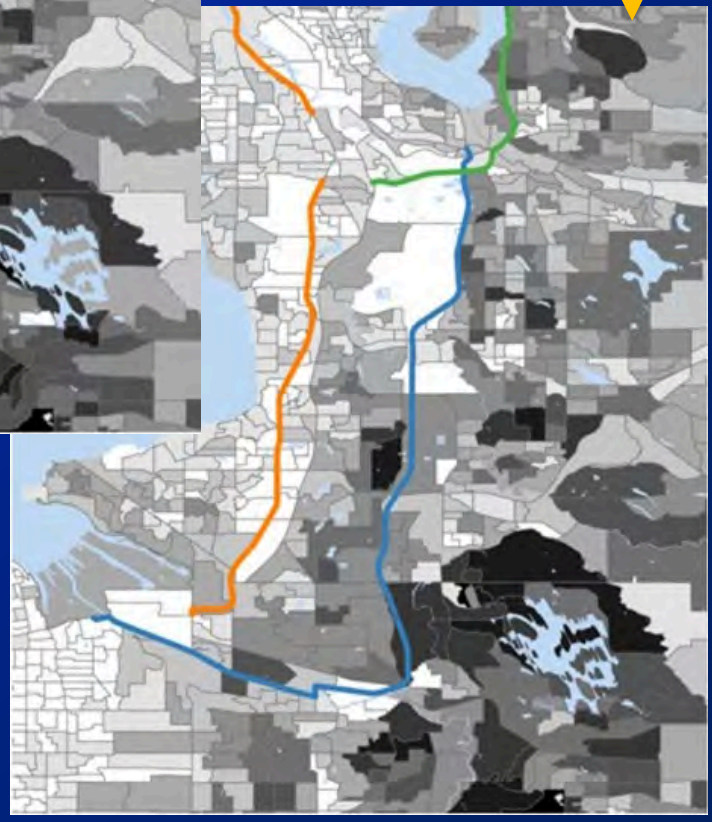


HH Income
$50K - $100K



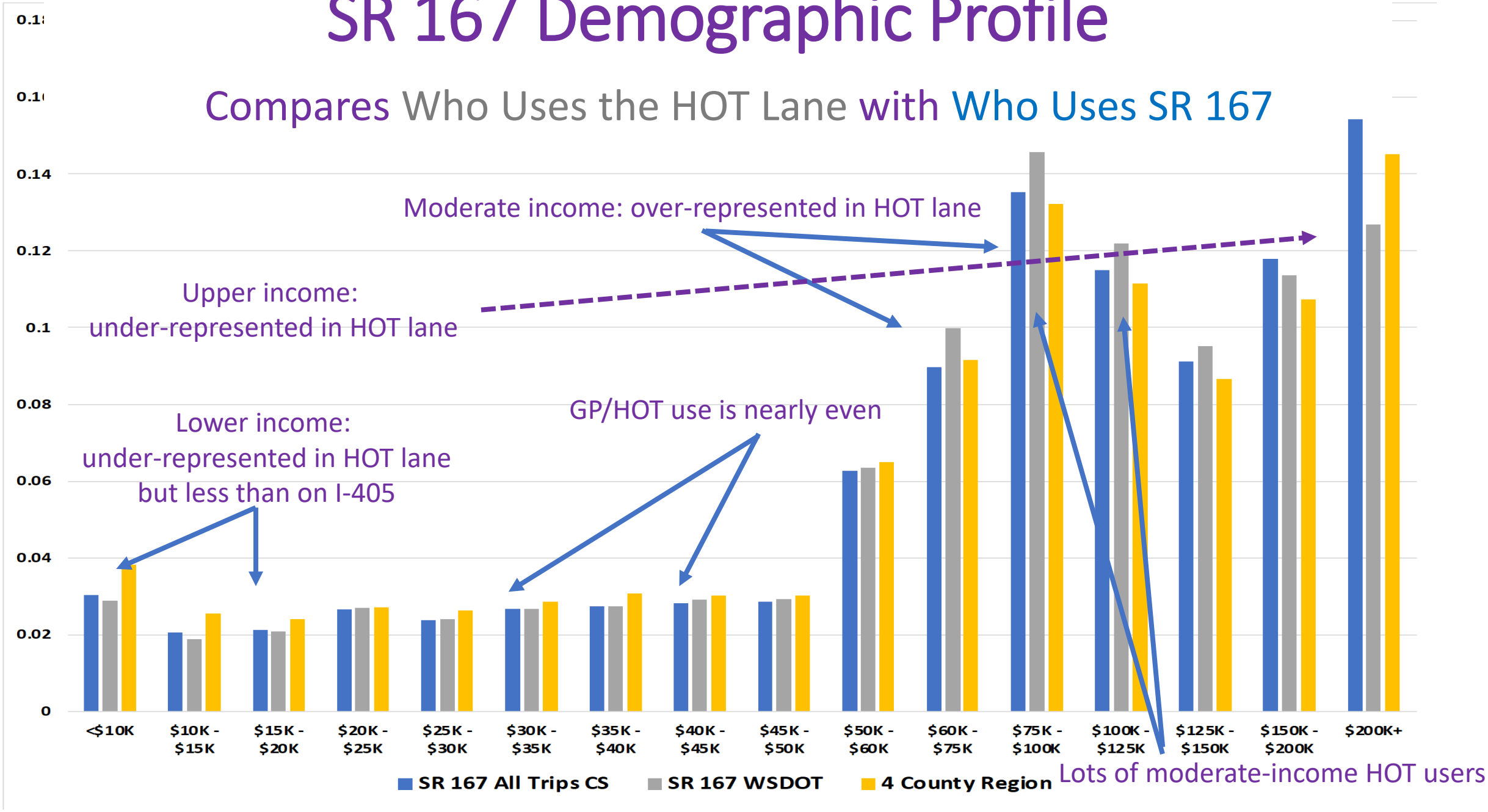
HH Income
$100K - $150K

HH Income
>$150,000



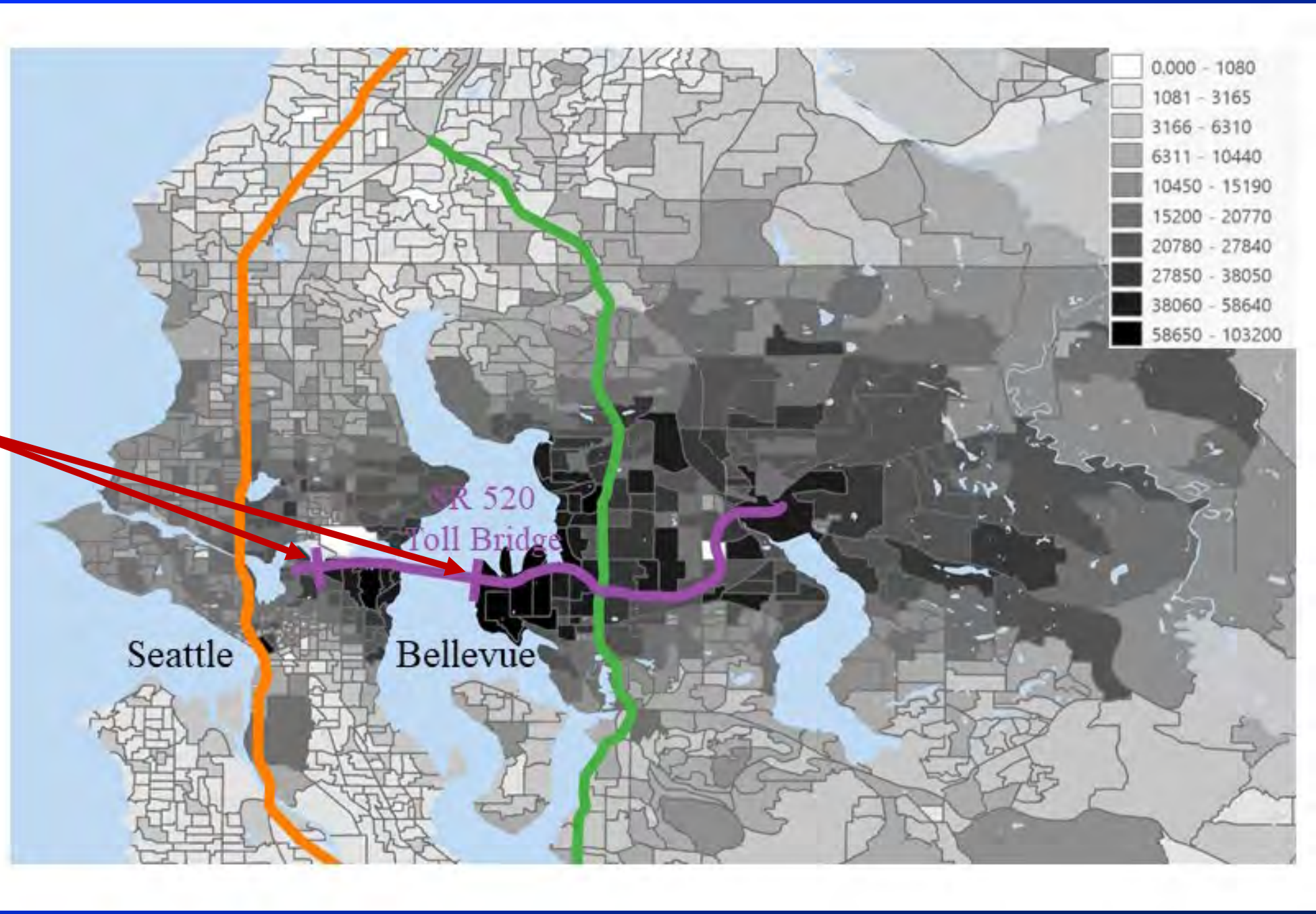
SR 167 Demographic Profile

Compares Who Uses the HOT Lane with Who Uses SR 167

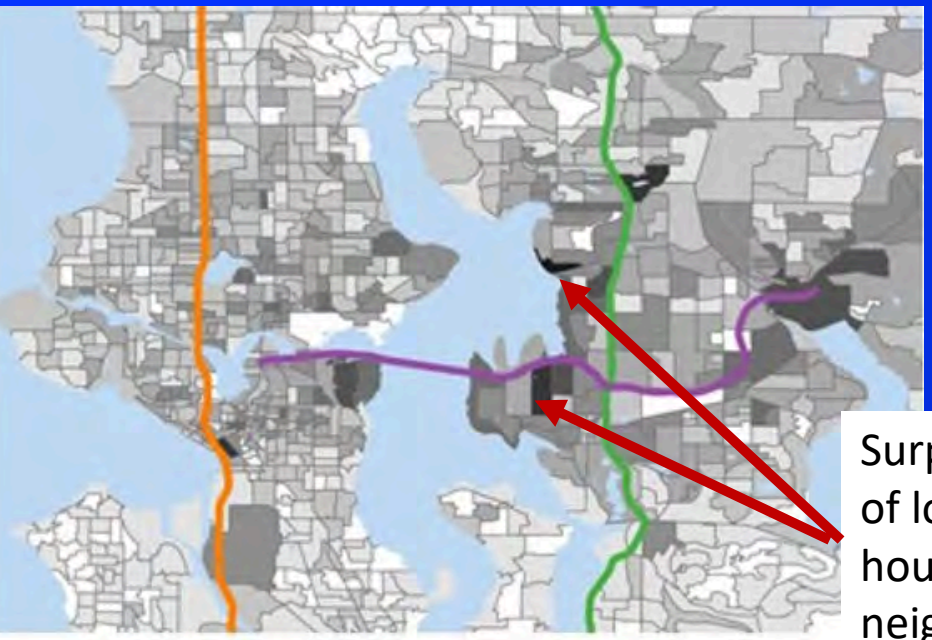


- Generally follows the income distribution of the region
- Toll facility has higher representation from “medium-high” incomes ($60K - $150K annual household income) than SR 167 overall
- (Note: LBS data skew higher for high-income households. This is likely caused by modest bias in the CS data, which also appears to have a lower representation of low-income households

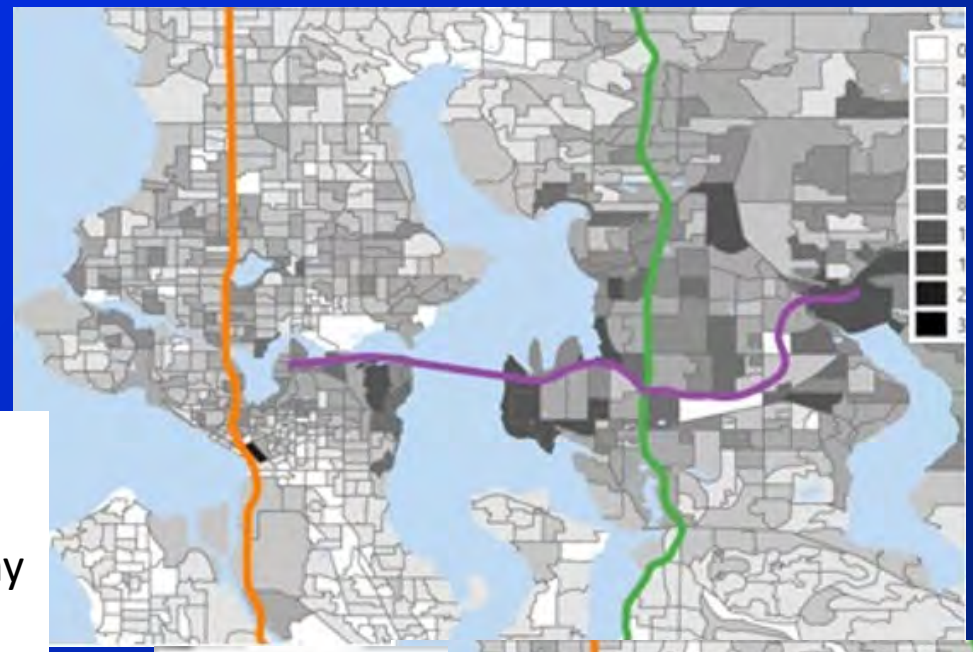
Trip Making Across SR 520



Income Levels and Geographic Location of SR 520 Users



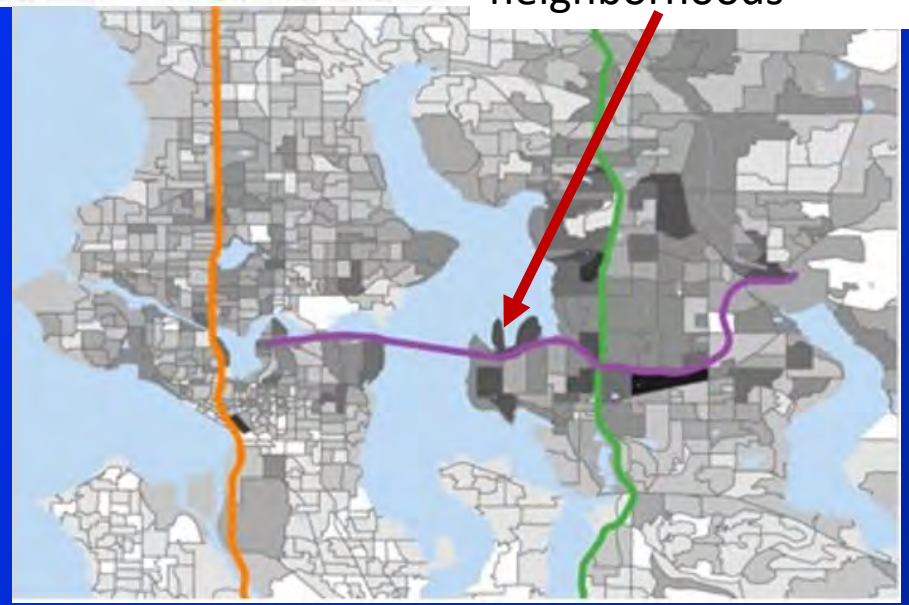
Surprising number of lower-income households in wealthy neighborhoods



