Review of Interstate Bridge Replacement Project
Draft Supplemental Environmental Impact Statement ("DSEIS")

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Executive Summary

I have reviewed the Interstate Bridge Replacement Project Draft Supplemental Environmental Impact Statement ("DSEIS"). I make the following findings:

1) Analysis of existing traffic data clearly shows that the Interstate Bridge is not the I-5 bottleneck. Rather, I-5 has two separate bottlenecks, at N. Lombard for a.m. (southbound) traffic and at N. Victory Boulevard for p.m. (northbound) traffic.
    a. In the morning peak period, southbound bridge congestion is caused by traffic spillback from significantly more congested I-5 segments to the south centered on N. Lombard.
    b. In the afternoon peak period, extreme I-5 northbound congestion south of N. Marine Drive, centered at Victory Boulevard causes the bridge to operate in an intermediate queue discharge condition as traffic flow begins to return to normal flow conditions that are achieved just north of the bridge.
2) Widening the bridge would do nothing to improve I-5 congestion and could make it worse, because expanded bridge capacity will funnel even more traffic into the actual, unresolved bottlenecks.
3) The DSEIS relies on invalid traffic forecast metrics derived from a series of two classes of traffic models:
    a. The regional model grossly exaggerates future traffic growth because it uses an outdated "static traffic assignment" methodology that ignores the metering effects of sequential bottlenecks.
    b. The more detailed VISSIM microsimulation operations models used to create "heat maps" of congestion rely directly on exaggerated forecasts from the regional model and translate them into unrealistic travel speed and travel time estimates, i.e. "garbage in – garbage out."
4) The DSEIS modeling is useless for understanding future traffic conditions because it overstates future traffic growth and fails to account for capacity limitations.
5) Transit investments could help address I-5 congestion, but the SDEIS models are not reliable in evaluating transit alternatives.
6) The I-5 corridor could carry much higher vehicle throughput at much higher speeds without widening if oversaturated flow could be prevented through more effective ramp metering and/or tolling. Existing I-5 ramp meters are poorly calibrated and do nothing to prevent the regular "hyper-congestion" that causes slow speeds and low traffic throughput on I-5.
7) The existing ramp metering system should be audited to determine why it is functioning so poorly, and operations should be improved. Better ramp timing could improve freeway traffic flow and reduce waiting lines at ramp signals, producing a win-win at low cost.
8) Implementing system-wide tolling on I-5 would actually would address the I-5 congestion that the IBR project falsely claims to address. ODOT's Regional Mobility Pricing Project analysis (September 11, 2023) found that system-wide tolling would improve speeds, and increase throughput.

Smart Mobility, Inc.

Smart Mobility is a consulting firm based in Thetford Center, Vermont founded in 2001 that offers advanced transportation modeling and planning services. We have worked on significant modeling projects throughout the United States including being the prime contractor with a $250,000 project with the California Air Resources Board to review advanced travel demand models and land use models.

Norman Marshall, President, specializes in analyzing the relationships between the built environment and travel behavior and doing planning that coordinates multi-modal transportation with land use and community needs. He has managed transportation projects in over 30 U.S. states including projects for the U.S. government, state transportation departments, Metropolitan Planning Organizations, cities, and public interest groups. Areas where Mr. Marshall's travel demand modeling expertise is nationally recognized include Dynamic Traffic Assignment ("DTA") accounting for induced travel, and modeling non-motorized trips.

Mr. Marshall has presented his innovative modeling work at many national conferences, including the Transportation Research Board's Planning Applications conferences in Portland (2019) and Raleigh (2017) and the Transportation Research Board's Tools of the Trade Conference for Transportation Planning in Small and Medium-Sized Communities in Kansas City (2018).

The DSEIS Traffic Analysis Mispresents Present Traffic Conditions

When stuck in traffic, it is natural to think that the traffic throughput is very high. However, that is not the case. The *Highway Capacity Manual* ("HCM") describes three different operations regimes. The highest speed and the highest throughput are achieved together in *undersaturated* flow conditions. In *oversaturated* (congested) conditions, both speed and traffic throughput are significantly lower. The third regime, *queue discharge flow*, is a transitional stage when traffic flow gradually returns from oversaturated to undersaturated flow conditions. The HCM descriptions of the three traffic flow regimes are:

1) *Undersaturated Flow* – Traffic flow during an analysis period (e.g. 15 min) is specified as undersaturated when the following conditions are satisfied: (1) the arrival flow rate is lower than the capacity of a point or segment, (b) no residual queue remains from a prior breakdown of the facility, and (c) traffic flow is unaffected by downstream conditions.

   Uninterrupted-flow facilities operating in a state of undersaturated flow will typically have travel speeds within 10% to 20% of the facility's free-flow speed, even at high flow rates, under base conditions (e.g., level grades, standard lane withs, good weather, no incidents). Furthermore, no queues would be expected to develop on the facility.

2) *Oversaturated Flow* – Traffic flow during an analysis period is characterized as *oversaturated* when any of the following conditions is satisfied: (a) the arrival flow rate exceeds the capacity of a point or segment, (b) a queue created from a prior breakdown of a facility has not yet dissipated, or (c) traffic flow is affected by downstream conditions.

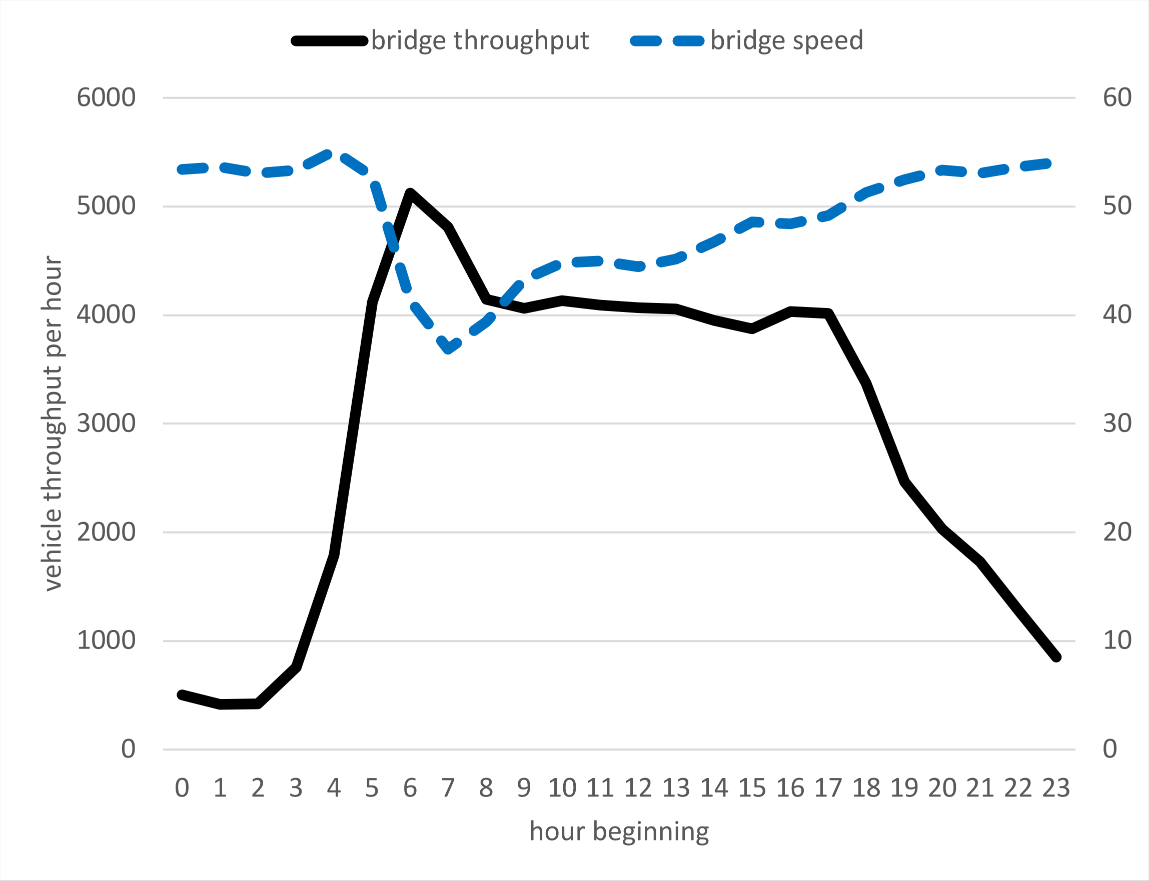
   On uninterrupted-flow facilities, oversaturated conditions result from a bottleneck on the facility. During periods of oversaturation, queues form and extend backward from the bottleneck point. Traffic speeds and flows drop significantly as a result of turbulence, and they can vary considerably, depending on the severity of the bottleneck. . . On freeways, vehicles move slowly through a queue, with periods of stopping and movement. Even after the demand at the back of the queue drops, some time is required for the queue to dissipate because vehicles discharge from the queue at a slower rate than they do under free-flow conditions. Oversaturated conditions persist within the queue until the queue dissipates completely after a period of time during which demand flows are less than the capacity of the bottleneck.

3) *Queue Discharge Flow* – Queue discharge flow represents traffic flow that has just passed through a bottleneck and, in the absence of another bottleneck downstream, is accelerating back to the facility's free-flow speed. Queue discharge flow is characterized by relatively stable flow as long as the effects of another bottleneck downstream are not present.

   On freeways, this flow type is typically characterized by speeds ranging from 35 mi/h up to the free-flow speed of the freeway segment. Lower speeds are typically observed just downstream of the bottleneck. Depending on horizontal and vertical alignments, queue discharge flow usually accelerates back to the facility's free-flow speed within 0.5 to 1 mi. downstream of the bottleneck. The queue discharge flow rate from the bottleneck is lower than the maximum flows observed before the breakdown.[1]

Understanding I-5 traffic congestion requires understanding the three traffic flow regimes. Figure 1 shows average non-holiday weekday hourly vehicle throughput and speed for the southbound bridge based on data from all 2023 non-holiday weekdays.