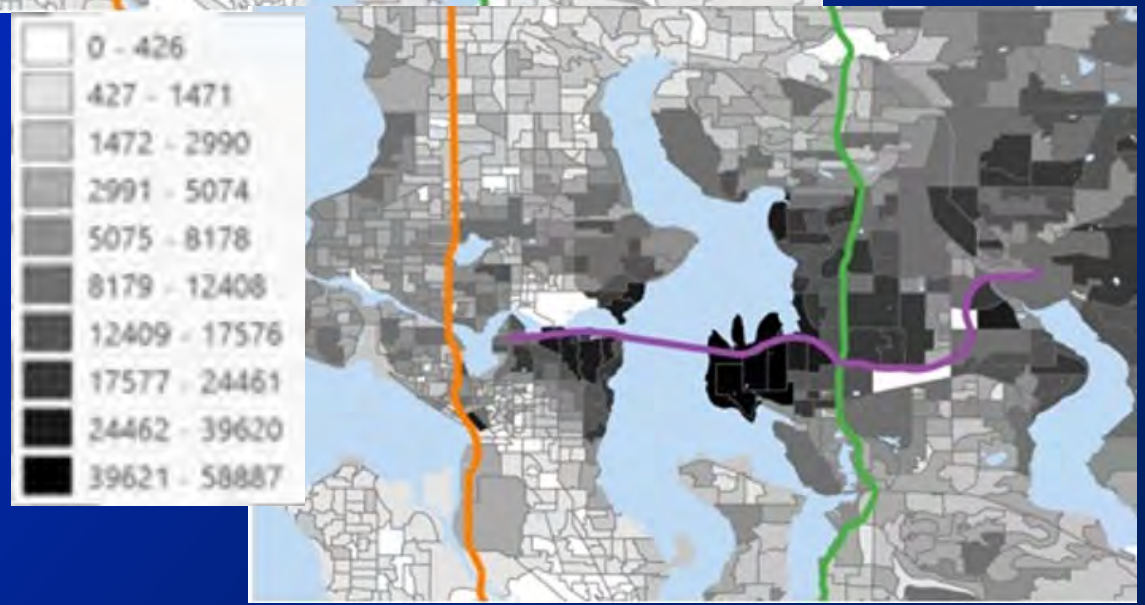
HH Income $100K - $150K

HH Income >$150,000

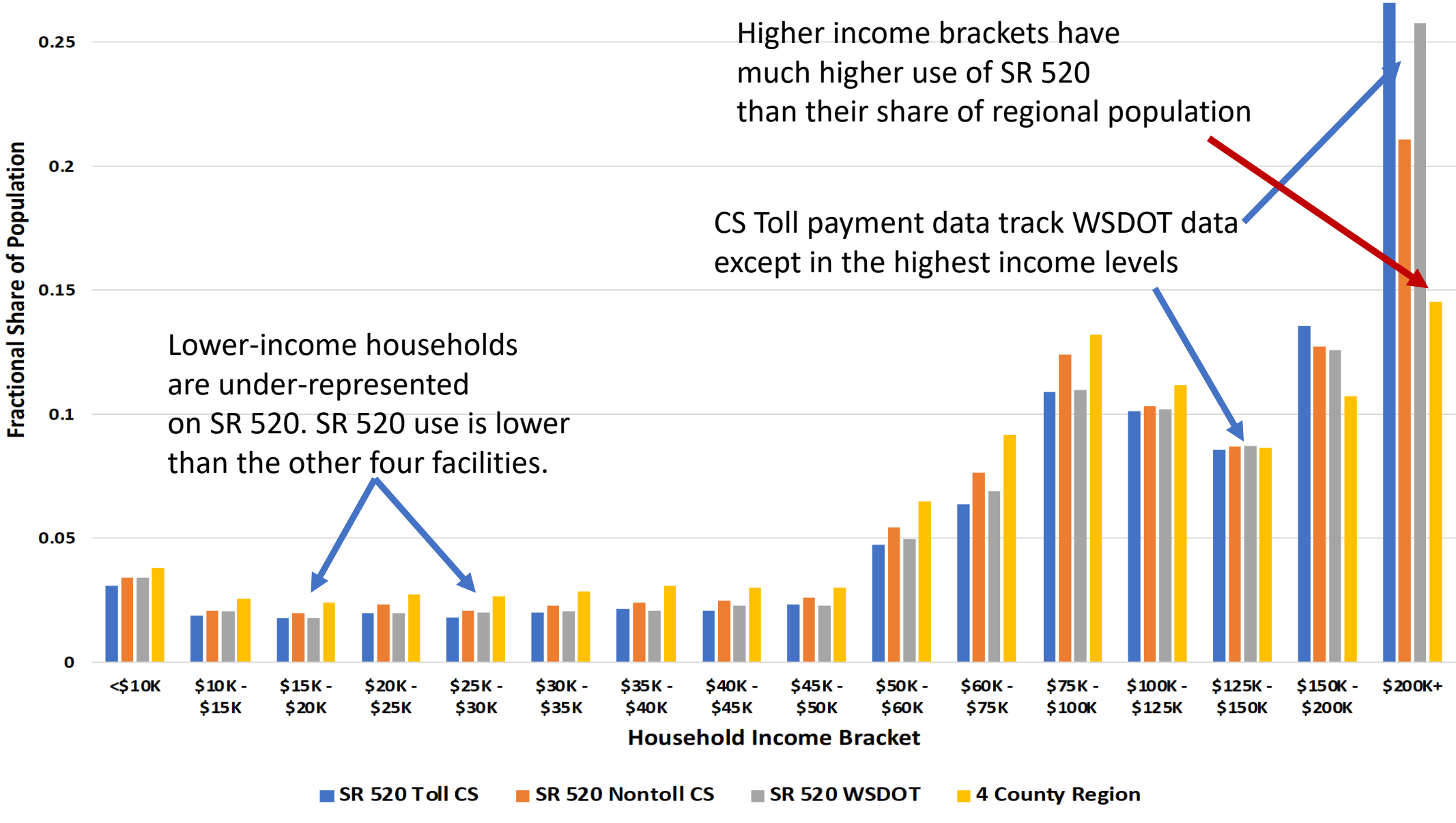
HH Income <$50K



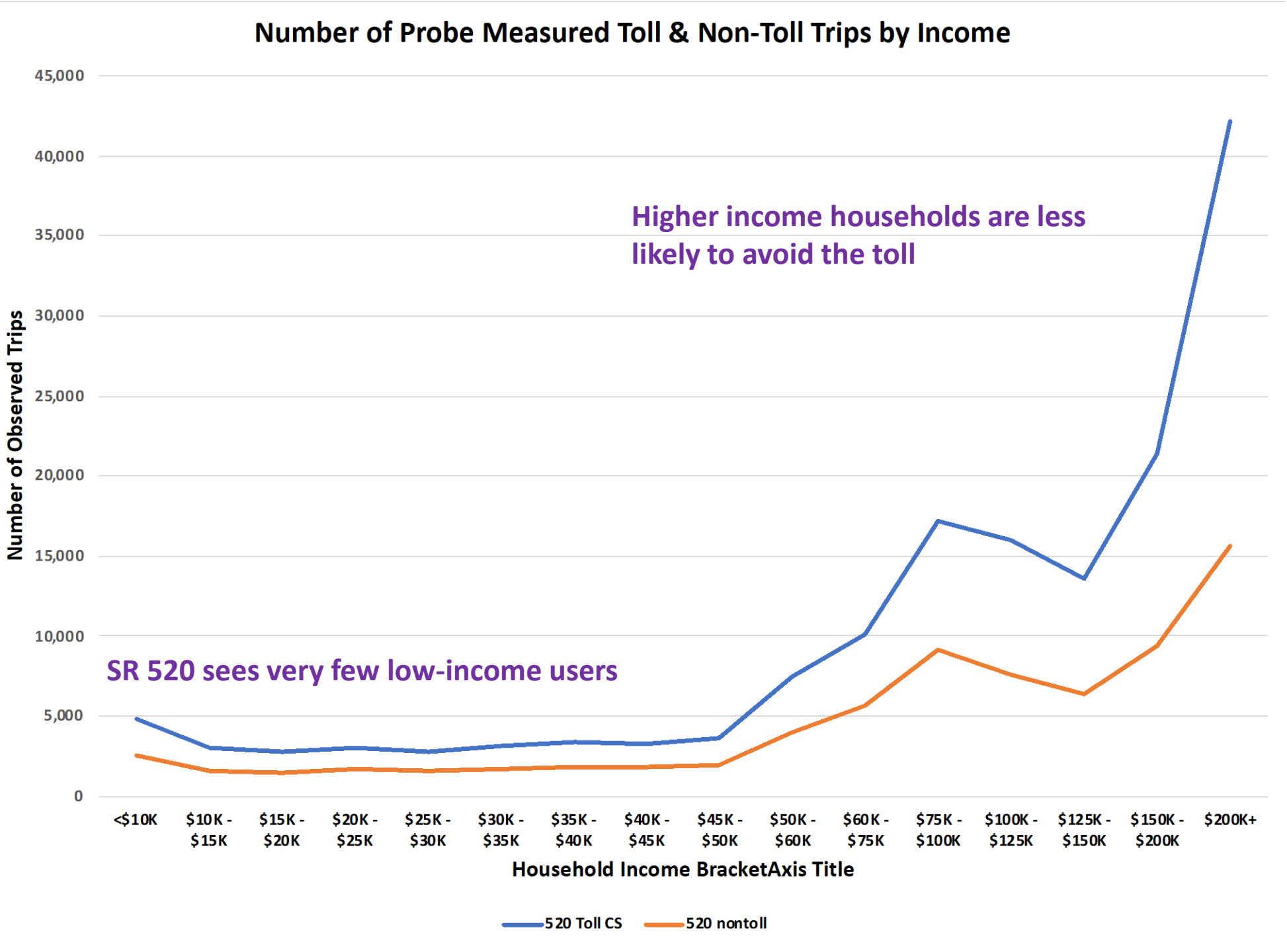
HH Income $50K - $100K



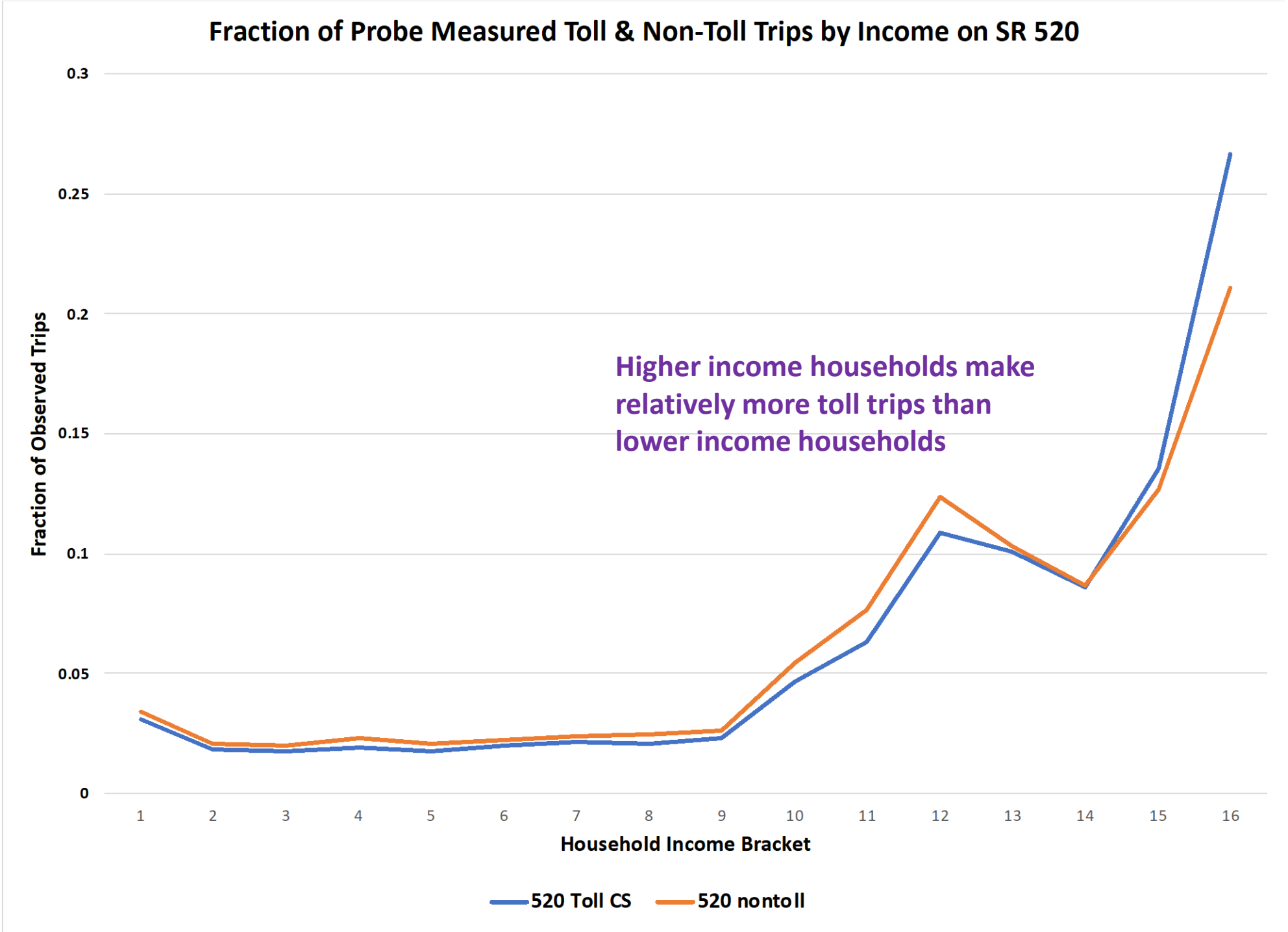
SR 520 Demographic Profile



SR 520 Toll vs. Non-Toll Trip Making



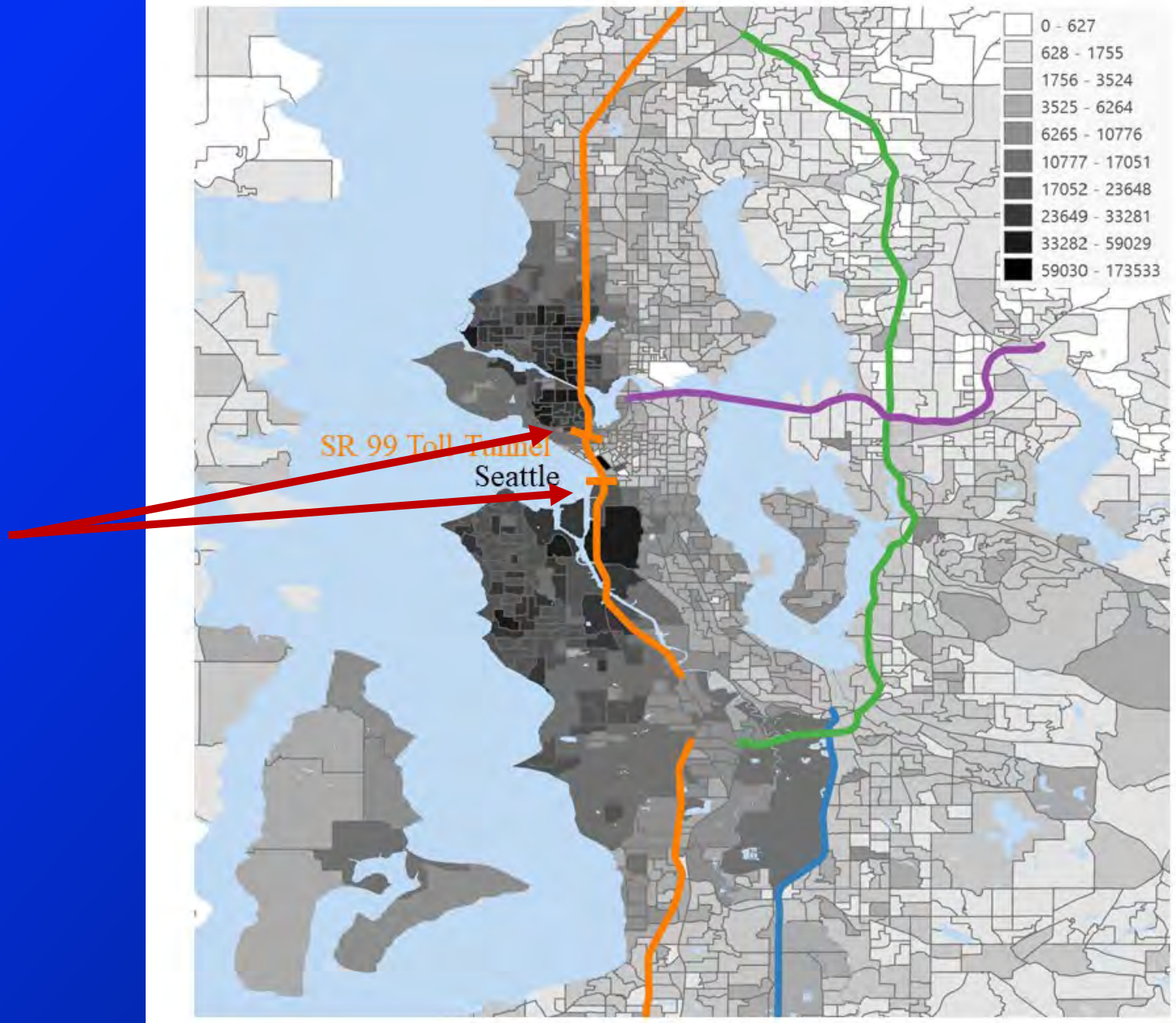
SR 520 Toll vs. Non-toll Trip Making



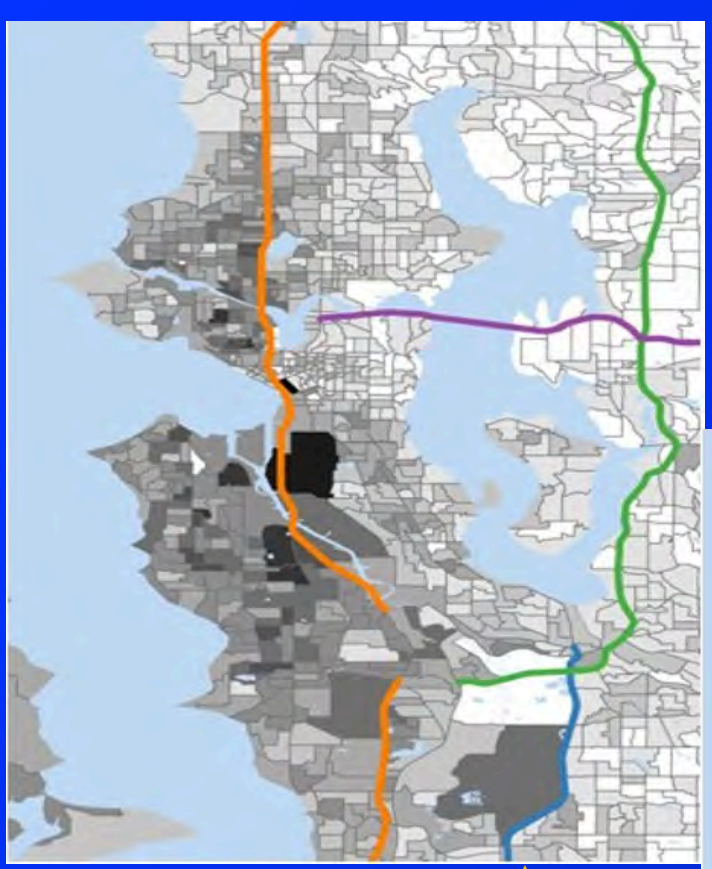
Who Uses / Doesn't Use SR 520

- Users of the corridor have higher incomes than the region as a whole.
  - SR 520 is the "wealthiest" corridor of the five in our study
- Higher income households use the corridor at far greater rates (relative to the regional population) than either 1) lower income households, or 2) other regional toll facilities
- Comparatively fewer high-income households make trips that avoid the toll