Figure 1: 2023 Southbound Average Non-Holiday Weekday Hourly Bridge Vehicle Throughput and Speed[2]



The time periods for the different traffic flow regimes are:

- Undersaturated flow – 6 p.m. – 5 a.m. (hours beginning 0-4 and 18-23)
- Saturated flow – 5.am. – 5 p.m. (hours beginning 5-16)
- Queue discharge flow – 5 p.m. – 6 p.m. (hour beginning 17)

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[1] Transportation Research Board. Highway Capacity Manual, 7th Edition, 2022, p. 2-14 – 2-15.

[2] Vehicle throughput from ODOT automatic traffic recorder; speed from Regional Integrated Transportation Information System (RITIS).

Note that these the traffic patterns in these periods match the descriptions in the HCM.

- Undersaturated flow – Throughput is higher at the end of the undersaturated flow period (hours 6 and 7) than at any other time of the day
- Saturated flow – as the HCM states: "Traffic speeds and flows drop significantly."
- Queue discharge flow –. as HCM states: The queue discharge flow rate from the bottleneck is lower than the maximum flows observed before the breakdown."

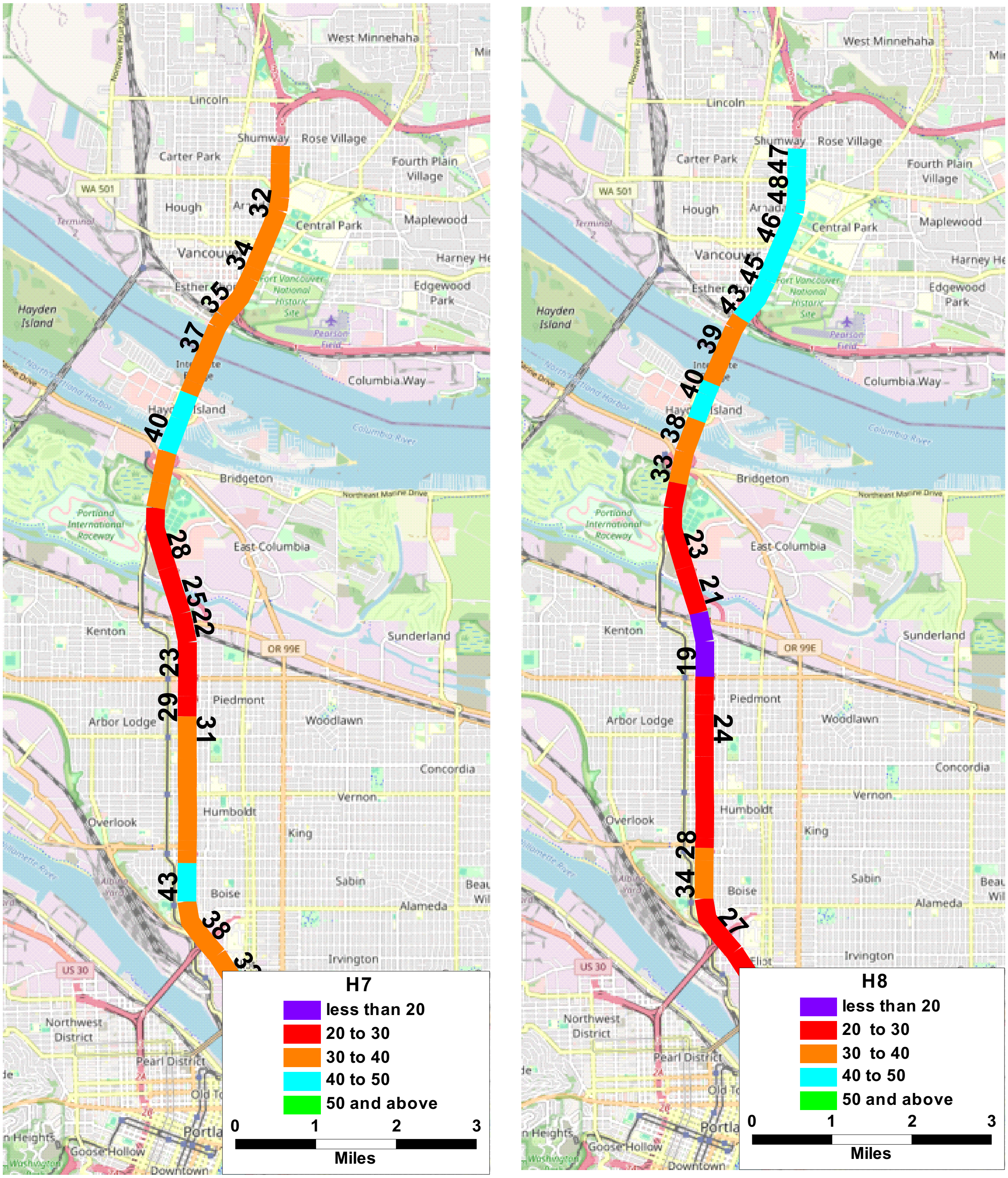
The key planning question is: what is the cause of the "breakdown" to oversaturated flow conditions? The HCM identifies three possibilities:

a) the arrival flow rate exceeds the capacity of a point or segment,
b) a queue created from a prior breakdown of a facility has not yet dissipated, or
c) traffic flow is affected by downstream conditions.

Capacity (a) is not the issue here. This question is addressed in more detail in a subsequent section. Prior breakdown (b) relates primarily to incidents including crashes, and these would have only a minor affect on the annual averages. Southbound morning congested (saturated flow) conditions result from downstream bottleneck conditions.

Figure 2 shows that I-5 southbound downstream of the bridge is much more congested than the bridge during the peak morning hours. The slowest a.m. Southbound speeds are reported from N. Victory Boulevard to N. Lombard, areas well south of the Interstate Bridge.

Figure 2: 2023 Non-Holiday Weekday Average Southbound Speed – 7-8 a.m. and 8-9 a.m. -
The Bottleneck is North of North Lombard Street



In Figure 2, the slowest speed/most congested segment is the 19 mph section shown in purple in the 8-9 a.m. hour which is north of North Lombard Street. Figure 3 adds the speeds for this bottleneck section to the data included in Figure 1.

Figure 3: 2023 Southbound Average Non-Holiday Weekday Hourly Bridge Vehicle Throughput and Speed and Speed at Bottleneck North of North Lombard St.[3]

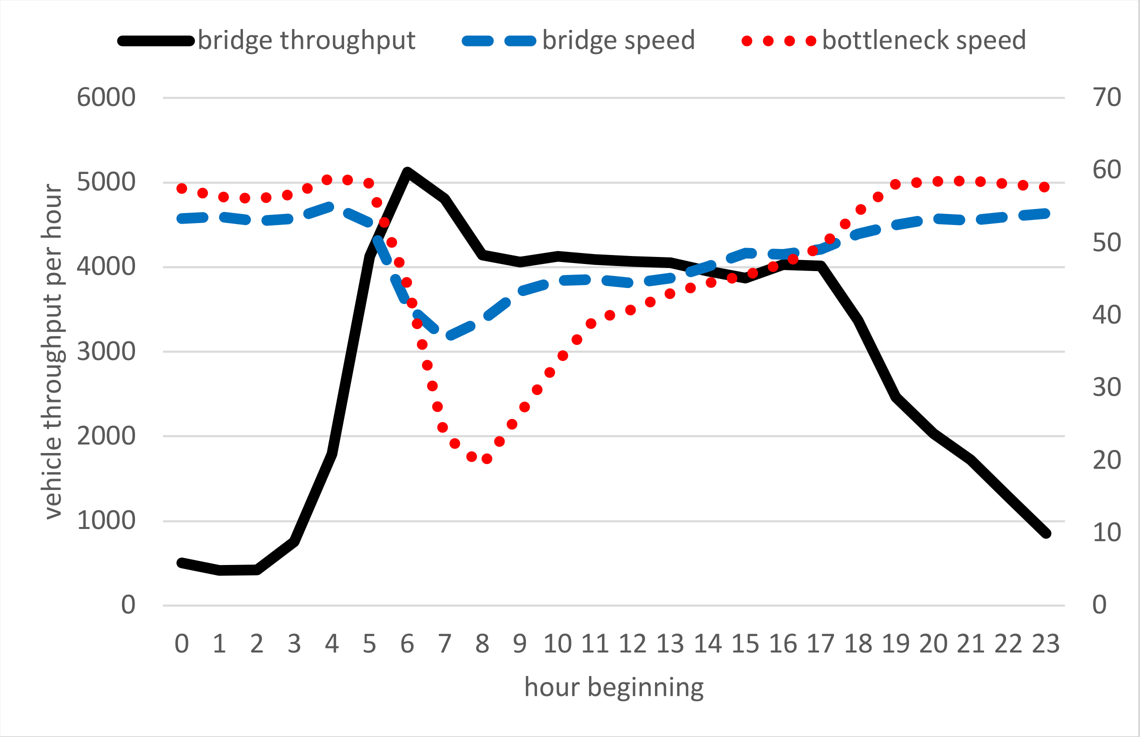


Figure 3 shows the same diurnal pattern of traffic flow regimes at the bottleneck location as on the bridge:

- Undersaturated flow – 6 p.m. – 5 a.m. (hours beginning 0-4 and 18-23)
- Saturated flow – 5.am. – 5 p.m. (hours beginning 5-16)
- Queue discharge flow – 5 p.m. – 6 p.m. (hour beginning 17)

However, the speed at the N. Lombard bottleneck is much lower than on the bridge. As is discussed below, this lower speed also indicates lower throughput than on the bridge. This lower throughput represents a temporary capacity constraint that limits upstream I-5 traffic throughput, including the southbound bridge. Reiterating the description in the HCM: “During periods of oversaturation, queues form and extend backward from the bottleneck point." This is why the southbound bridge is congested in the morning, queues are extending backward from the N. Lombard bottleneck point.

Widening the bridge would not increase either speed or vehicle throughput in the study area because throughput is metered by the downstream bottleneck at N. Lombard.

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[3] The RITIS data that is the source for the speed data also includes throughput estimates. However, these throughput numbers are estimates based on a sample of vehicle, and are less reliable than the speed data. Therefore, I am only using throughput data from the ODOT and WSDOT automatic traffic recorders.

As shown in Figure 4, p.m. peak northbound congestion in the I-5 corridor is significantly worse than southbound congestion, but the extreme congestion is south of the bridge. The worst segment is near the N. Victory Boulevard exist, just south of N. Marine Drive.

Figure 4: 2023 Non-Holiday Weekday Average Northbound Speed – 3-4 p.m. and 4-5 p.m.

The Bottleneck is near the N. Victory Boulevard exist, just south of N. Marine Drive

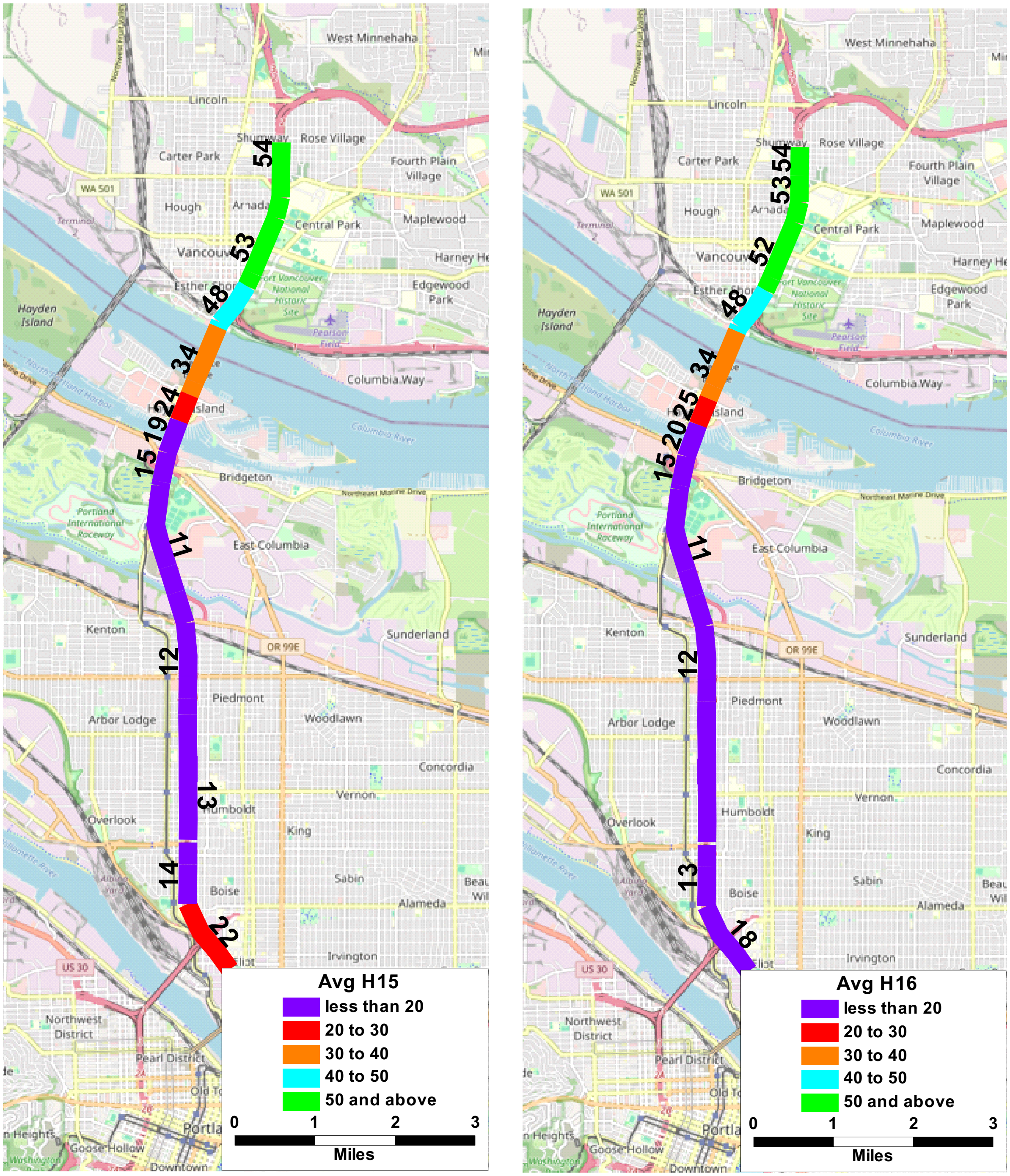
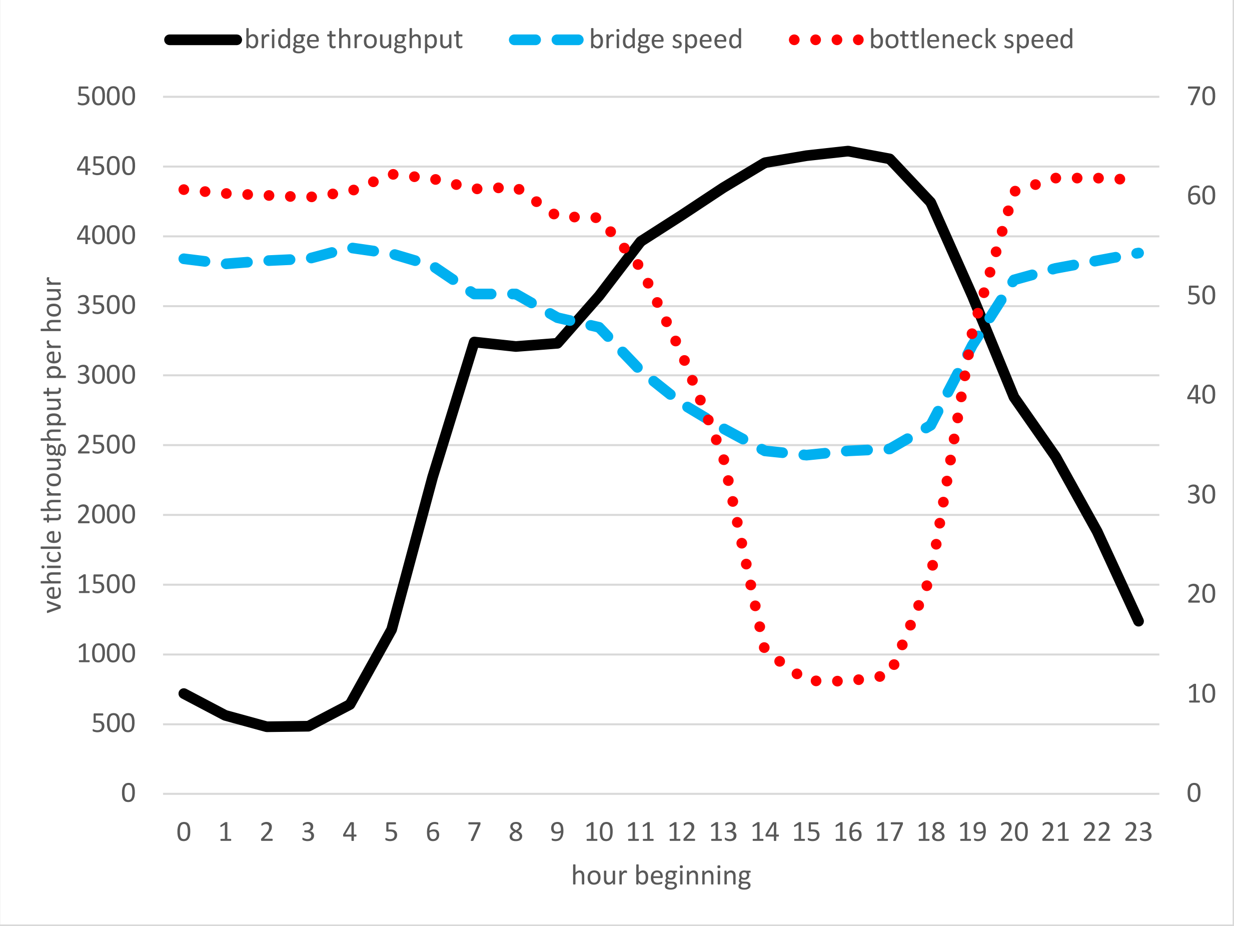


Figure 5 shows average non-holiday weekday hourly vehicle throughput and speed for the northbound bridge and the speed at the bottleneck at N. Victory Boulevard.

Figure 5: 2023 Southbound Average Non-Holiday Weekday Hourly Bridge Vehicle Throughput and Speed and Speed at N. Victory Boulevard Bottleneck