Trip Making Through SR 99 Tunnel

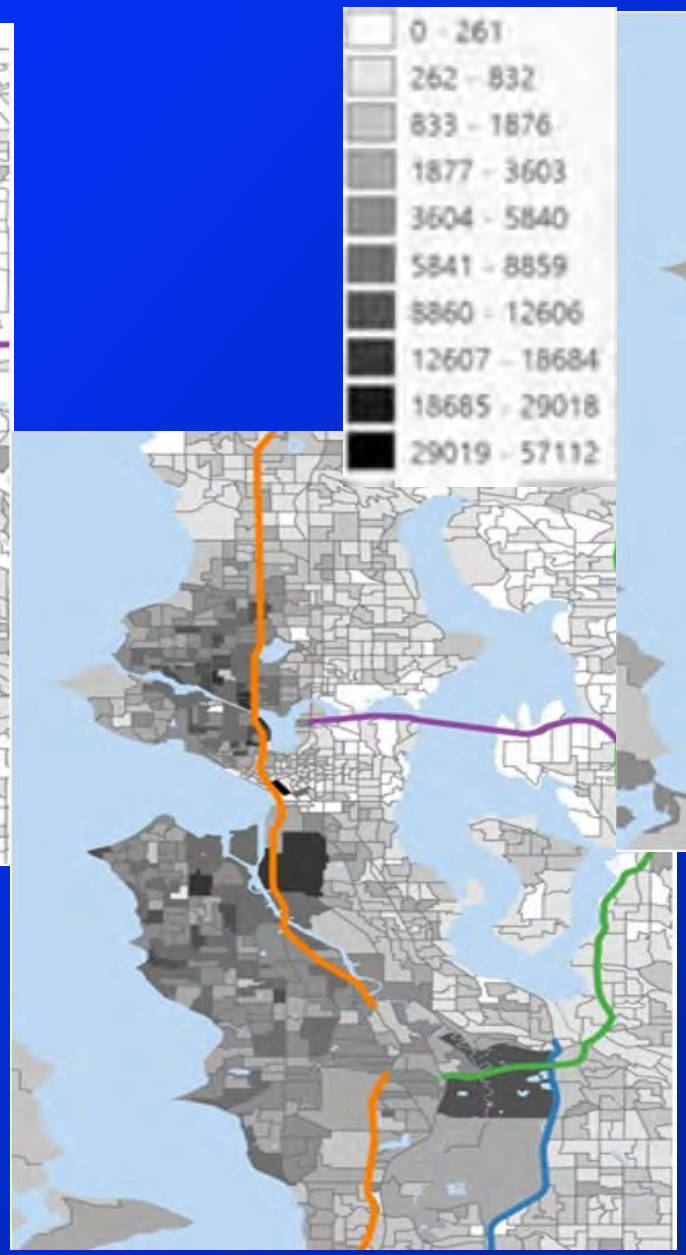


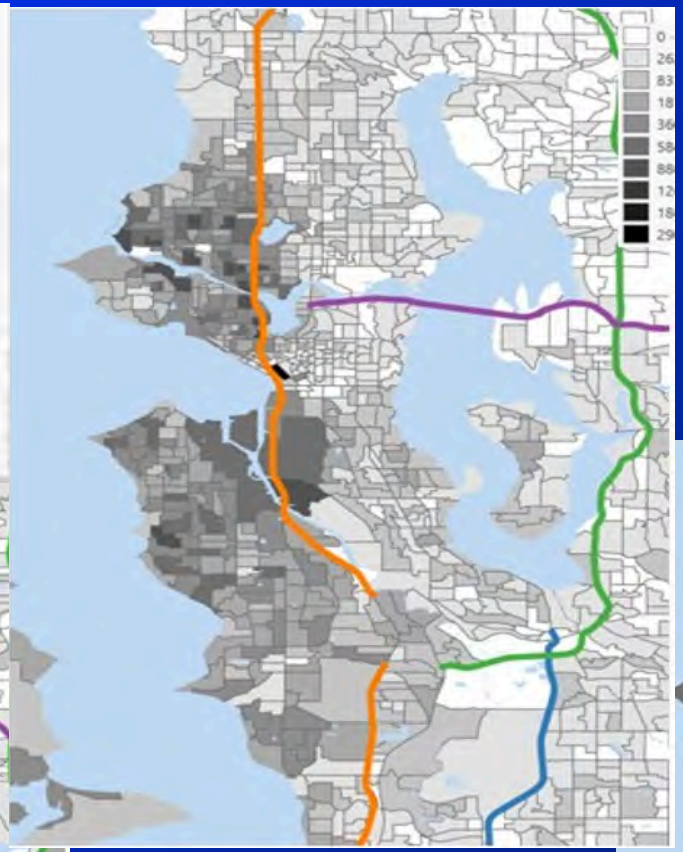
Income Levels and Geographic Location of SR 99 Users