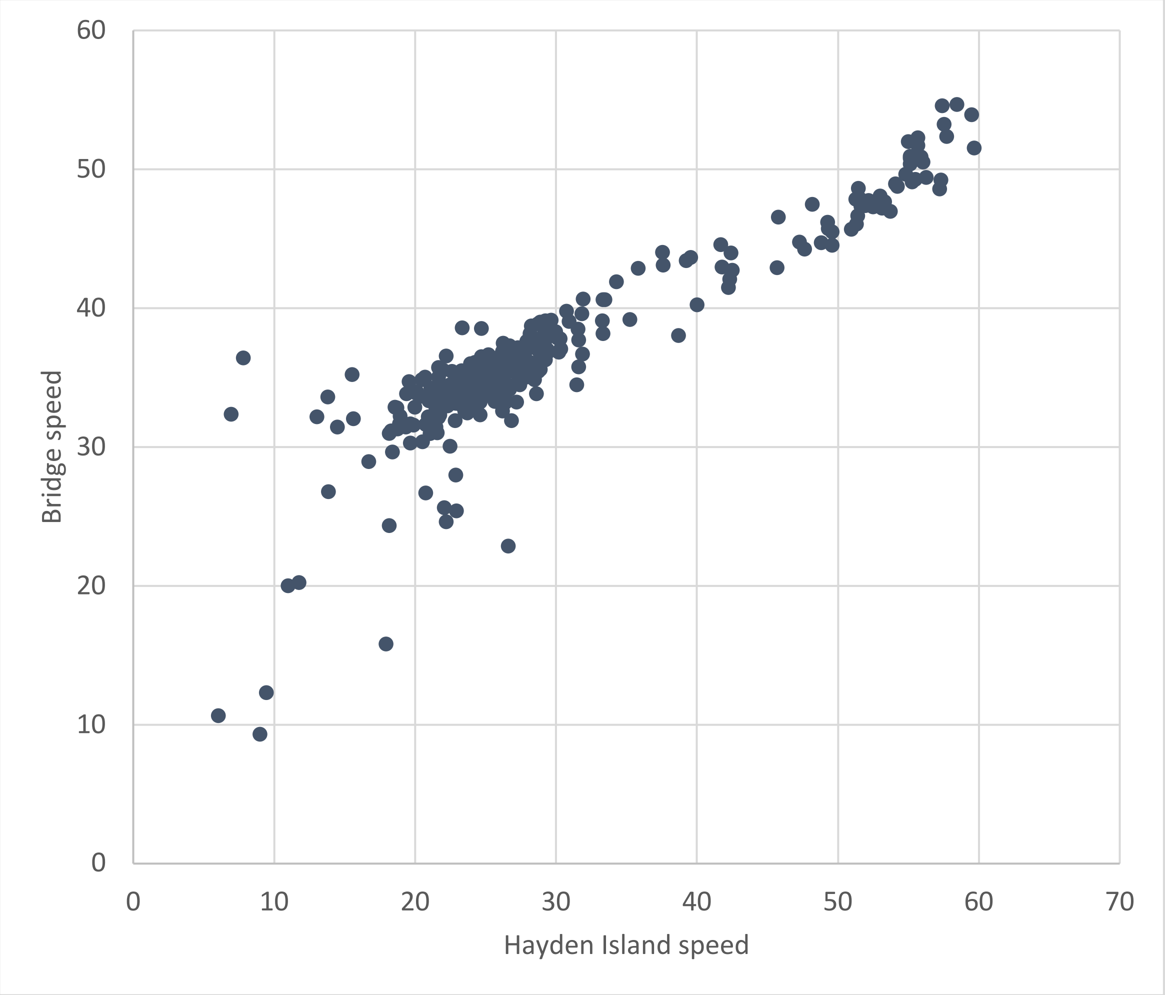
Focused first on the speeds at the N. Victory Boulevard bottleneck, the three traffic flow regimes are clearly visible:

- Undersaturated flow – 8 p.m. – 9 a.m. (hours beginning 0-8 and 20-23)
- Saturated flow – 9.am. – 6 p.m. (hours beginning 9-17)
- Queue discharge flow – 6 p.m. – 8 p.m. (hours beginning 18-19)

While the N. Victory Boulevard bottleneck experiences oversaturated flow, the Interstate Bridge does not appear to have significant oversaturated flow periods. Instead, there is a long period of queue discharge flow during which traffic flow recovers from speeds as low as 11 mph at the bottleneck to 34 mph over the approximately one mile distance between the N. Victory Boulevard bottleneck and the bridge, and then to 48 mph just north of the bridge in both the 4-5 p.m. and 5-6 p.m. hours.

The afternoon northbound queue discharge flow regime begins on Hayden Island. Figure 6 graphs data from Hayden Island and the bridge together for individual afternoon peak period hours. It shows the northbound speed on the bridge in the afternoon peak period is about 10 mph faster than the upstream road segment on Hayden Island.

Figure 6: 2023 Non-Holiday Weekday Northbound Bridge Speed vs. Hayden Island Speed – 3-4 p.m.



The largest cluster of data points in Figure 6 is for hours where the Hayden Island speed is between 20 mph and 30 mph, and the bridge speed is 10 mph higher, i.e., between 30 mph and 40 mph. The increase in speed on the bridge is even greater than 10 mph because vehicles are accelerating from the slower start on Hayden Island. As shown in Figure 4 above, the average speed on the first Washington segment is 14 mph faster than the average bridge speed. This suggests that the speed increase on the bridge from beginning to end is over 20 mph. The bridge is not the bottleneck; it is the road segment after a series of bottlenecks where better traffic flow resumes. This is consistent with the HCM description of queue discharge flow which states: “queue discharge flow usually accelerates back to the facility’s free-flow speed within 0.5 to 1 mi. downstream of the bottleneck.”

Widening the bridge could speed up this queue discharge process slightly by letting vehicles spread out over more lanes, but it would not increase vehicle throughput because vehicle throughput on the bridge is metered by the upstream bottleneck at N. Victory Boulevard.

The DSEIS takes a myopic view of the project as shown in DSEIS Figure 1-1 reproduced here as Figure 7. This myopic view apparently prevents a full understanding of traffic flow in the larger I-5 corridor.

Figure 7: DSEIS Figure 1-1 Program Vicinity (DSEIS p. 1-2)

Regarding p.m. northbound congestion in the study area, the DSEIS states:

> In the northbound direction, the main bottleneck originates at the Interstate Bridge and lasts for 8.75 hours between 11:15 a.m. and 8 p.m. The congestion extends south from the Interstate Bridge and influences traffic flows south of the study area, back to I-405 and I-84. (DSEIS p. 3.1-7)

This is simply wrong. As demonstrated above, the bottleneck does not originate at the Interstate Bridge. It ends about a mile south of the bridge, just past the N. Victory Boulevard bottleneck. Queue discharge flow conditions are present on the bridge due to the extreme upstream congestion, but the queue discharge is mostly completed by the north end of the bridge.

The DSEIS fundamentally misrepresents existing northbound traffic conditions in the I-5 corridor and, in doing so, creates an erroneous "need" for the project.

The DSEIS also misrepresents a.m. southbound congestion when it states:

> In the southbound direction, the Interstate Bridge experiences 3 hours of congestion between 6 and 9 a.m. . . The congestion is caused by approaching traffic that is above the bridge's limited capacity, limited sight distance, substandard shoulders, short merge and diverge locations north and south of the bridge, heavy on-and off-ramp flows north of the river, and heavy truck volumes. (DSEIS p. 3.1-6)
>
> Southbound travel in the study area is also affected by backups from regional bottlenecks such as the I-5/I-405 split in north Portland, which results in 6.5 hours of congestion between 6:30 a.m. and 1 p.m. that can extend north and combine with the Interstate Bridge bottleneck. Another southbound regional bottleneck is at the Rose Quarter, where congestion occurs for 12.5 hours from 7:15 a.m. to 2 7:45 p.m. where I-5 is reduced from three to two travel lanes. (DSEIS p. 3.1-6 – 3.1-7)

The DSEIS acknowledges that southbound congestion is worse south of the study area, with up to 12.5 hours of congestion vs. the 3 hours on congestion on the bridge, but fails to acknowledge that the congestion to the south is the cause of the congestion on the bridge.

The DSEIS fundamentally misrepresents existing southbound traffic conditions in the I-5 corridor and, in doing so, creates an erroneous "need" for the project. Southbound morning congestion on I-5 is not caused by a bottleneck at the Interstate Bridge, but rather by the bottleneck at N. Lombard, which is not addressed by the IBR project.

The DSEIS Traffic Modeling Cannot Represent Existing Traffic Conditions Accurately

The DSEIS Transportation Technical Report ("TTR") describes a series of two classes of traffic models: Metro's regional travel demand model (EMME), and operations models (VISSIM, Synchro, SimTraffic). (TTR, p. 441). The regional travel demand model estimates the origins, destinations and volume of vehicle traffic for the entire metropolitan area. The operations models take the estimates of vehicle volumes from the regional Metro model, and use these volumes as inputs to the operations models. The operation model claims (shown as heat maps of travel speeds) depend entirely on the accuracy of the regional travel demand model. The regional travel demand model cannot represent existing traffic conditions described in the section above accurately, and is even less capable of forecasting future traffic conditions accurately. The more detailed operations models can be used to model *existing* traffic conditions, but the operations models rely on erroneous regional model forecasts, and this makes all of the *future* operations modeling invalid.

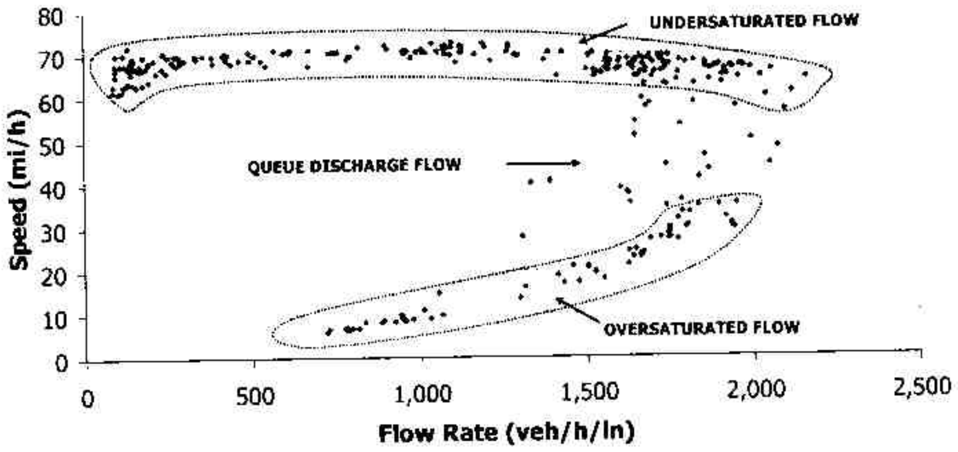
Metro's regional travel demand model uses a static traffic assignment ("STA") process. The STA algorithm was standardized in the 1960s and 1970s when computers had less processing power than today's cellphones. (More accurate Dynamic Traffic Assignment ("DTA") algorithms are discussed in a later section.) This outdated STA algorithm has two fatal flaws that prevent its outputs being useful for evaluating the DSEIS alternatives:

1) STA treats every roadway segment as independent; there is no queueing behind bottlenecks in the model. In the STA model, traffic that backs up on one section of roadway doesn't affect speed or volumes on other segments of roadway, a plainly unrealistic assumption.
2) STA cannot model the three different traffic flow regimes discussed above. At best, it tries to represent some average condition of all three, and this fails to accurately represent any of the traffic flow regimes.

Treating every roadway segment as independent (#1) causes the regional model to exaggerate the benefits of widening individual segments because it assumes that traffic throughput can grow on road segments even where traffic growth is prevented by upstream and downstream bottlenecks.

For each individual roadway segment, STA assumes that higher vehicle throughput translates directly into lower speed (#2). As discussed above, this is wrong. In general, undersaturated flow conditions have high throughput and high speed, and oversaturated flow conditions have low throughput and low speed as shown in Figure 8 reproduced from the HCM.

Figure 8: HCM Exhibit 12-3 Three Types of Flow on a Basic Freeway Segment

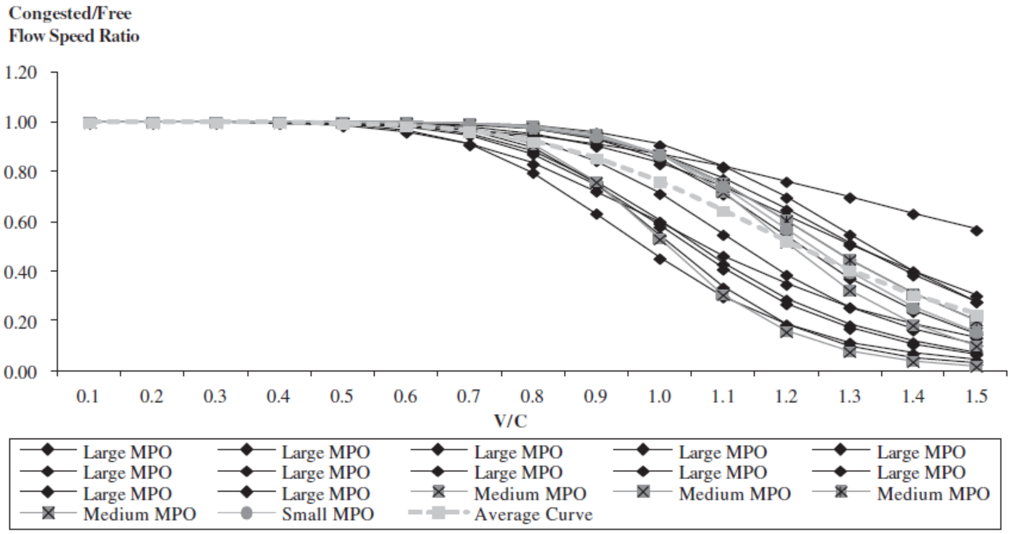


Source: California Department of Transportation, 2008.
Note: I-405, Los Angeles, California.

Instead of modeling the three traffic flow regimes properly, STA models unrealistically assume that higher vehicle throughput always translates into lower speed. This relationship is expressed in the form of a volume delay function with a “capacity” (most often set to maximum possible throughput), and two or more parameters depending on the mathematical function that is embedded in the model.

The DSEIS does not document the STA parameters in the regional model volume delay functions. Figure 9 below shows representative volume-delay functions from a set of regional models reproduced from a modeling reference.

Figure 9: Freeway Congested/Free-Flow Speed Ratios Based on BPR Functions[4]



Source: MPO Documentation Database.

Figure 4.6. Freeway congested/free-flow speed ratios based on BPR functions.

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[4] Cambridge Systematics et. al. Travel Demand Forecasting Parameters and Techniques, National Demand Cooperative Highway Research Program (NCHRP) Report 716, 2012, p 76..

What is most striking about the functions graphed in Figure 9 is how varied they are. Some of the functions assume that traffic will continue to move swiftly when volumes reach 150% of capacity, i.e. one and a half times the theoretical maximum volume. Others predict a steeper decline in speed as a result of increased traffic volume. If there was a true simple relationship between volume and speed, the functions would be more similar. Different regions apply widely different functions because none of them work across all three traffic regimes, and some regions stress one regime or another in the function applied. The less steep functions do a fair job of representing undersaturated flow conditions, but fail badly in representing oversaturated flow conditions – predicting high speeds at impossibly high vehicle throughput. The steeper functions attempt to prevent impossibly-high throughput but underestimate speeds for most undersaturated traffic flow conditions (and exaggerate calculated "vehicle hours of delay") while still being unable to represent the lower speeds associated with oversaturated flow conditions

STA models generally routinely overestimate future traffic growth on congested urban freeways because they fail to constrain modeled vehicle throughput to realistic levels. In my peer-reviewed journal article: *Forecasting the impossible: The status quo of estimating traffic flows with static traffic assignment and the future of dynamic traffic assignment*[5]*,* I document these problems and demonstrate that replacing STA with Dynamic Traffic Assignment ("DTA") addresses the STA problems described above, i.e.,

1) DTA models queueing behind bottlenecks in the model, and
2) DTA models all three traffic flow regimes.

In the DSEIS, the STA model overestimates bridge traffic volumes significantly, even in the model base year, 2015 as shown in Figure 10. The model used to predict future traffic cannot even accurately predict current traffic levels.

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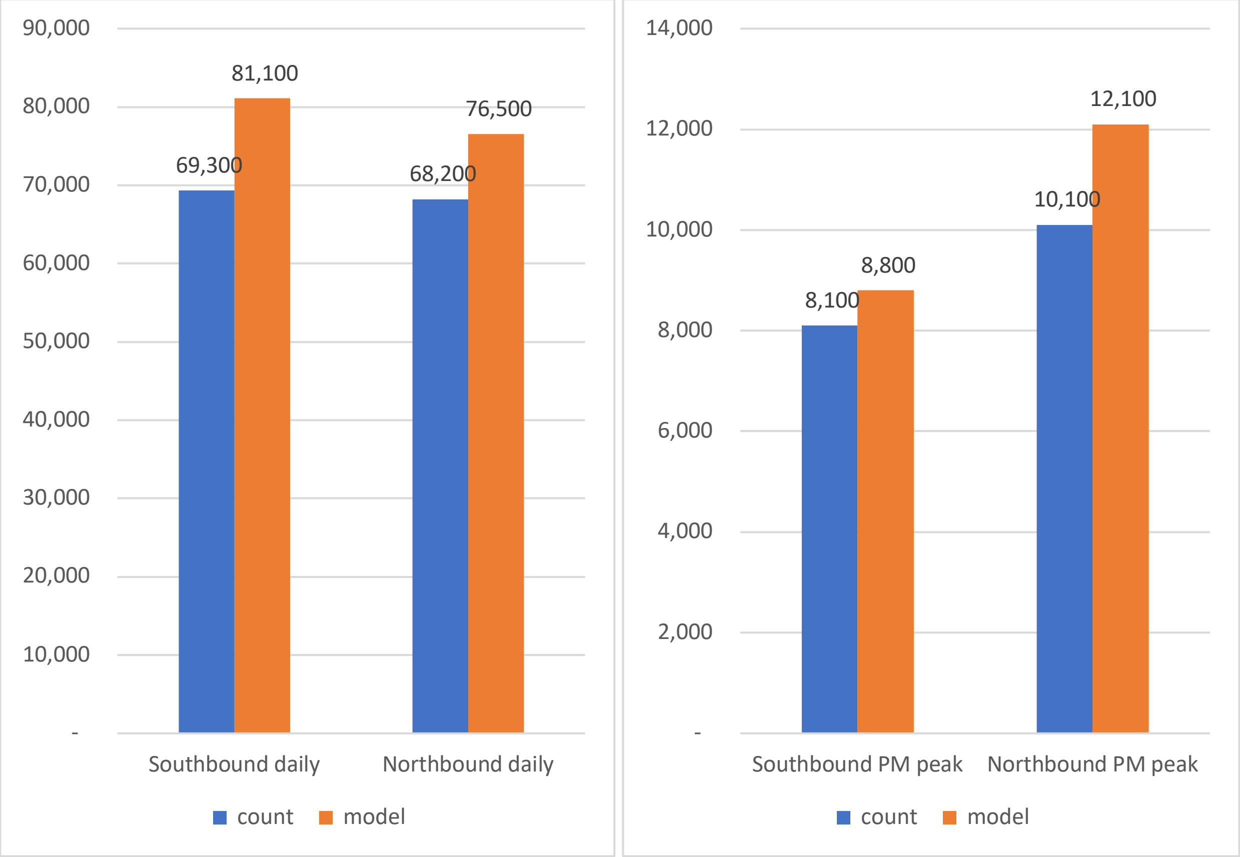
[5] https://www.sciencedirect.com/science/article/pii/S2210539517301232?via%3Dihub

Figure 10: 2015 Regional Model Bridge Traffic Volume Errors (from TTR p. 616)



The errors reported in the DSEIS are:

- Daily southbound +17%
- Daily northbound +12%
- PM peak southbound 9%
- PM peak northbound 19%

The model performs worst in the afternoon peak period northbound, the most congested time/direction. This suggests that higher congestion results in poorer model fit. The model cannot properly account for congested conditions and therefore, is useless for evaluating DSEIS alternatives.

STA's problems with over-assigning traffic volumes in congested conditions and the DTA solution to are well known to ODOT and Metro. In 2019, I co-led a DTA Development and Application Workshop with Peter Bosa of Metro at the Transportation Research Board's Planning Applications Conference held in Porland. A DTA model was used in ODOT's I-205 Toll Project Environmental Assessment. In that project, the *Modeling Methodology and Assumptions for Environmental Assessment* (February 2023) states:

> In comparison to a static model, a DTA model will generate traffic and speed estimates that more closely align with observed traffic during congested times. Table 2 shows how the DTA model improves the match of modeled results with observed peak period volumes along I-205. The results show that the subarea DTA model estimates more closely align with observed volumes at these locations, and that the RTDM [Metro's

regional travel demand model] tends to over-assign volumes along I-205 during the peak periods.