HH Income <$50K

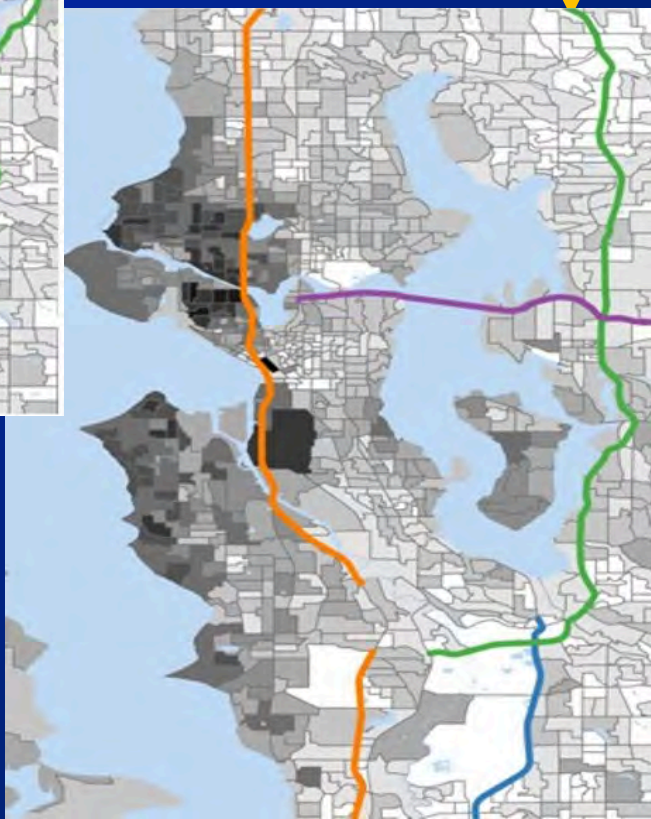
HH Income
$50K - $100K



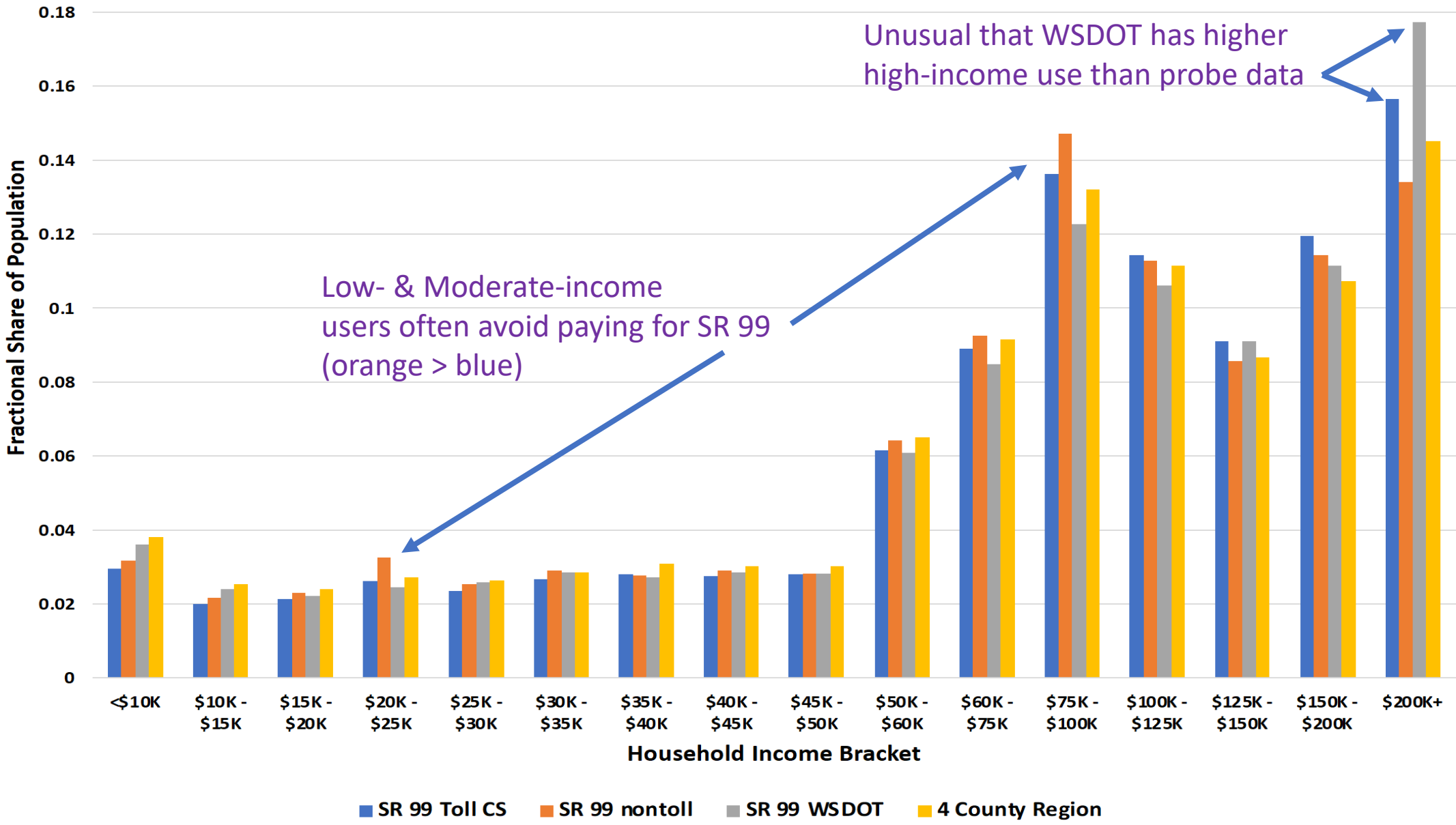


HH Income
$100K - $150K

HH Income
>$150,000



SR 99 Demographic Profile

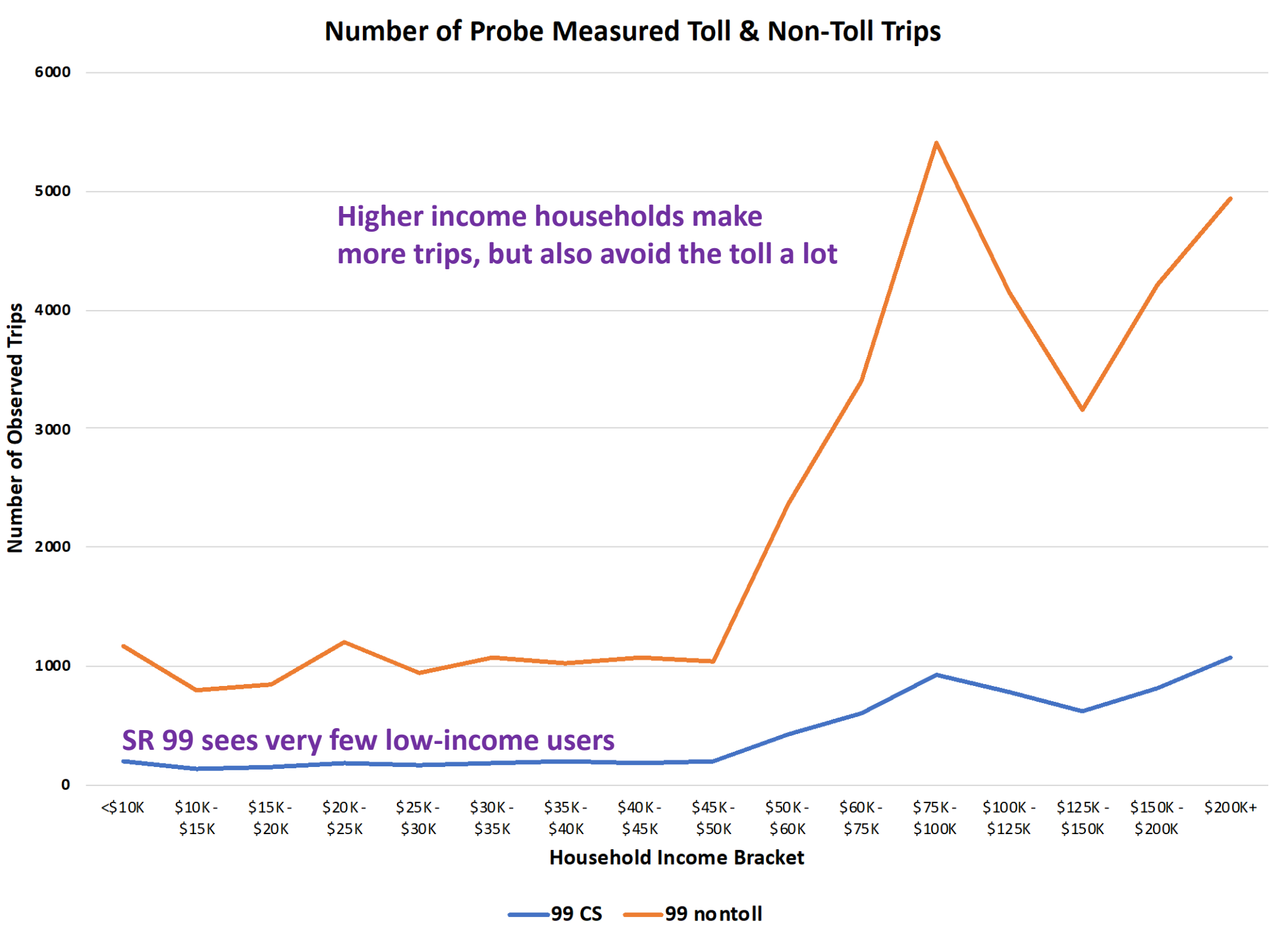


SR 99 Demographic Profile

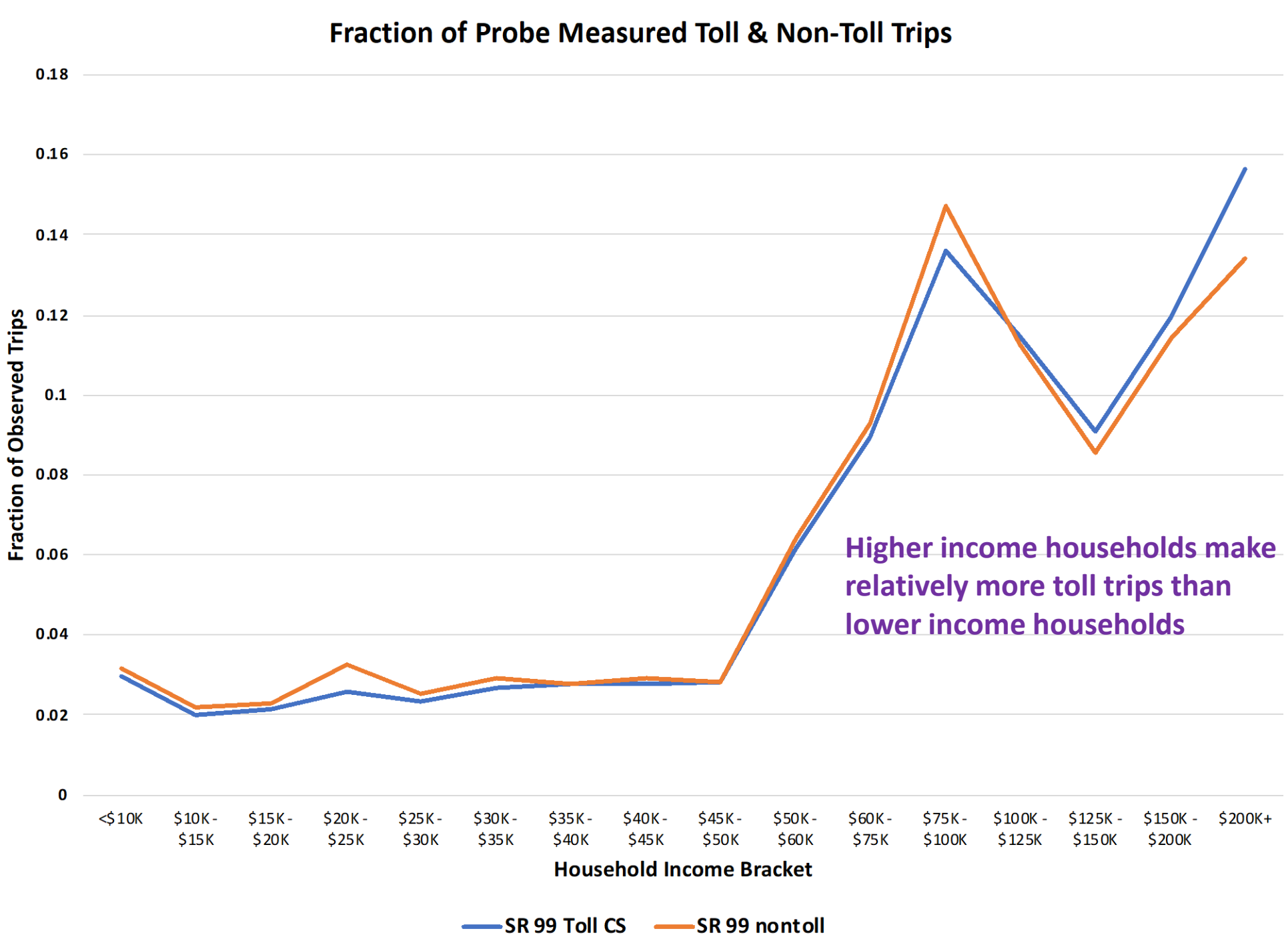
- User demographics more closely follow the regional demographic profile than either I-405, SR 520
  - Non-toll use closely follows the regional demographic pattern

- WSDOT tag data show a larger use of the facility than probe data for other corridors – which is unusual
  - Also a large difference at the highest income bracket between toll/no-toll use
  - Indicates that in this corridor, higher income users are willing to purchase travel advantages more than in other corridors

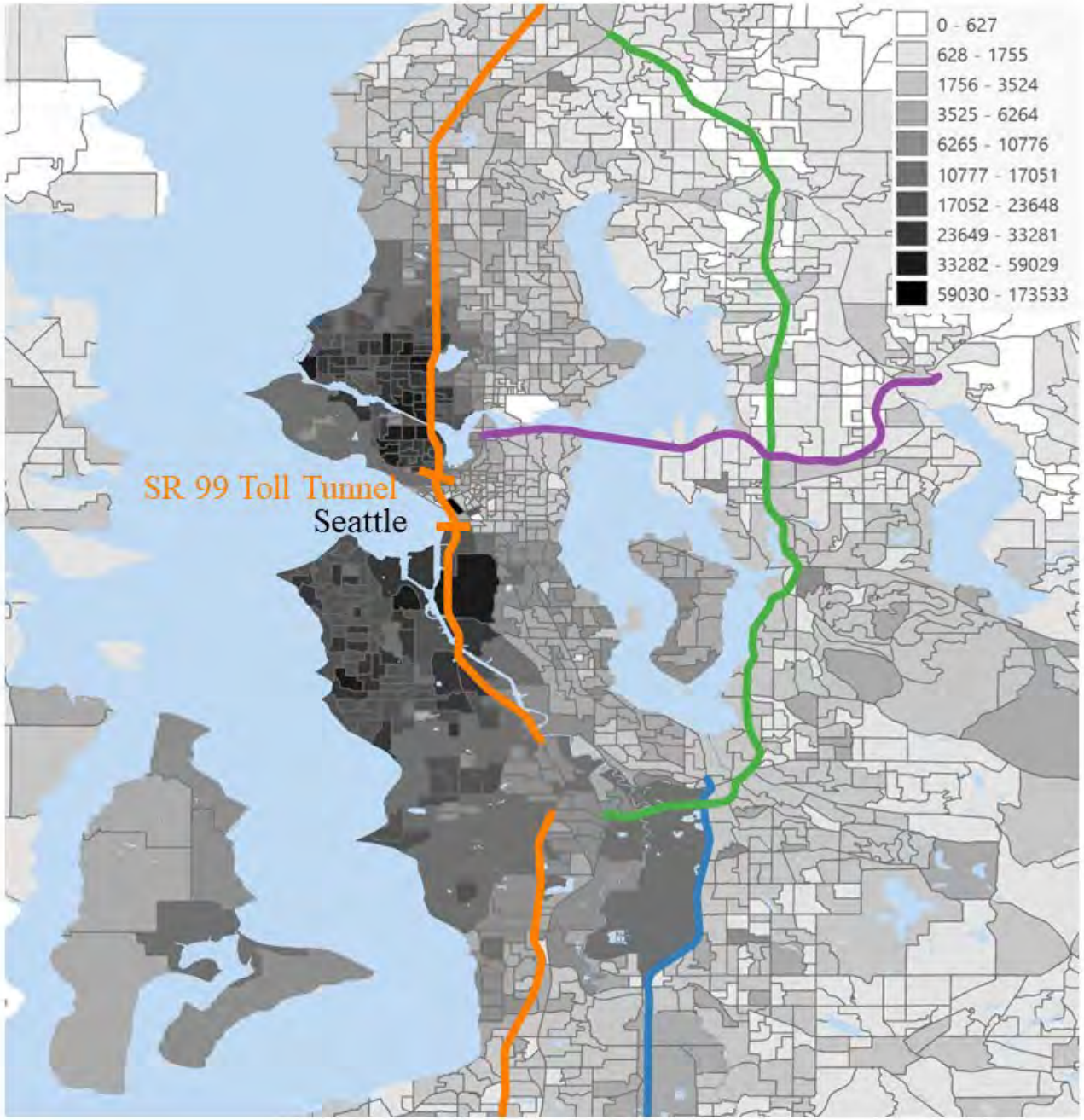
SR 99 Toll vs. Non-Toll Trip Making



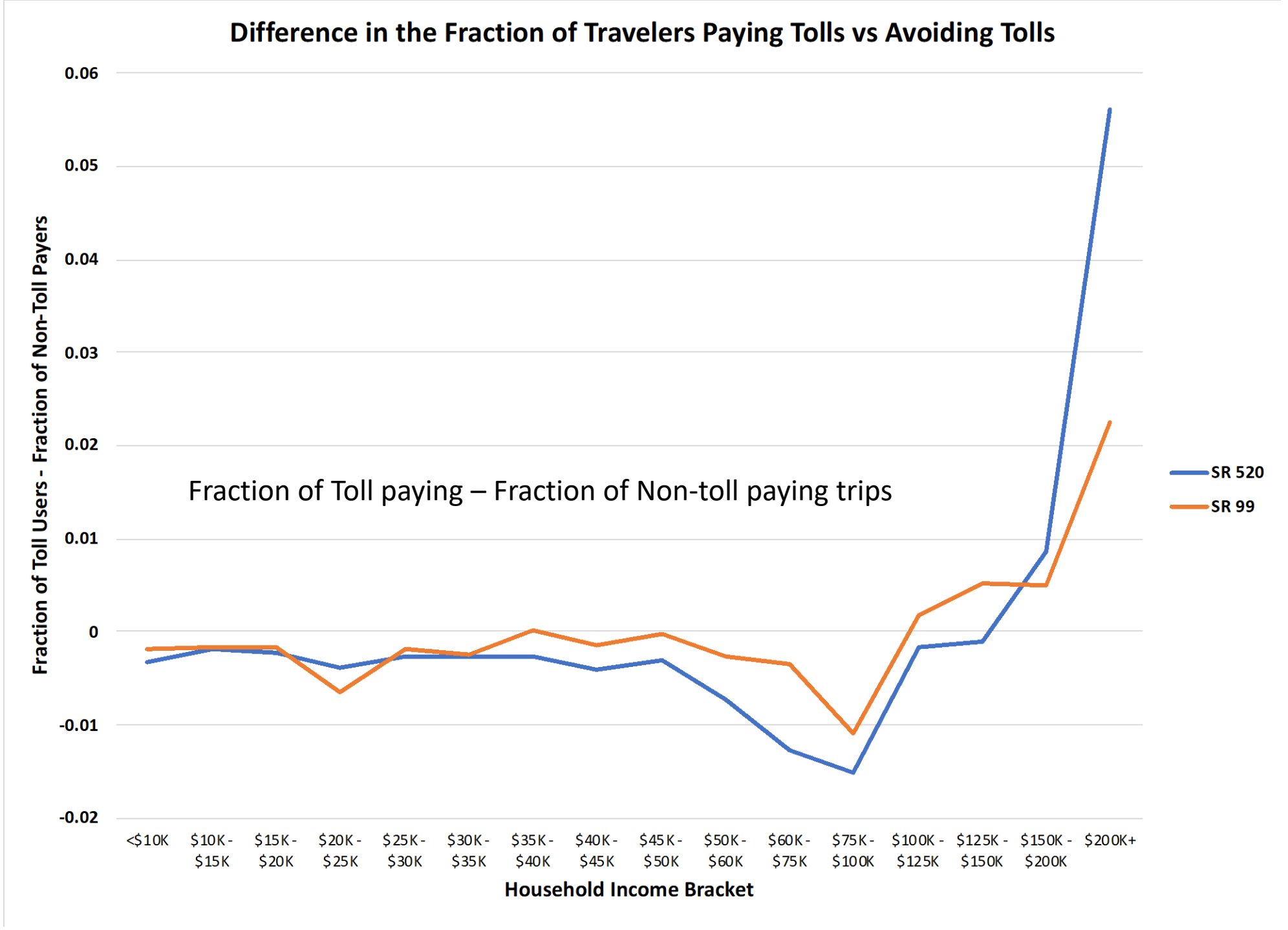
SR 99 Toll vs. Non-toll Trip Making



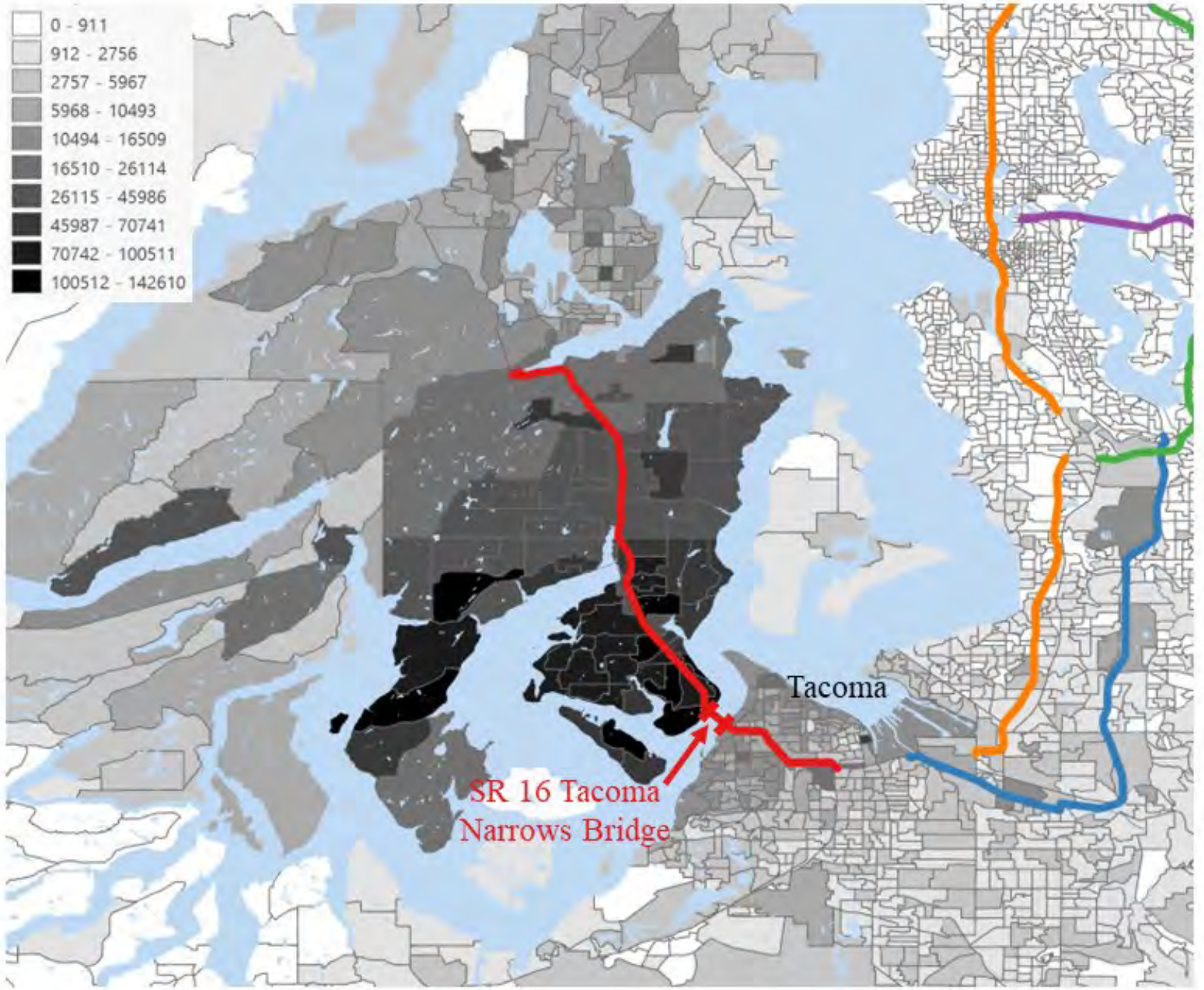
Trip Making Through SR 99 Tunnel



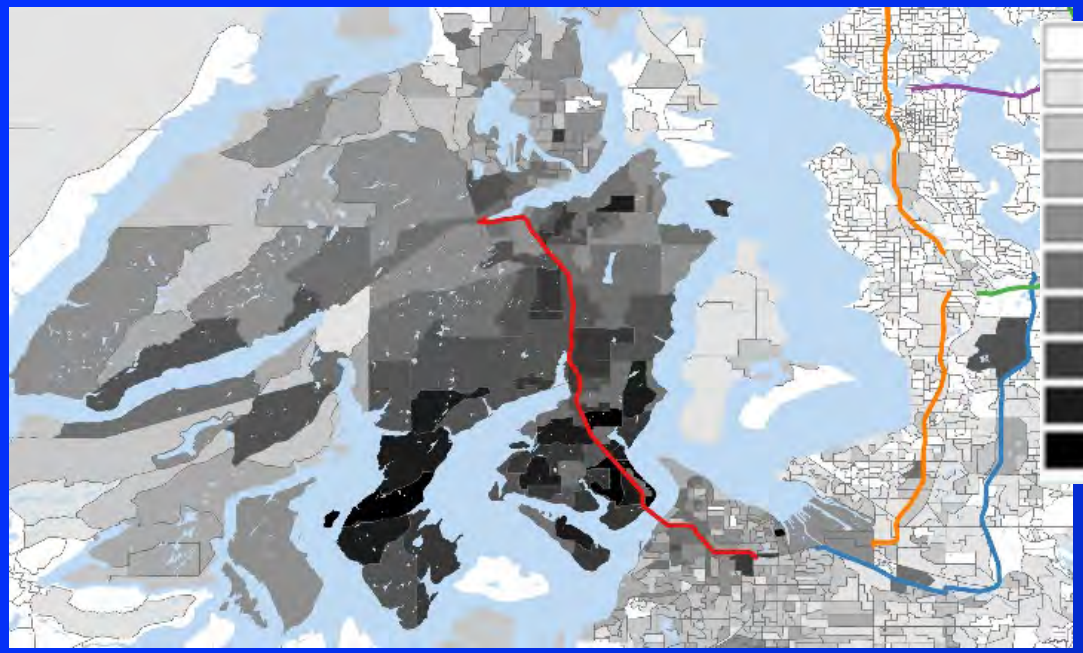
SR 520 & SR 99 Toll vs. Non-Toll Trip Making