As shown in Figure 11 which reproduces Table 2 from the I-205 report, Metro's STA model over-predicted traffic on every segment analyzed in both the morning and afternoon peak periods and in both directions, with the errors being as great as 37%. Substituting the DTA model reduced the individual errors to no greater than 7% and provided a much more valid basis for analyzing the I-205 project than if the Metro STA regional model had been relied on.

Figure 11: Table 2 from I-205 Toll Project Modeling Methodology and Assumptions for EA

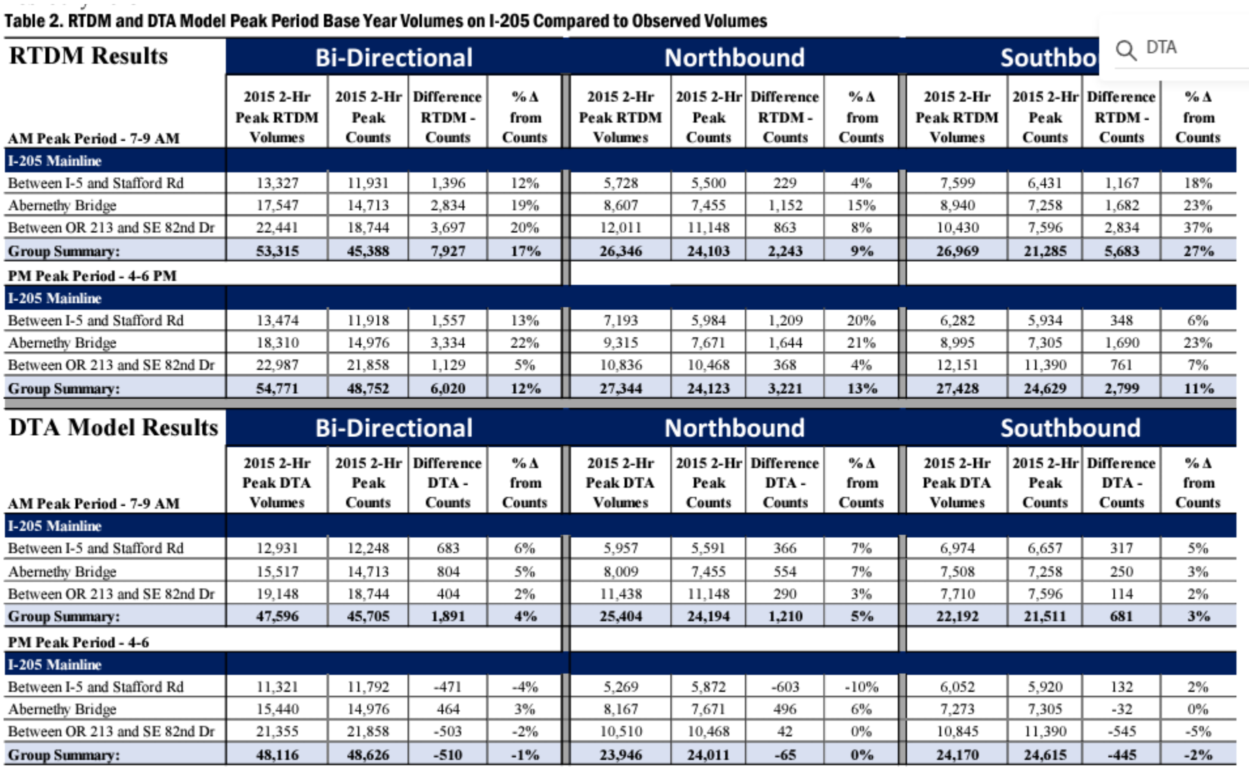


Table 2. RTDM and DTA Model Peak Period Base Year Volumes on I-205 Compared to Observed Volumes

RTDM Results	Bi-Directional				Northbound				Southbo			
AM Peak Period - 7-9 AM	2015 2-Hr Peak RTDM Volumes	2015 2-Hr Peak Counts	Difference RTDM - Counts	% Δ from Counts	2015 2-Hr Peak RTDM Volumes	2015 2-Hr Peak Counts	Difference RTDM - Counts	% Δ from Counts	2015 2-Hr Peak RTDM Volumes	2015 2-Hr Peak Counts	Difference RTDM - Counts	% Δ from Counts
I-205 Mainline												
Between I-5 and Stafford Rd	13,327	11,931	1,396	12%	5,728	5,500	229	4%	7,599	6,431	1,167	18%
Abernethy Bridge	17,547	14,713	2,834	19%	8,607	7,455	1,152	15%	8,940	7,258	1,682	23%
Between OR 213 and SE 82nd Dr	22,441	18,744	3,697	20%	12,011	11,148	863	8%	10,430	7,596	2,834	37%
Group Summary:	**53,315**	**45,388**	**7,927**	**17%**	**26,346**	**24,103**	**2,243**	**9%**	**26,969**	**21,285**	**5,683**	**27%**
PM Peak Period - 4-6 PM												
I-205 Mainline												
Between I-5 and Stafford Rd	13,474	11,918	1,557	13%	7,193	5,984	1,209	20%	6,282	5,934	348	6%
Abernethy Bridge	18,310	14,976	3,334	22%	9,315	7,671	1,644	21%	8,995	7,305	1,690	23%
Between OR 213 and SE 82nd Dr	22,987	21,858	1,129	5%	10,836	10,468	368	4%	12,151	11,390	761	7%
Group Summary:	**54,771**	**48,752**	**6,020**	**12%**	**27,344**	**24,123**	**3,221**	**13%**	**27,428**	**24,629**	**2,799**	**11%**

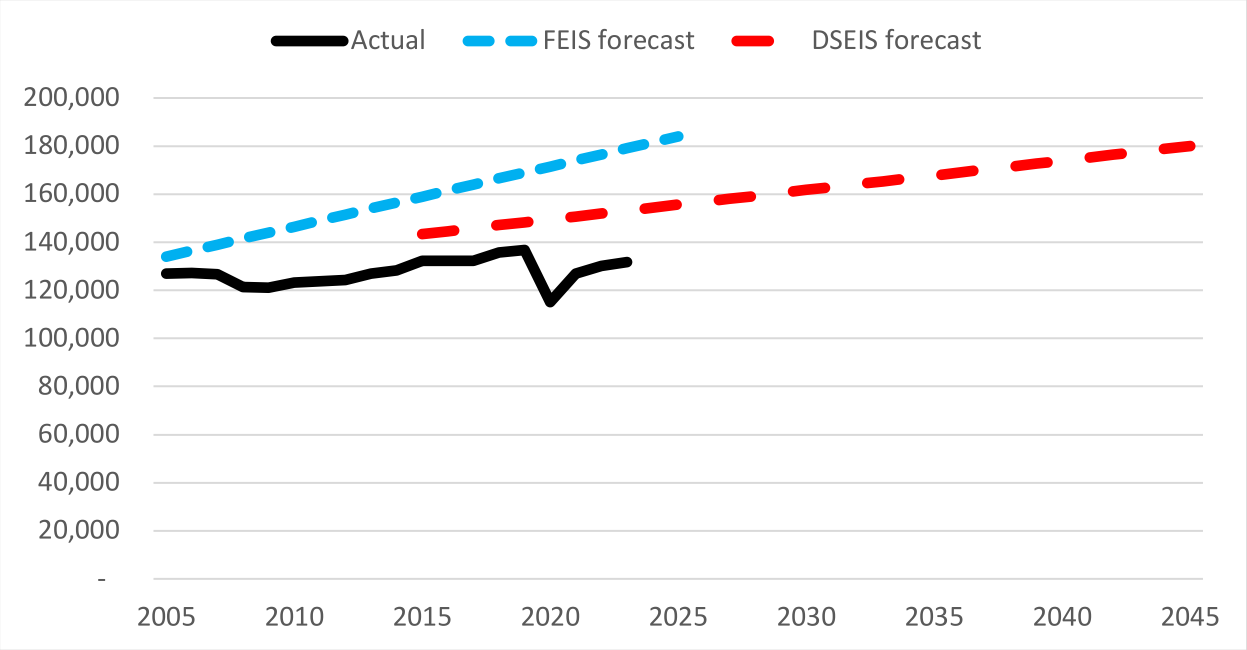
DTA Model Results	Bi-Directional				Northbound				Southbound			
AM Peak Period - 7-9 AM	2015 2-Hr Peak DTA Volumes	2015 2-Hr Peak Counts	Difference DTA - Counts	% Δ from Counts	2015 2-Hr Peak DTA Volumes	2015 2-Hr Peak Counts	Difference DTA - Counts	% Δ from Counts	2015 2-Hr Peak DTA Volumes	2015 2-Hr Peak Counts	Difference DTA - Counts	% Δ from Counts
I-205 Mainline												
Between I-5 and Stafford Rd	12,931	12,248	683	6%	5,957	5,591	366	7%	6,974	6,657	317	5%
Abernethy Bridge	15,517	14,713	804	5%	8,009	7,455	554	7%	7,508	7,258	250	3%
Between OR 213 and SE 82nd Dr	19,148	18,744	404	2%	11,438	11,148	290	3%	7,710	7,596	114	2%
Group Summary:	**47,596**	**45,705**	**1,891**	**4%**	**25,404**	**24,194**	**1,210**	**5%**	**22,192**	**21,511**	**681**	**3%**
PM Peak Period - 4-6												
I-205 Mainline												
Between I-5 and Stafford Rd	11,321	11,792	-471	-4%	5,269	5,872	-603	-10%	6,052	5,920	132	2%
Abernethy Bridge	15,440	14,976	464	3%	8,167	7,671	496	6%	7,273	7,305	-32	0%
Between OR 213 and SE 82nd Dr	21,355	21,858	-503	-2%	10,510	10,468	42	0%	10,845	11,390	-545	-5%
Group Summary:	**48,116**	**48,626**	**-510**	**-1%**	**23,946**	**24,011**	**-65**	**0%**	**24,170**	**24,615**	**-445**	**-2%**

Even more importantly, the DTA model much more realistically constrains future traffic growth to capacity relative to the regional model. A DTA model should have replaced the STA model in the IBR DSEIS alternatives analyses.