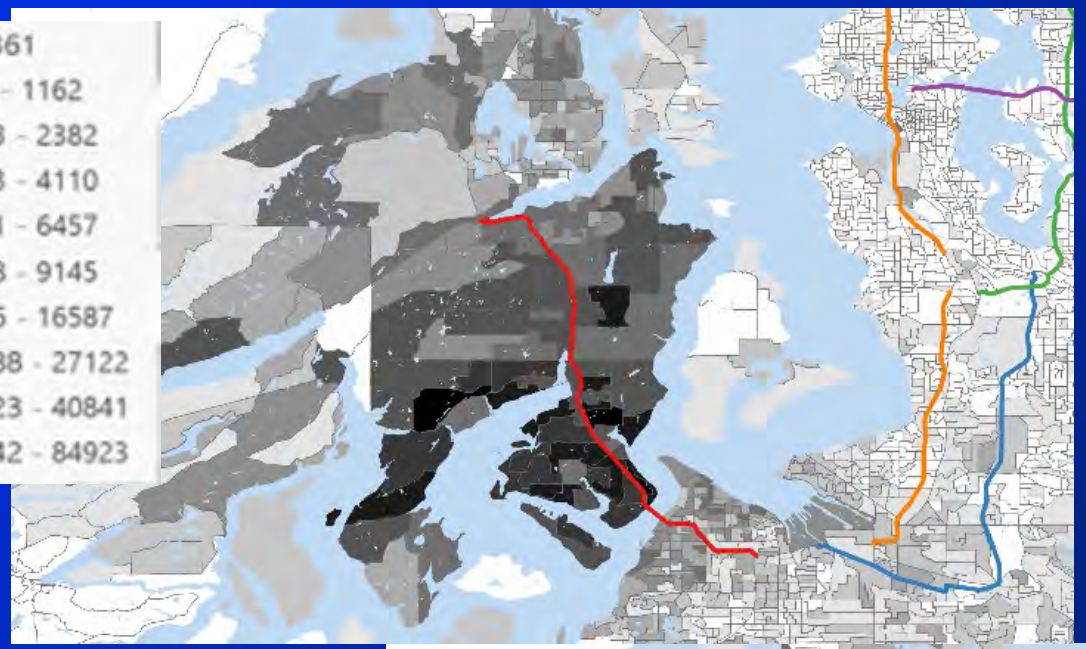


Trip Making Across Tacoma Narrows Bridge (SR 16)



Income Levels and Geographic Location of SR 16 Users

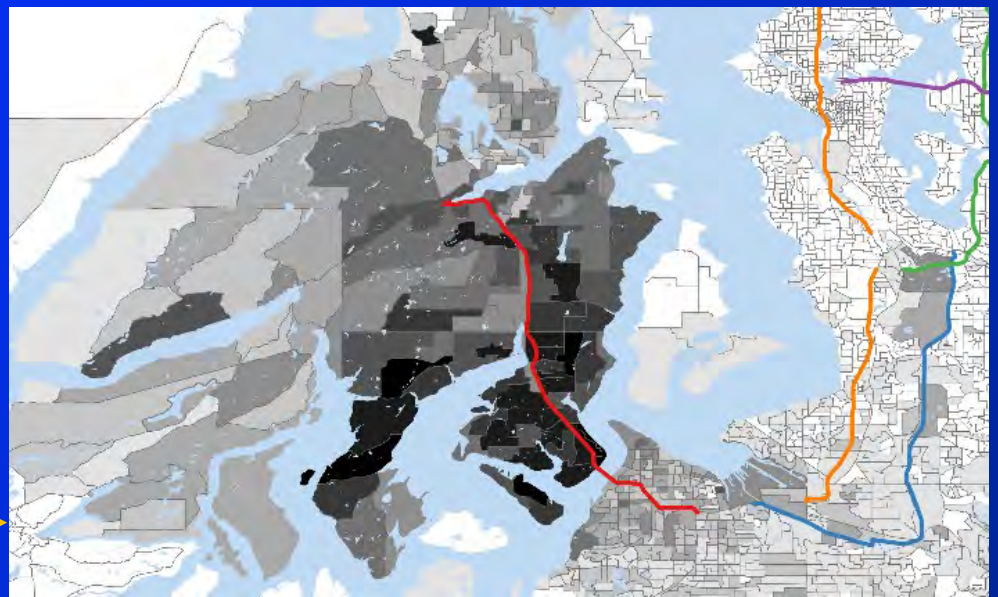




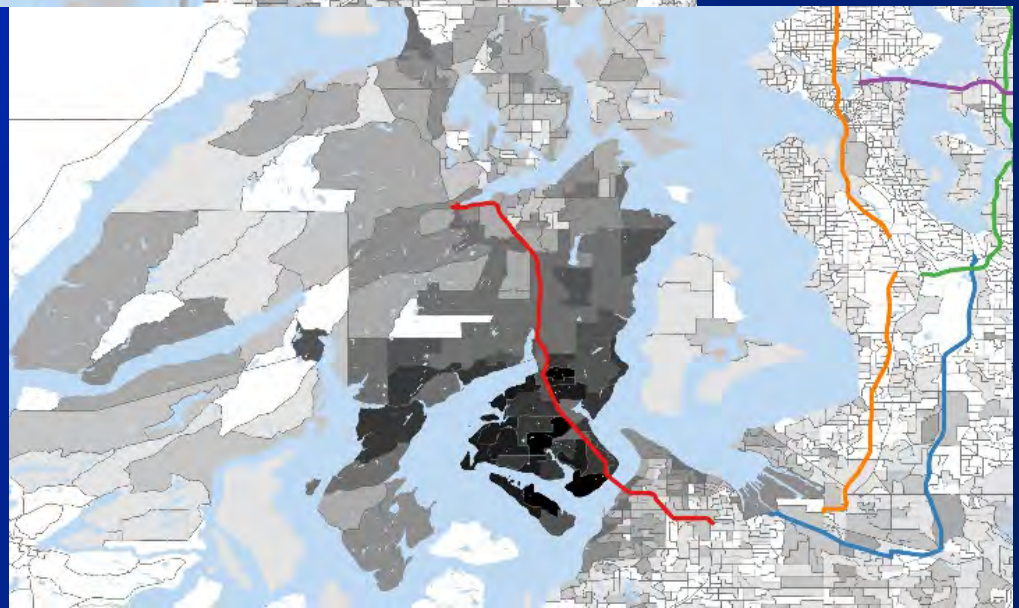
HH Income
$100K - $150K

HH Income
>$150,000

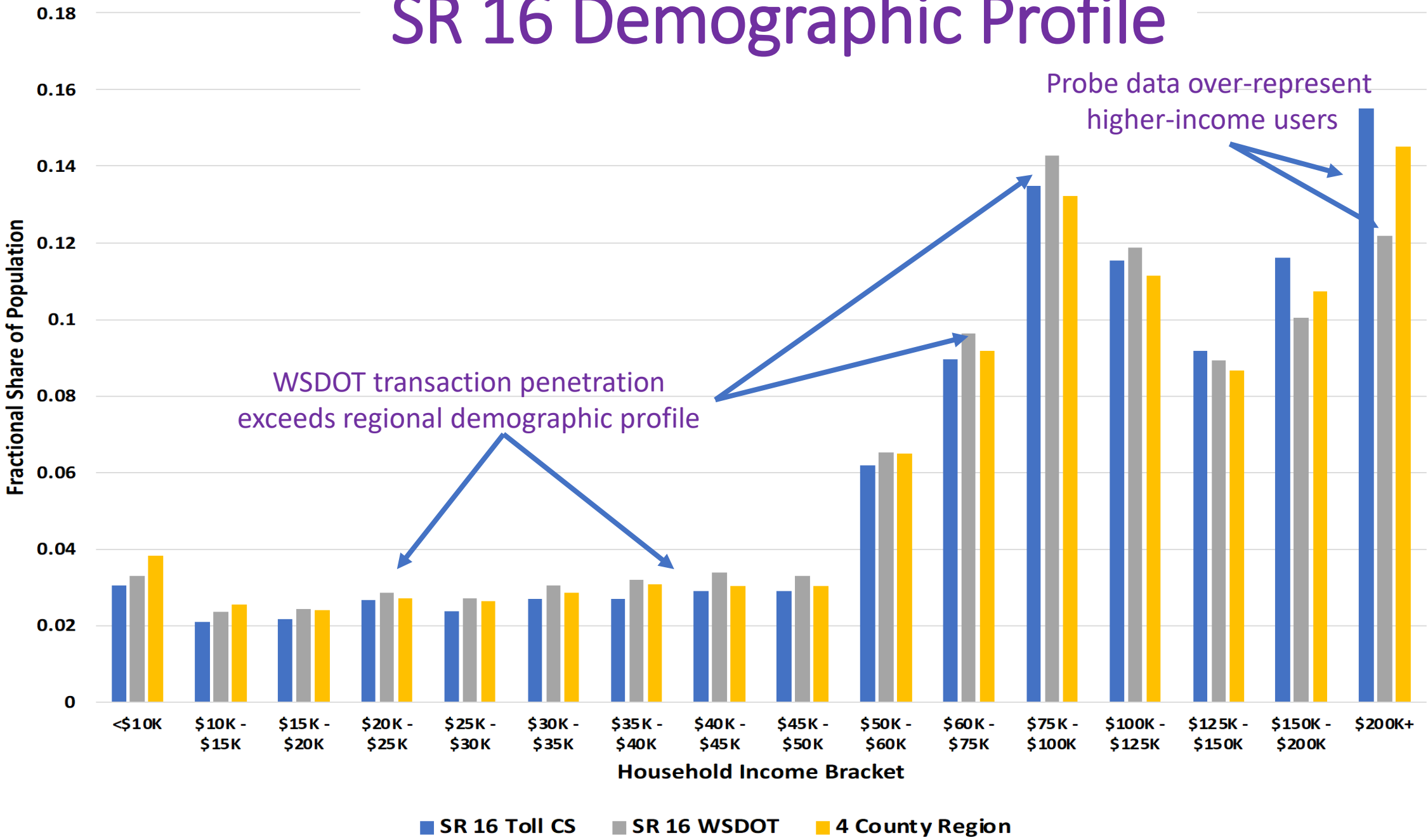
HH Income
<$50K



HH Income
$50K - $100K



SR 16 Demographic Profile



SR 16 Demographic Profile

- No realistic non-toll alternative to the Tacoma Narrows bridge
- Trends are similar to those observed on SR 167
  - Similar to SR 99 as well, EXCEPT for higher-income brackets
- WSDOT toll transaction are typically higher than census demographic distributions, especially in the middle-income bracket ($60K - $125K), but not the higher income brackets
- Probe data over-estimates facility use by higher income households and slightly under-estimates use by lower-income households

Value of Time (VOT) and Value of Reliability (VOR) Computations

VOT & VOR

- Two different types analyses were performed
- Use the method developed by DSSG in 2019 to examine
  - Change on VOT and VOR on I-405 from 2018 to post-pandemic 2021/22
  - Compute VOT & VOR on SR 167, and compare to I-405
- Use the difference in travel time between O/D pairs available through LBS data to compute time savings for toll facilities with no direct GP comparison

Summary Findings: I-405

- VOT increased slightly
- VOR decreased fairly significantly
- Elasticity changed moderately
- Details described shortly

Summary Findings: SR 167

- The technique did not provide results with a high degree of reliability
- PM peak period (southbound) results are mostly reasonable, but quite different than observed on I-405
- AM peak period (northbound) are not very reasonable
- Details described shortly

Summary Findings: SR 99/SR 520/SR 16

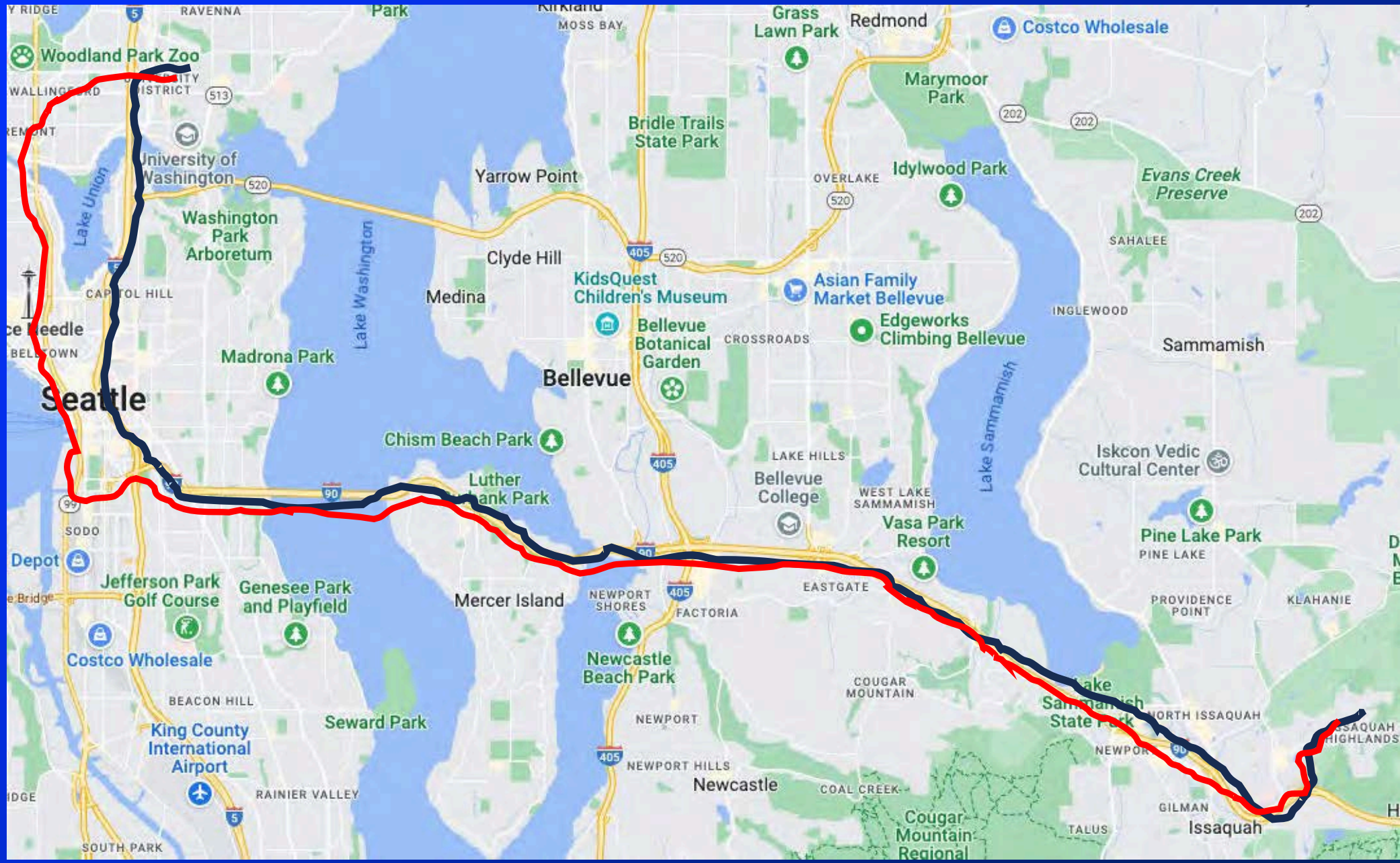
- Planned technique did not work
  - Origins & destinations are too distributed to provide good direct comparisons
    - Statistical comparisons have small sample sizes for individual O/D pairs
  - Considerable variability is present in most O/D pair travel times
    - Informed decision-making means that measured Toll and Non-toll travel times are not representative of conditions experienced by travelers
      - Motorists are more likely to take non-toll routes when time savings on toll routes are expected to be low that day
  - Attempts to work around these limitations were not successful
    - Different geographic / time of day aggregations
    - Use of a limited set of O/D pairs – those with highest volumes

Mark's Friday afternoon trip

If I-5 is bad take SR 99

Unless SR 99 is also bad

Then either I-5 or SR 520 / I-405



Summary findings: SR 99/SR520/SR 16

- So we need a different approach for testing the value of time/reliability of these roads