Without true capacity constraint, the STA model relied on in the DSEIS forecasts ridiculously high traffic in the 2045 forecast year. The DSEIS claims that Average Weekday Daily Traffic (AWDT) on the I-5 and I-205 bridges will grow by 28% from 313,000 in 2015 to 400,000 in 2045 in the No Build alternative. (DSEIS, Table 3.11, p. 3.21 and many other instances). This is absurd and repeating it doesn't make it any more plausible.

There has been no traffic growth on the I-5 bridge over the past 20 years, and traffic forecasts have been consistently wrong. Figure 12 shows the Columbia River Crossing FEIS (2011) and IBR DSEIS (2024) forecasts along with the actual average weekday daily traffic volume.

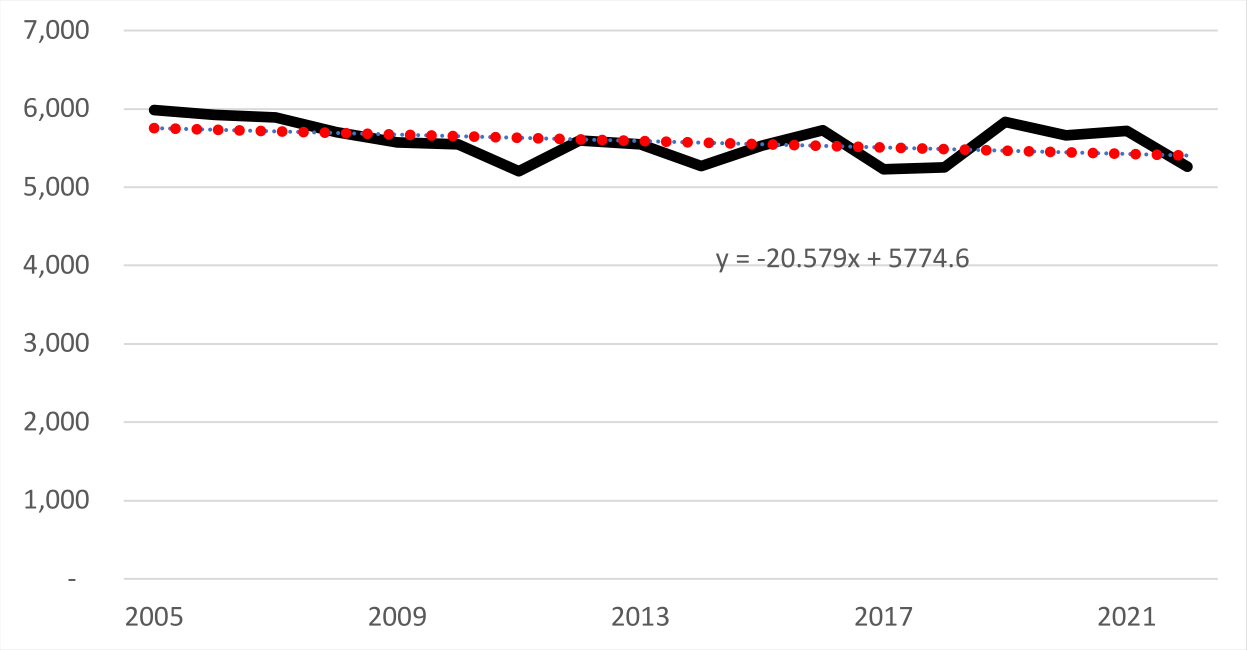
Figure 12: Average Weekday Bridge Traffic and FEIS and DSEIS Forecasts



Note that the FEIS forecast (finalized in 2011) also forecast 180,000 vehicles per day on the bridge in the horizon year – but that forecast said that the 180,000 vehicles total would be achieved by now – not 20 years from now. The STA model always will show this sort of traffic growth over the next 20 years – no matter what the base model year is. This is evidence that the STA model is wrong.

Daily traffic is illustrative of the flaws in the STA model but is not a critical metric for traffic analysis. What is important is peak period – peak direction traffic. Using the values given by ODOT for DHV-30 (the 30th highest hour of the year) and D% (directional split for DHV-30), there has been no growth in peak hour-peak direction traffic since 2005.

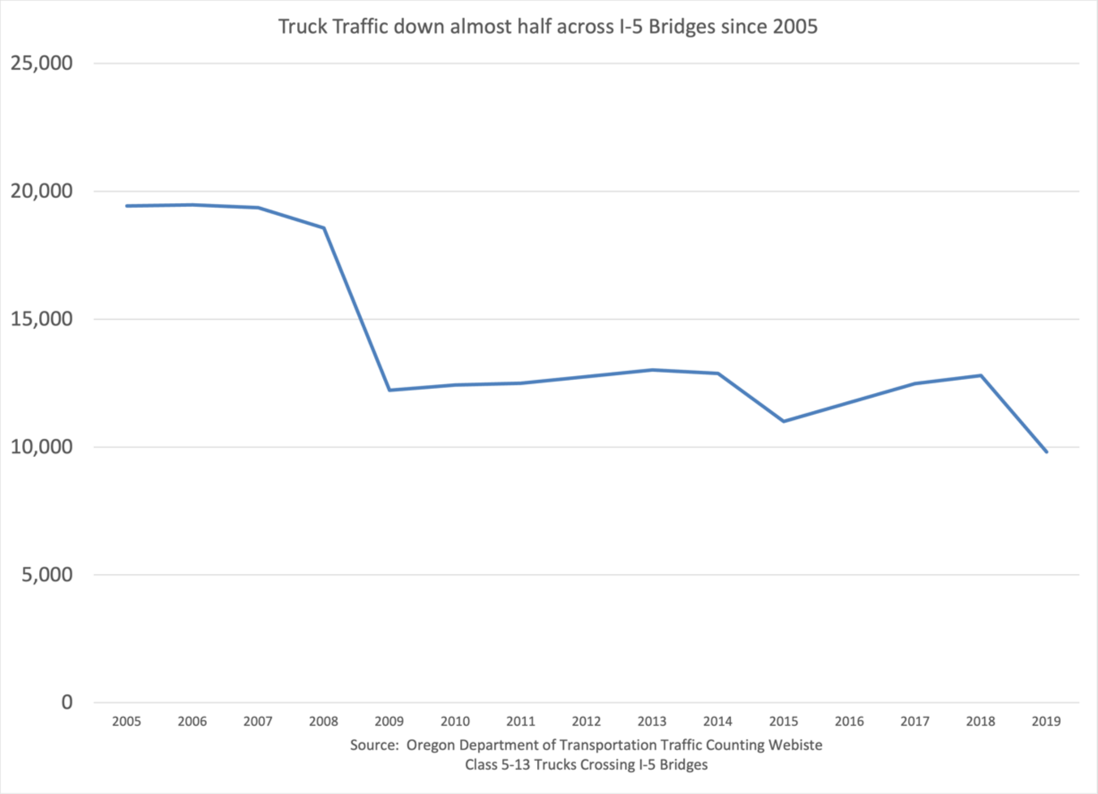
Figure 13: Peak Hour Peak Direction Traffic on the Bridge (ODOT Permanent Traffic Count Station)



As shown in Figure 13, the fitted (dotted) line is sloped downward, i.e. it shows a small decline since 2005. Peak hour peak direction traffic on the bridge has not grown because it cannot grow due to bottlenecks to the south in both the morning and afternoon peak periods. Without peak period traffic growth, traffic can only grow at all through additional peak spreading. The 28% daily traffic growth shown in the SDEIS table for the No Build alternative is preposterous. This problem demonstrates that all of the DSEIS traffic forecasts and analyses are invalid even without looking under the hood at the modeling details.

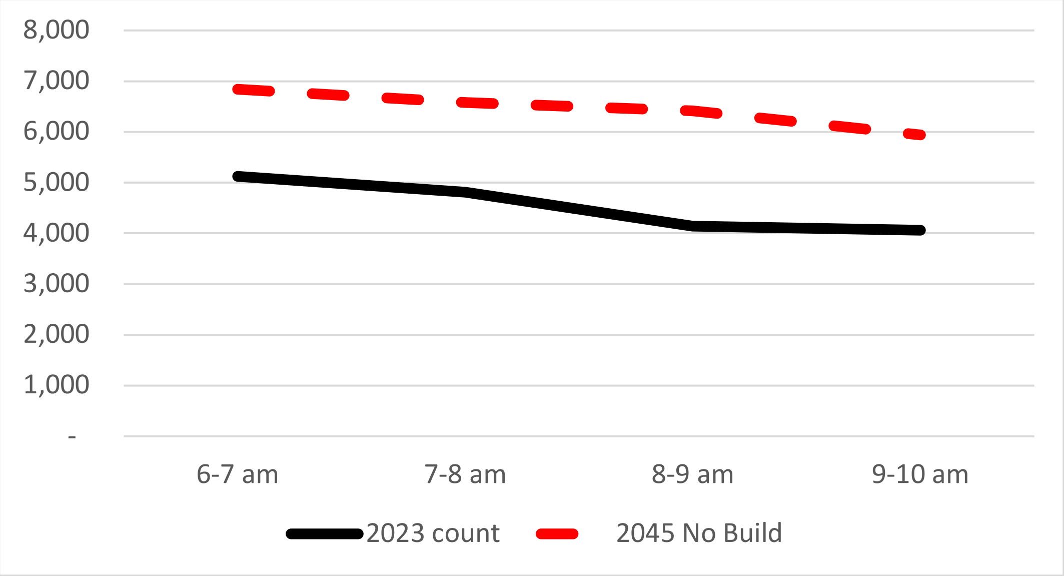
The truck traffic growth assumed in the DSEIS also is invalid. Although this growth is reported as a model output (DSEIS p. 3.1-31), the truck forecast is exogenous to the regional model, and the “outputs” simply restate the inputs, and have no separate meaning. Figure 14 shows that truck traffic has actually declined since 2005.