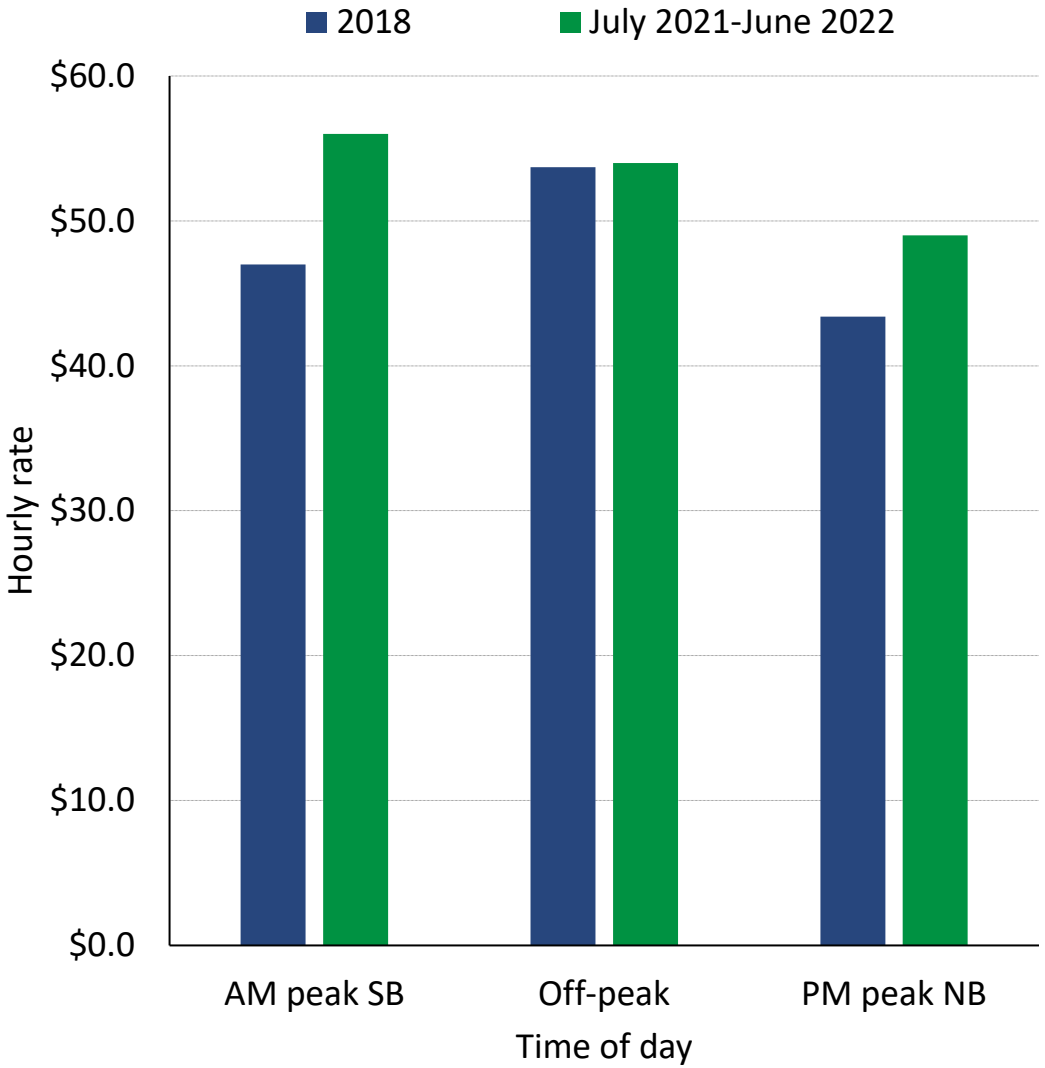
- Data exist that allow comparison of actual travel times by route, but those data are costly, and require a better understanding of WHICH O/Ds we wish to compare
  - There is a large variation in the O/Ds which use these facilities

I-405 Analysis Worked! ☺

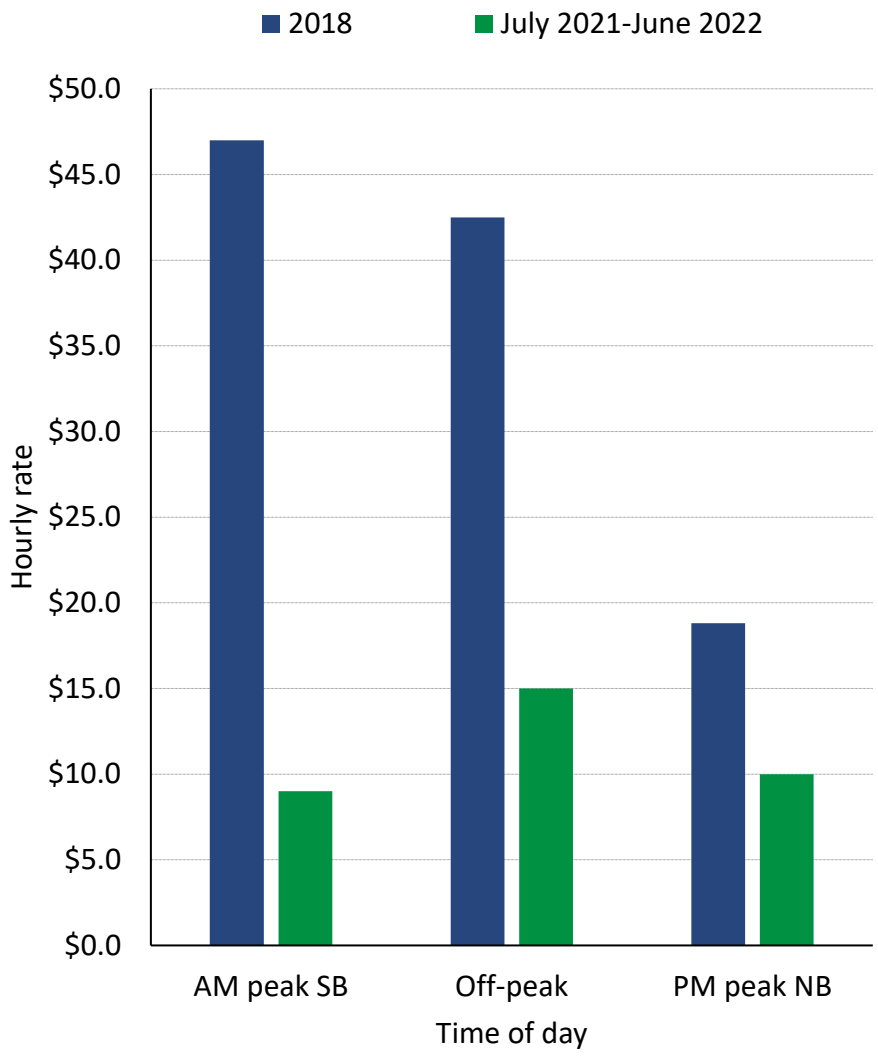
Overall Corridor Values

Parameter	Year	
	2018	July 2021-June 2022
Value of Time (VOT)	$53.1 per hour	$56.6 per hour
Value of Reliability (VOR)	$26.4 per hour	$14.0 per hour
Elasticity	-0.64	-0.71

VOT and VOR estimates by time of day and direction

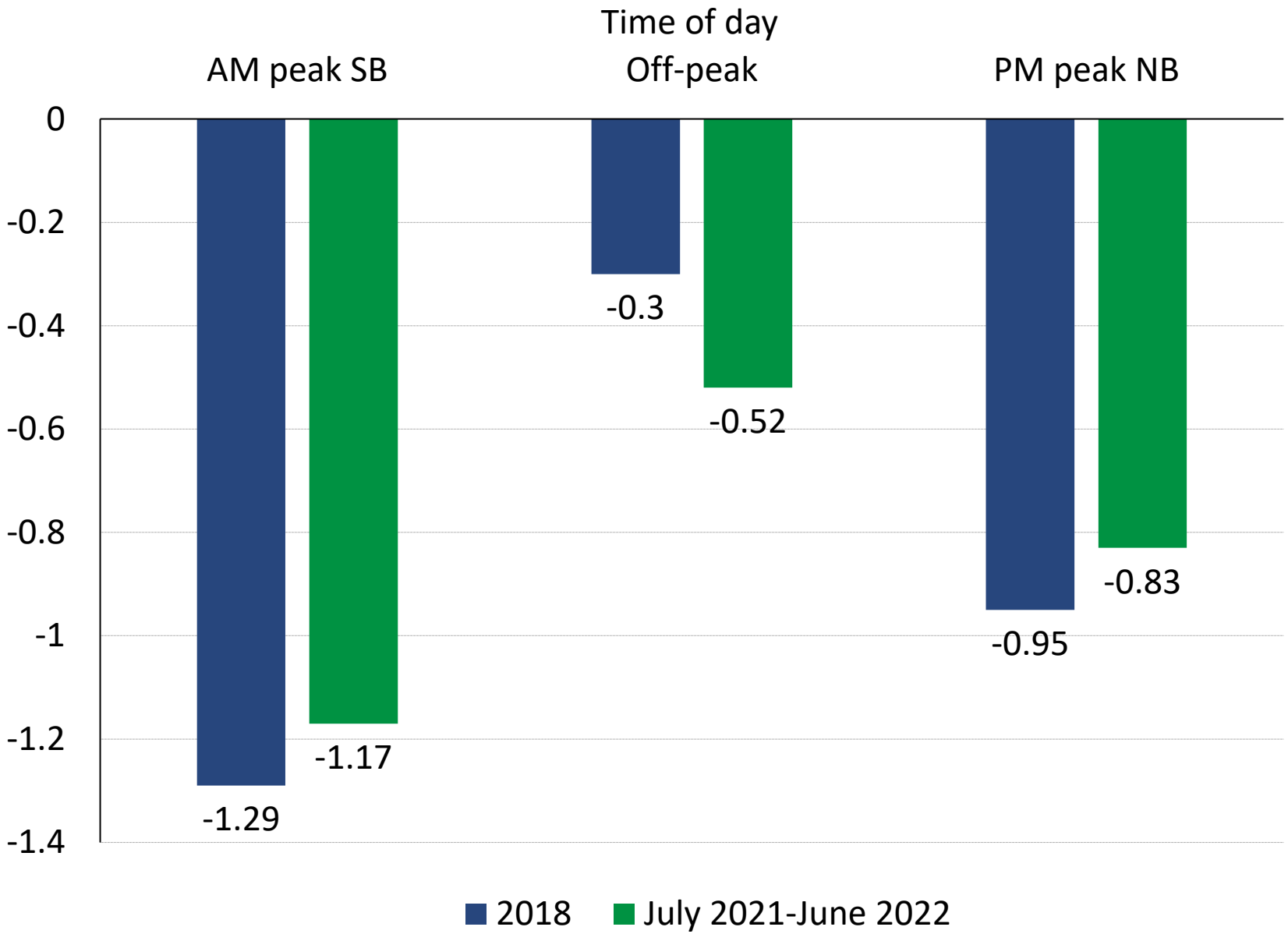


VOT

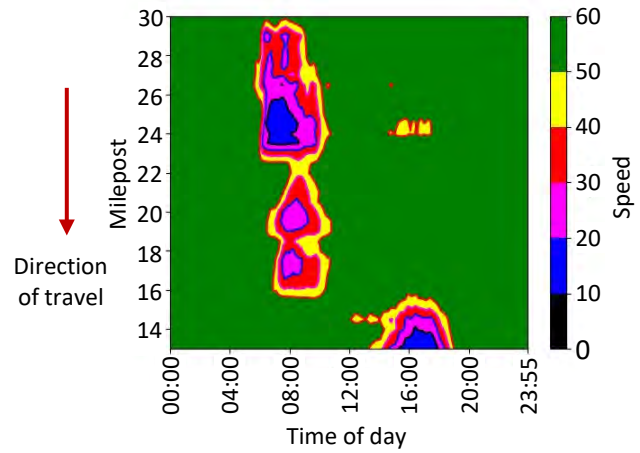


VOR

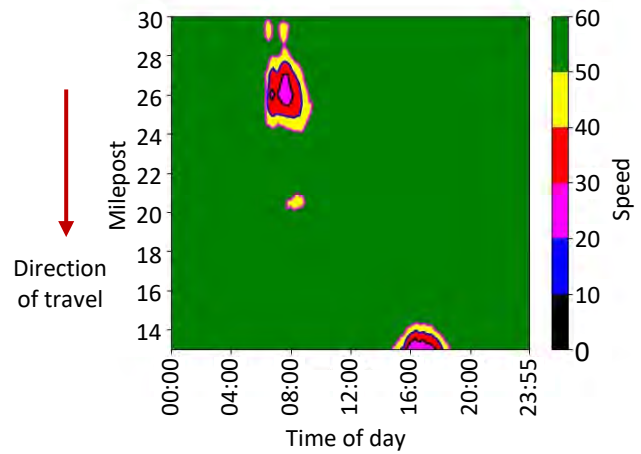
Price Elasticity Estimates By Time Of Day And Direction



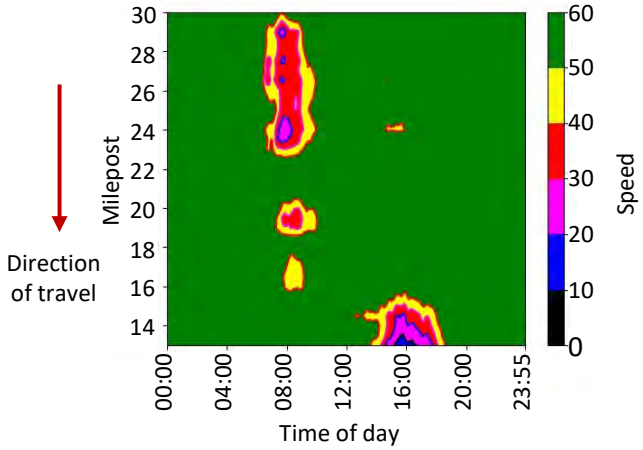
Mean Speed by Location and Year in Southbound Direction



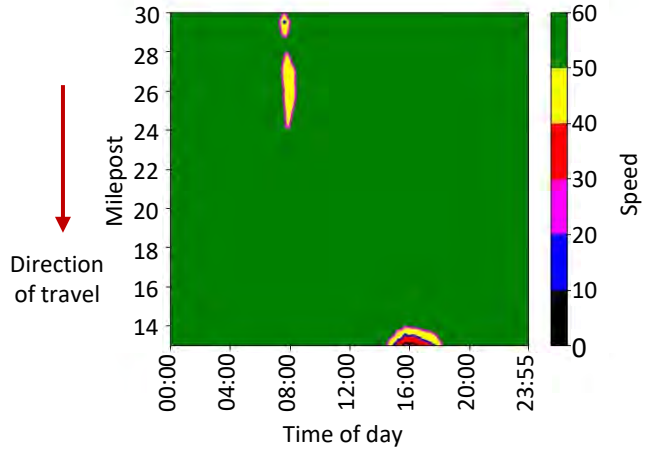
GP (2018)



ETL (2018)

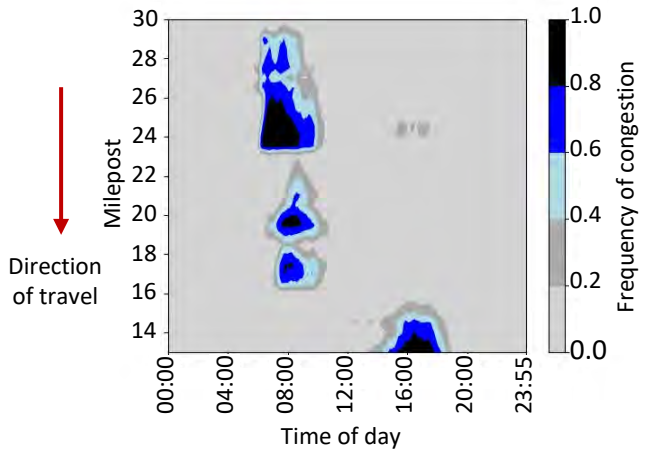


GP (July 2021-June 2022)

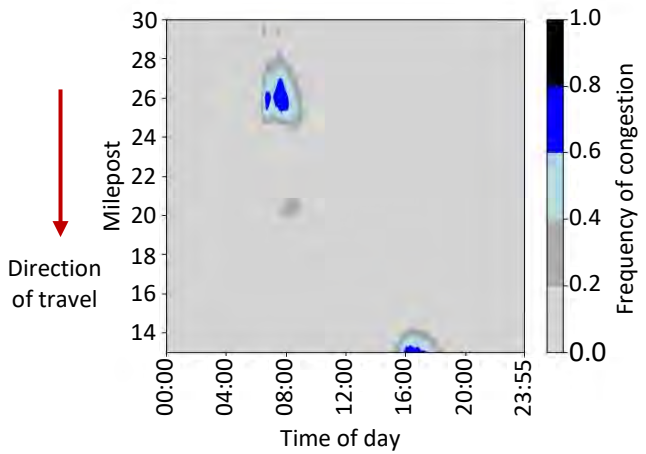


ETL (July 2021-June 2022)

Frequency of Congestion by Location and Year in Southbound Direction



GP (2018)



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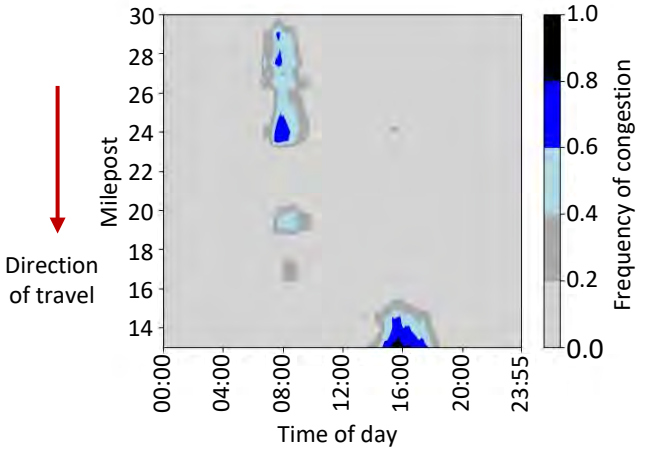
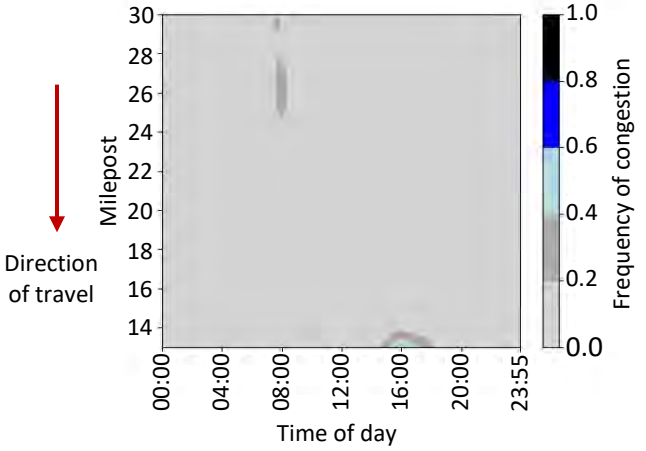
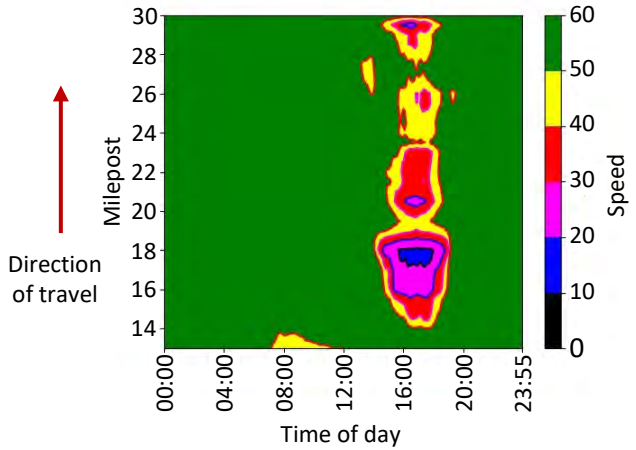


GP (Jul 2021-Jun 2022)



ETL (Jul 2021-Jun 2022)

Mean Speed by Location and Year in Northbound Direction



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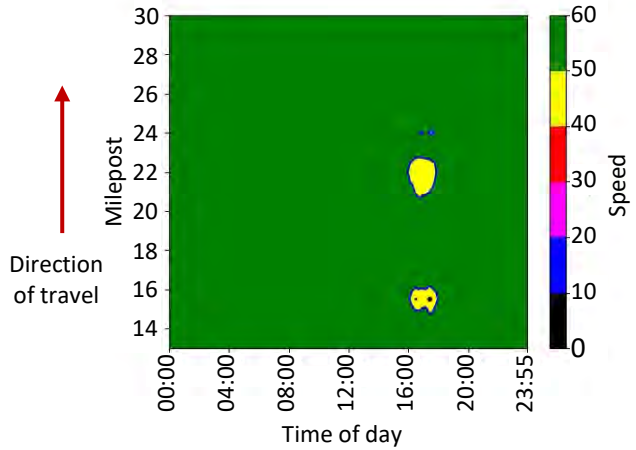

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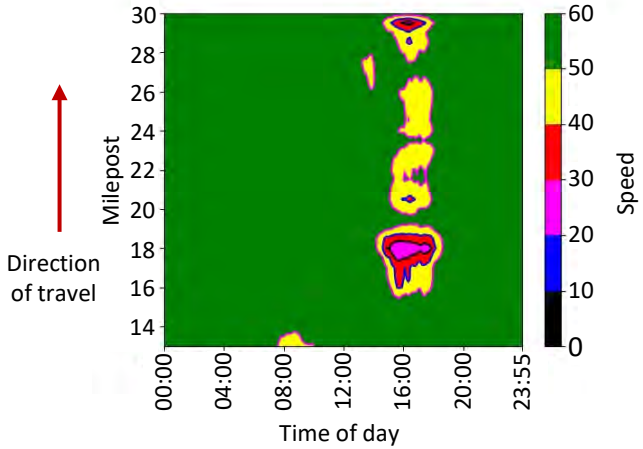

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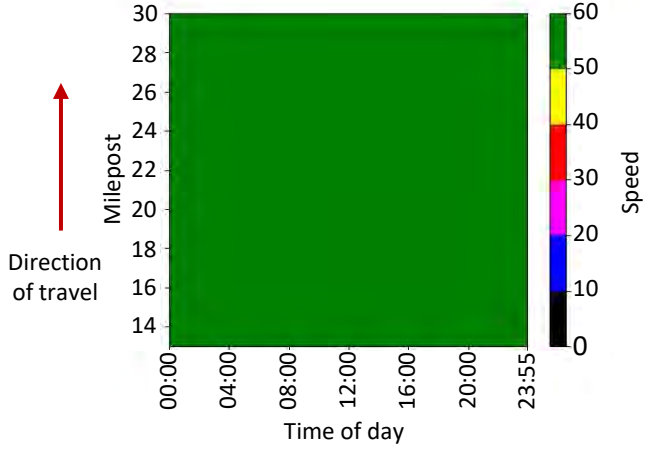

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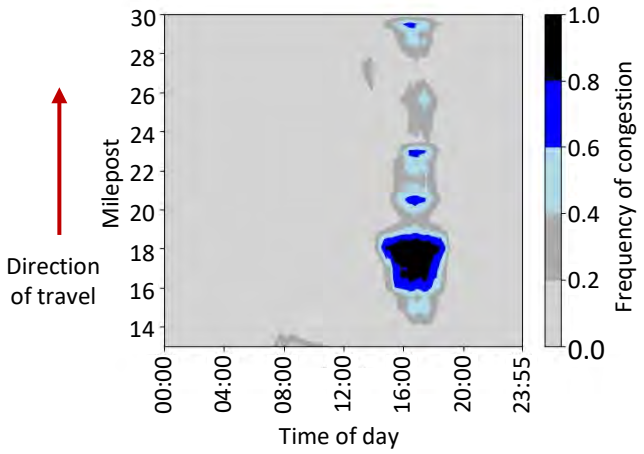
Frequency of Congestion by Location and Year in Northbound Direction



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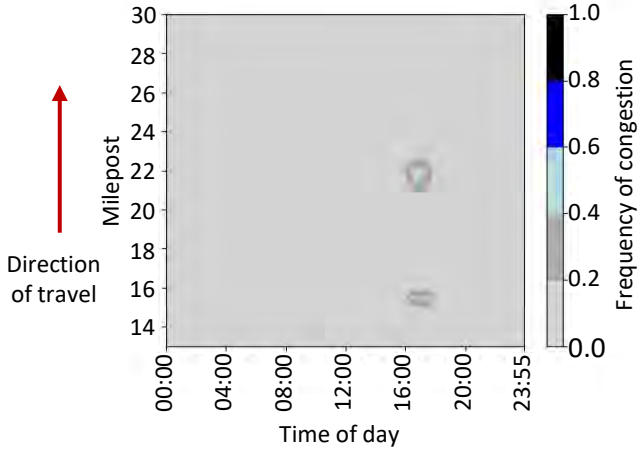

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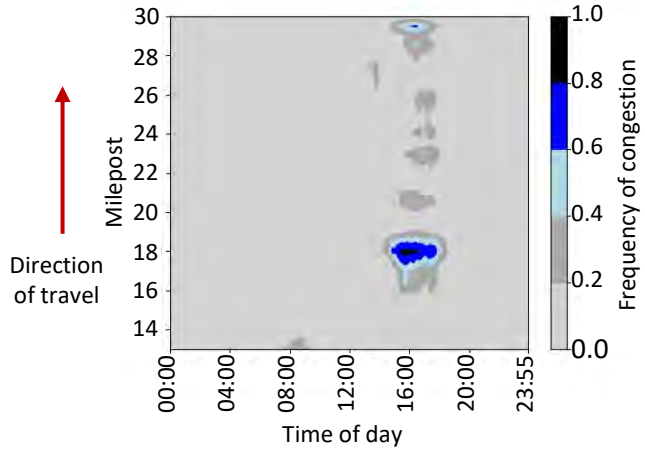

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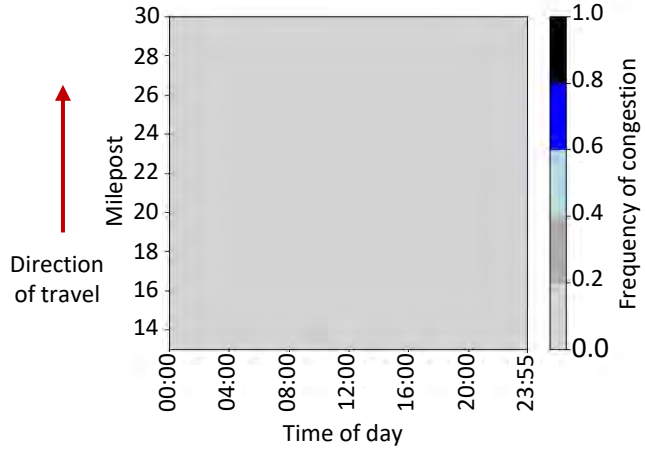
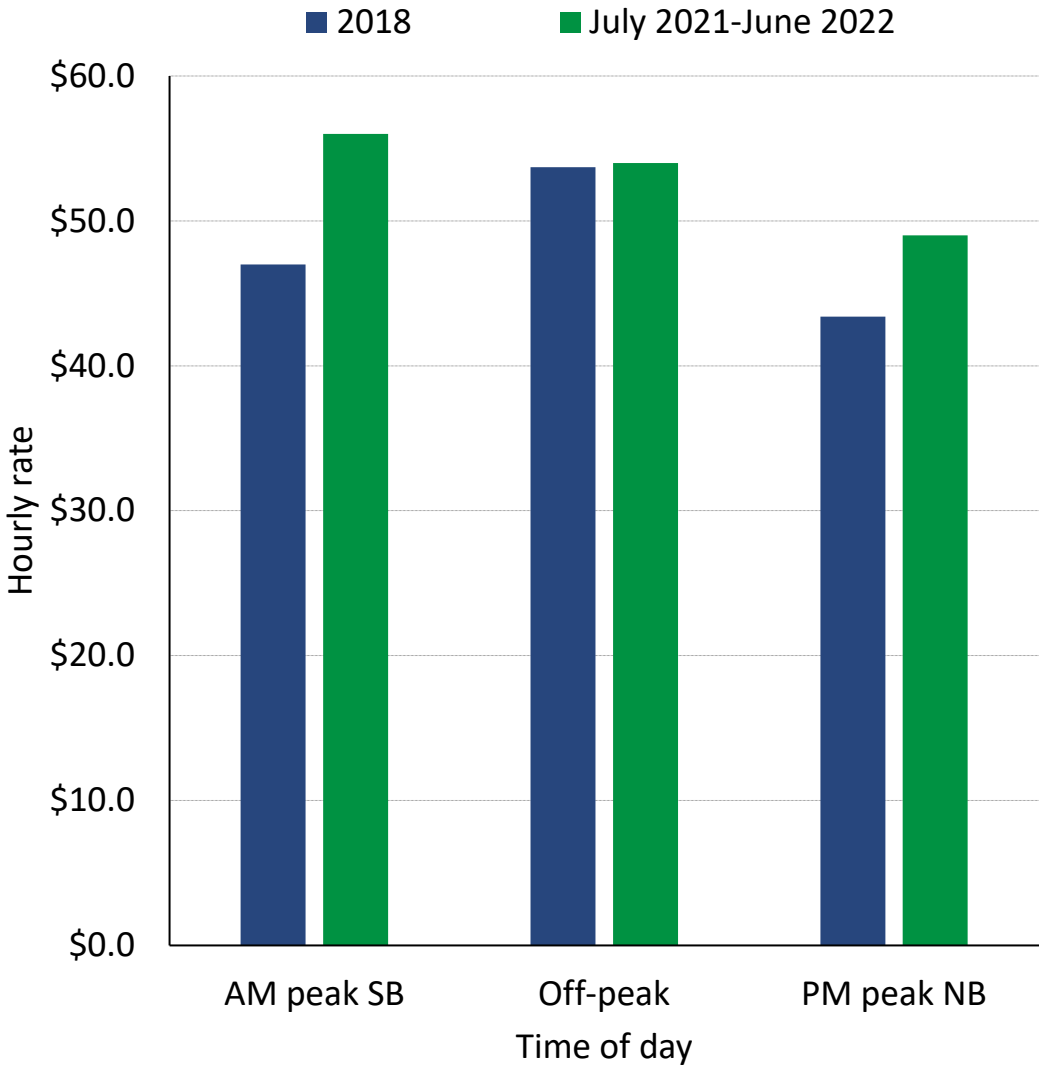
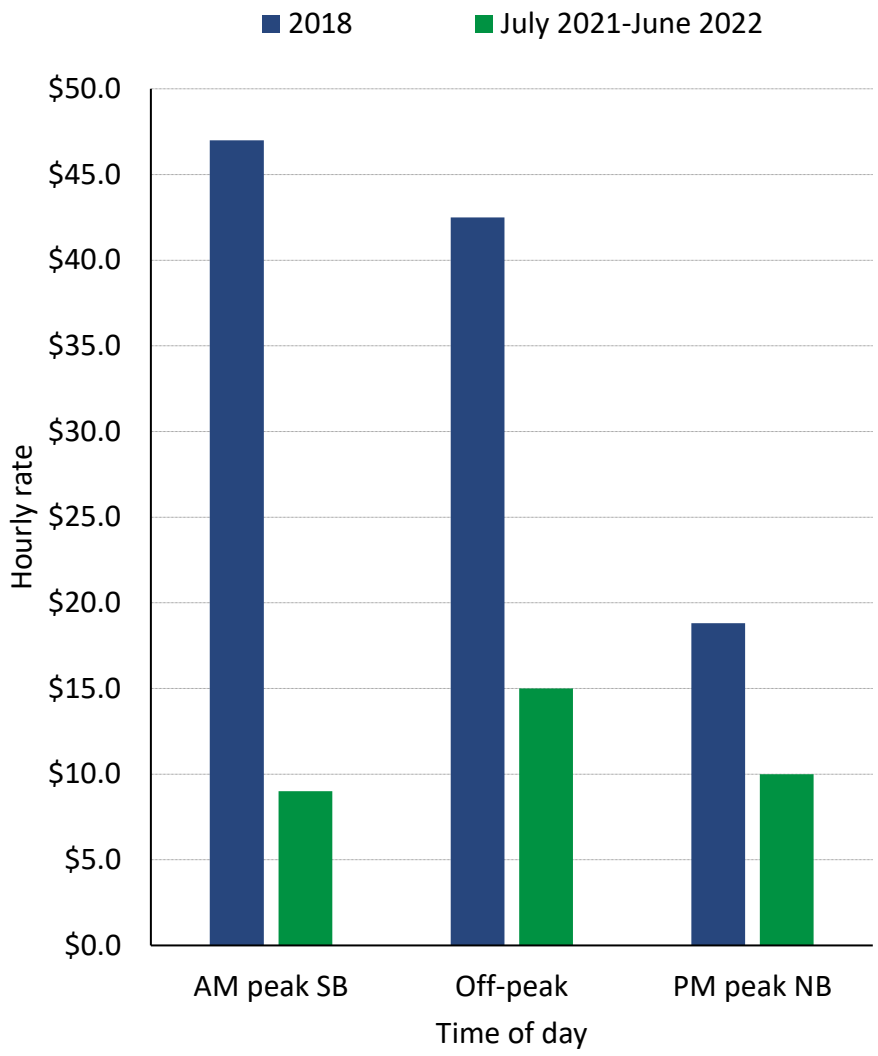


ETL (Jul 2021-Jun 2022)

VOT and VOR estimates by time of day and direction



VOT



VOR

Sketchy Values of Time and Reliability on SR 167

PM Southbound	7/2021 – 6/2022
VOT	$59.9 / hr
VOR	-$12.2 / hr
Elasticity	0.818
AM Peak	
VOT	-$203.0 / hr
VOR	-$114.0 / hr
Elasticity	0.565
Off Peak	
VOT	$61.7 / hr
VOR	-$10.3 / hr
Elasticity	0.256

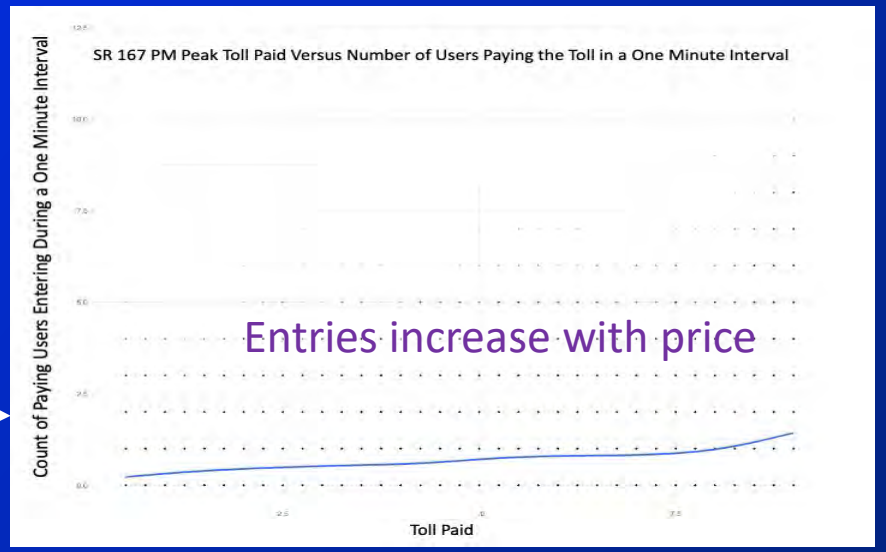
SR 167 Discussion

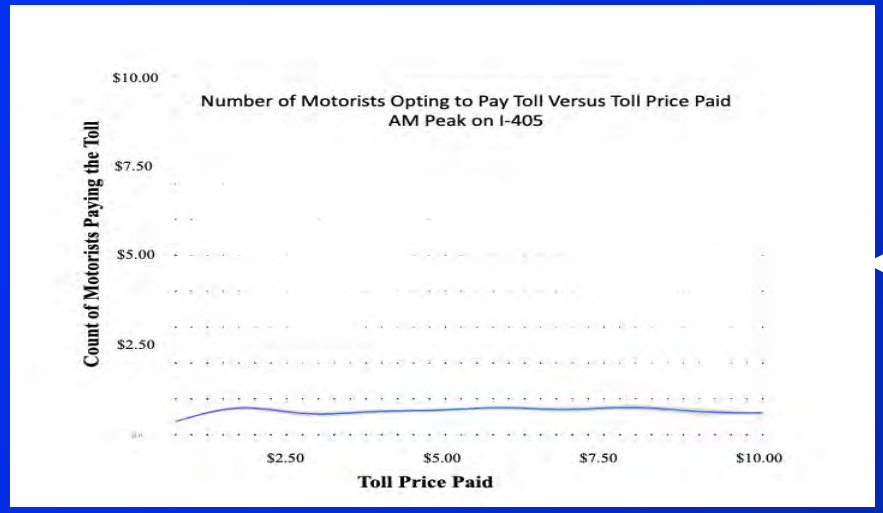
- We have done a lot of analysis, but still struggle to fully understand why these results are what they are
  - Major data issues did occur with WSDOT data in 2021/2022
  - How the corridor is used is very different than on I-405
    - Price is not related to distance, and thus time savings vary more widely with price
    - Variable corridor O's/D's are reflected in computed time savings, but those aren't reflected in price
    - AM prices are very low, and may be so low that they are low enough where time savings may be less important than other factors (use of lower volume lane)
    - Reliability of AM northbound is extremely different than PM southbound (as is price)
    - Entry/exit is not constrained geographically (so no incentive to get in early based on reliability)

Comparing Effect Price Has on Toll Entries

SR 167
AM NB

PM SB

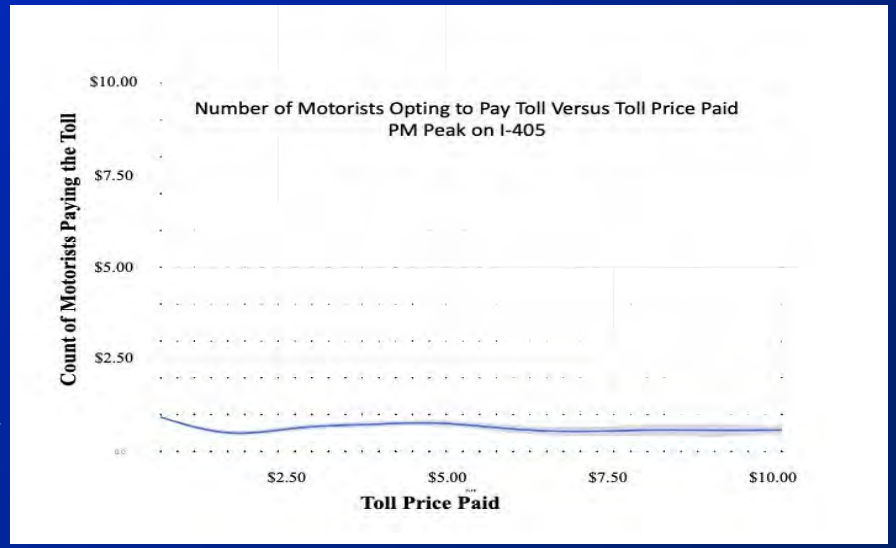




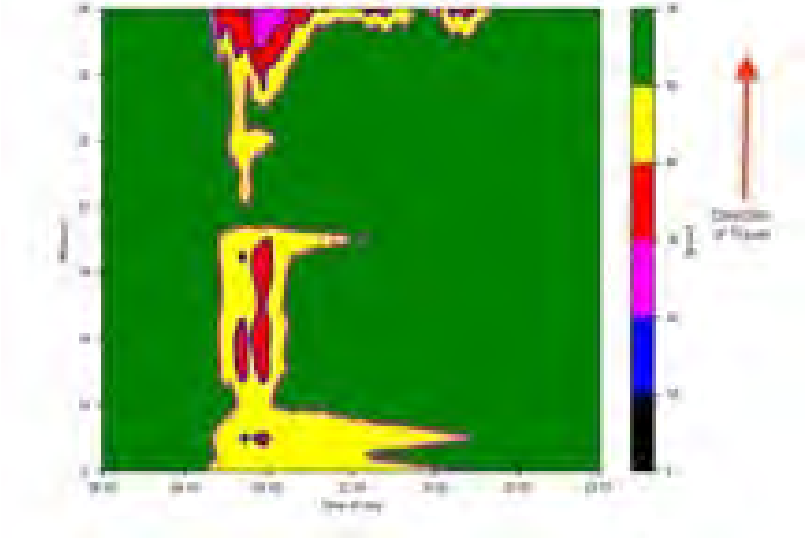
I-405
AM SB

PM NB

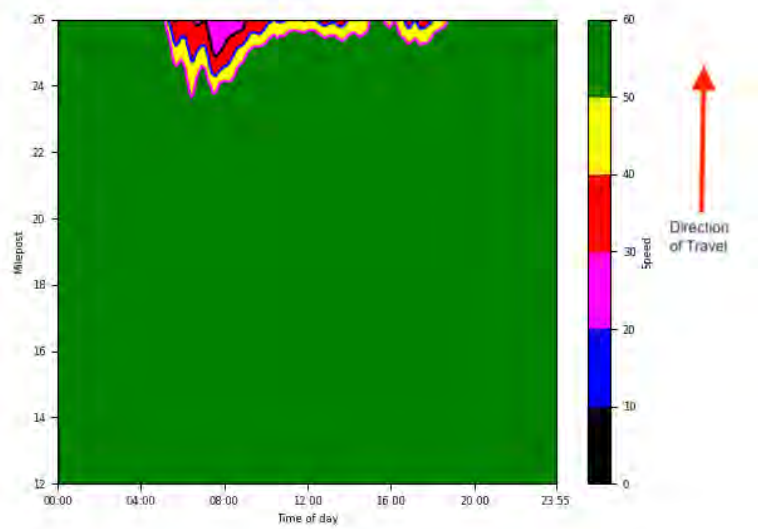
Both curves
stay flat



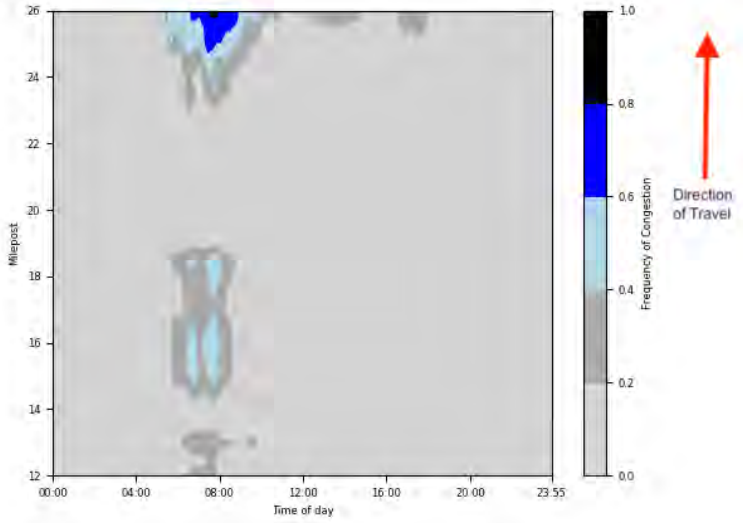
SR 167 Northbound Roadway Performance



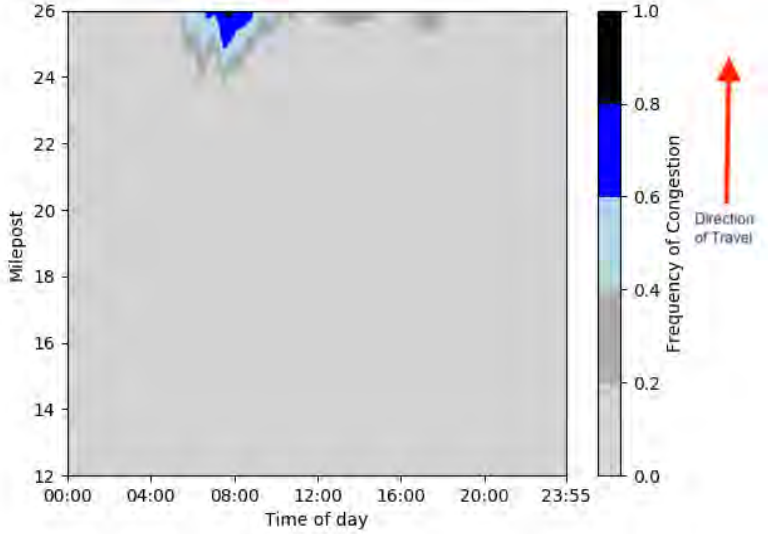
Average 2021/22 GP conditions



Average 2021/22 HOT Conditions

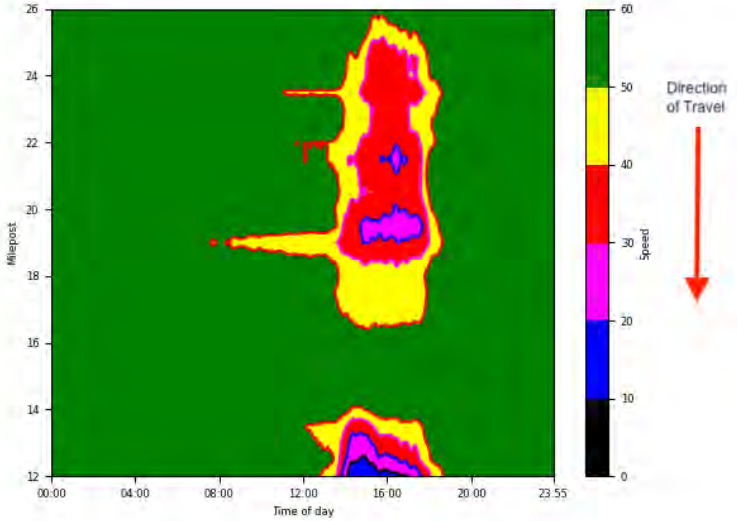


2021/22 Frequency of GP Congestion

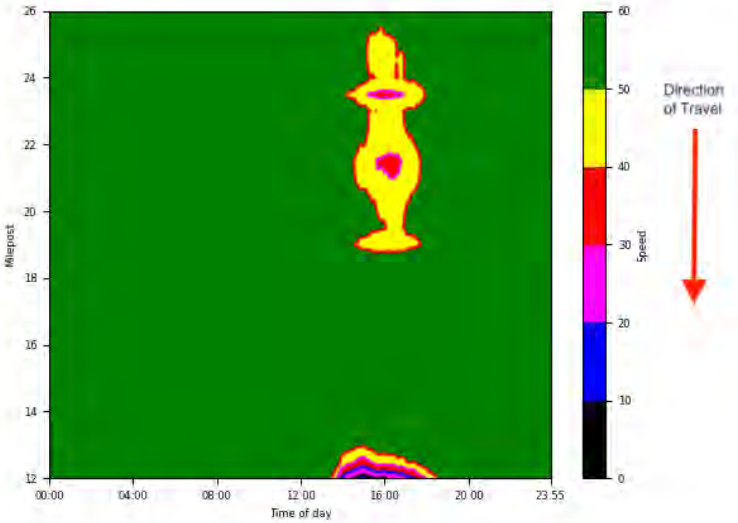


2021/22 Frequency of HOT Congestion

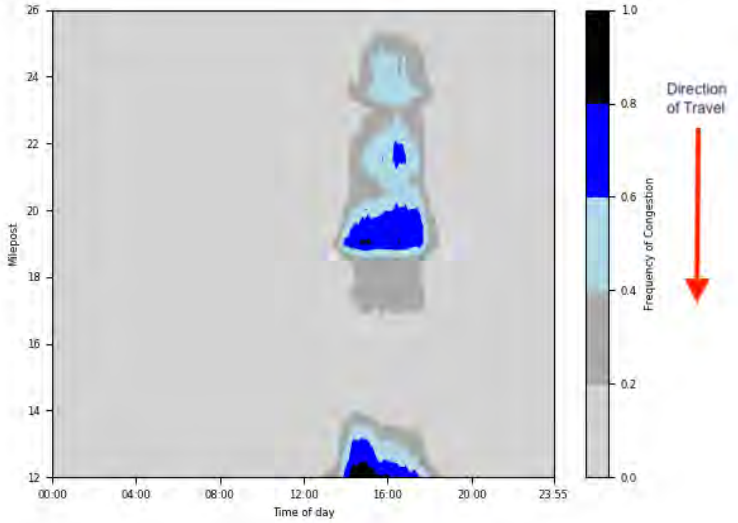
SR 167 Southbound Roadway Performance



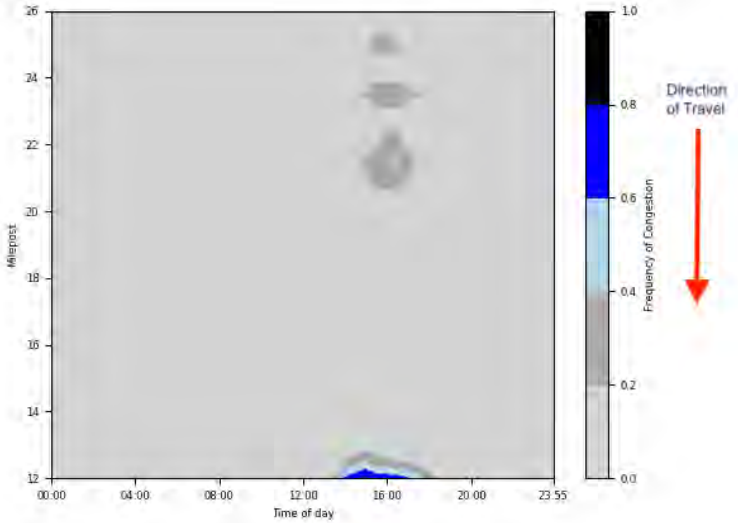
Average 2021/22 GP conditions



Average 2021/22 HOT Conditions



2021/22 Frequency of GP Congestion



2021/22 Frequency of HOT Congestion

The Best Conclusions We Have To Date about SR 167

- The combination of very different decision-making criteria for trips on SR 167
  - Corridor length AM northbound, vs
  - Short distance travel AM northbound, vs
  - Corridor length PM southbound, vs
  - Mid-corridor PM southbound entrances

  - Combined with highly variable corridor conditions, and
  - Unlimited choice or entry and exit for decision making
- Results in multiple price/performance outcomes that when combined hinder the performance of the selected mathematics.

Project Findings Summary

- On I-405, VOT went up slightly while VOR went down
- On SR 167 behavior (and thus VOT/VOR) NB is very different than SB. VOT/VOR computations were not very reliable
- For all five toll facilities, no significant surprises were observed in who is using the WSDOT toll facilities
  - Higher income households typically are over-represented on the facilities
  - Moderate income households are well represented on the southern roads

Project Findings Summary

- Geography plays a large role in who uses which facilities

- But it is very difficult to summarize specific travel sheds relative to income (who is over- under-using the facilities) as origins/destinations on the corridors vary considerably as do household incomes