Figure 14: Daily Class 5-13 Truck Traffic on I-5 Bridges (ODOT Traffic Count data)



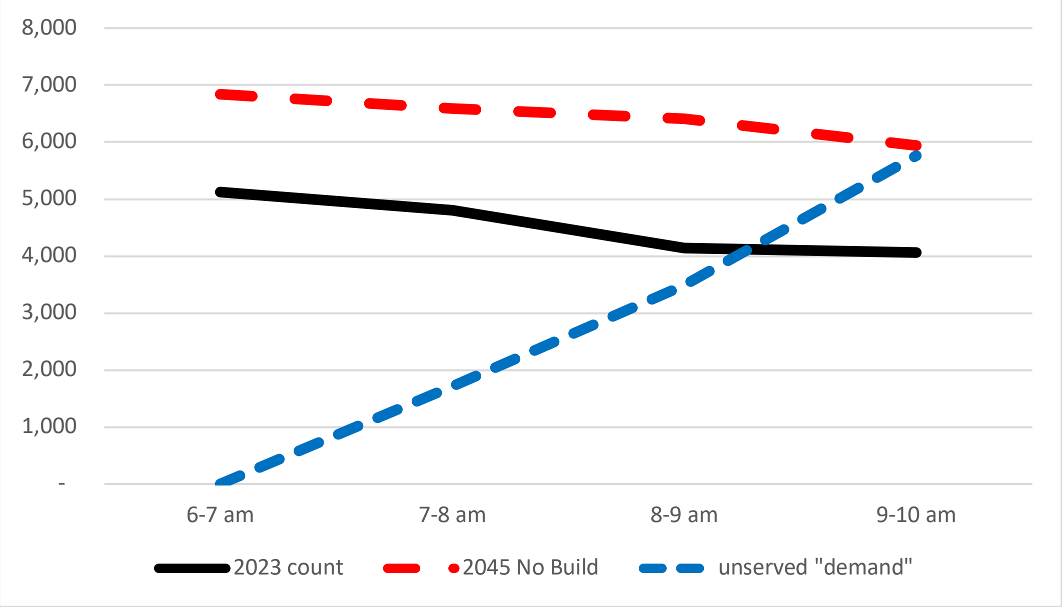
The attempts in the DSEIS to take this preposterous traffic growth through detailed operations modeling highlight the inherent absurdity. Figure 15 shows the hourly graphic growth assumed for the southbound bridge during the morning peak period in the 2045 No Build alternative compared to the 2023 traffic counts documented above.

Figure 15: Average 2013 Weekday Southbound Morning Peak Period Bridge Traffic Counts and DSEIS Assumed Demand (TRR p. 241)



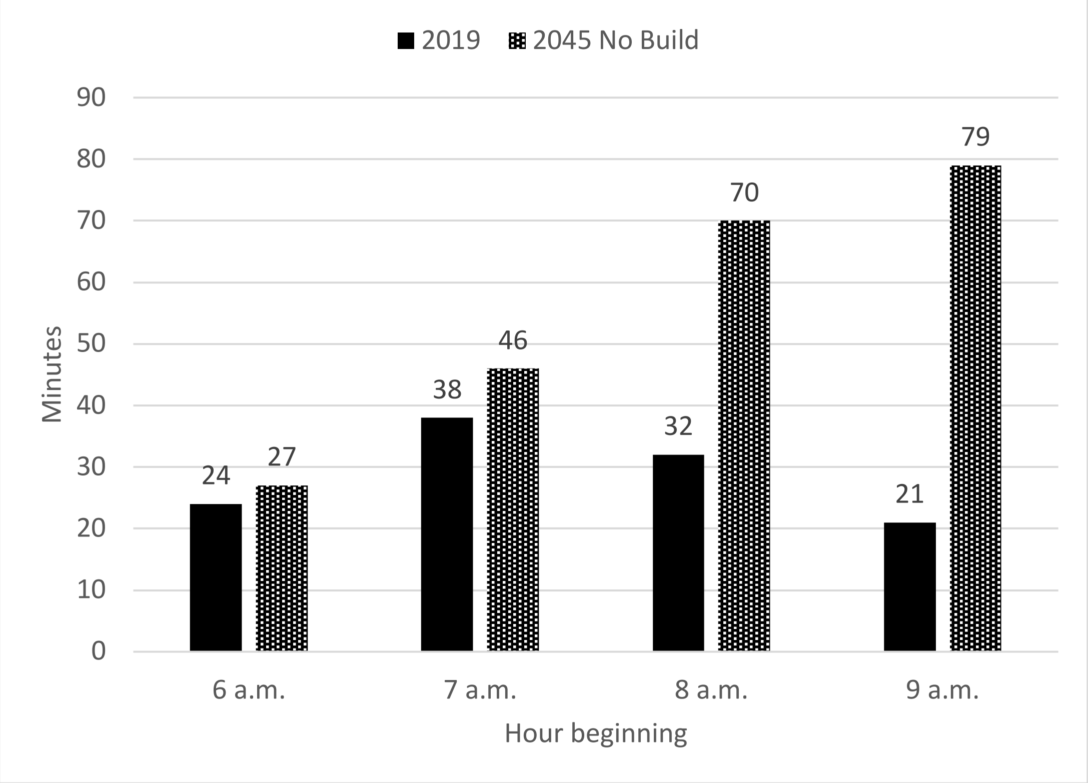
This cannot happen. As is documented above, in the morning peak period, once queues have formed to the south of the study area, southbound traffic is in the saturated flow regime, and is stuck at about 4,100 vehicles per lane per hour throughout much of the day. Unless something is done to eliminate the bottlenecks to the south, the assumed "demand" that exceeds throughput would accumulate over time as "unserved demand" as shown in Figure 16.

Figure 16: Unrealistic Traffic Demand in DSEIS Implies Lengthening Queues



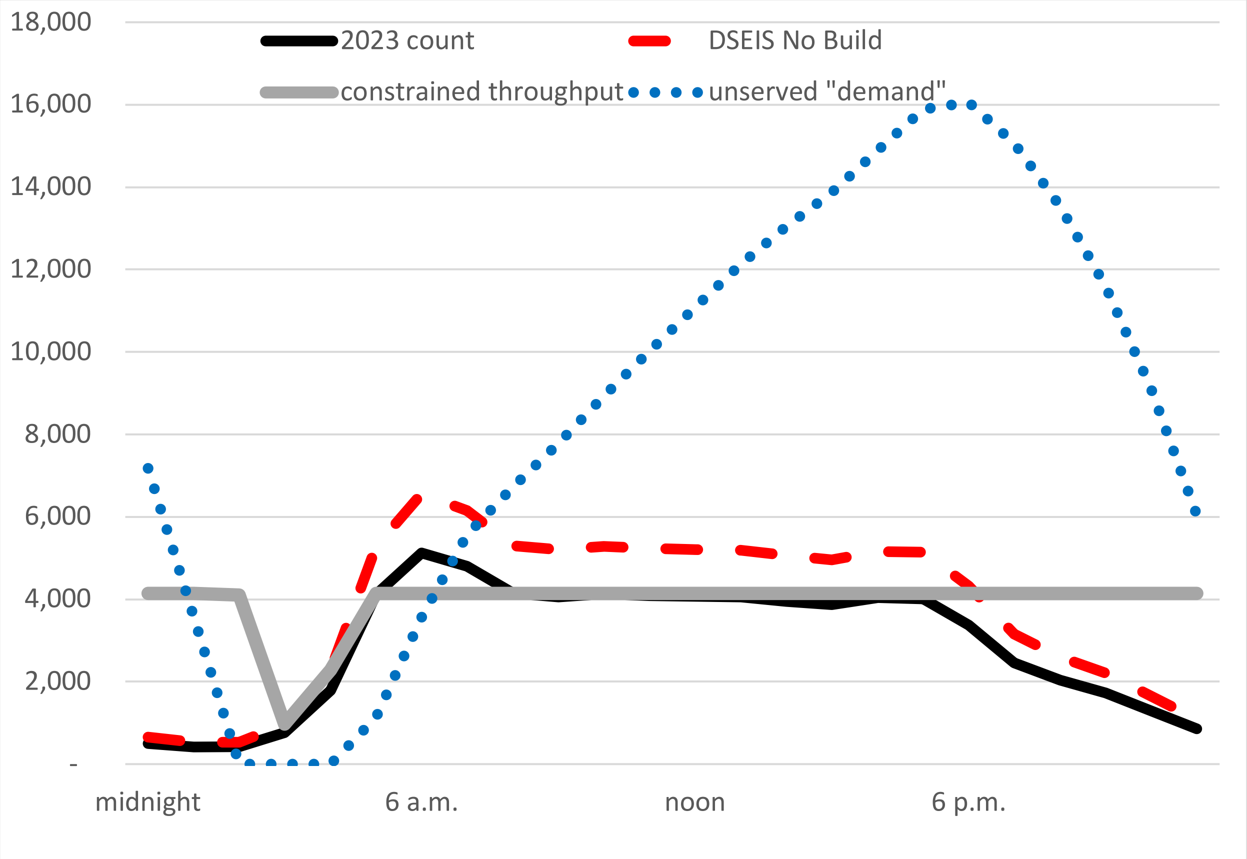
Unlike the regional STA model, the VISSIM operations model captures the three traffic flow regimes discussed above, and has been calibrated to match base year throughput. Therefore, it translates the lengthening queues shown in Figure 16 into lengthening corridor travel times (Figure 17) as queues spillback through the corridor.

Figure 17: VISSIM Model Translates Lengthening Queues into Lengthening Travel Times Southbound from I-205 to I-405 (TTR, p. 264)



The VISSIM morning peak period modeling metrics graphed in Figure 16 end at 10 a.m., but given the traffic growth assumed in the DSEIS, model queues would continue to lengthen after 10 a.m., peaking around 6 p.m. when the queue would represent about 4 hours of congested vehicle throughput. As shown in Figure 18, the queues that began to form in the beginning of the morning commute would not clear until the early morning hours the following day.

Figure 18: VISSIM Model Translates Lengthening Queues into Lengthening Travel Times Southbound from I-205 to I-405 (TTR, p. 264)



This is clearly ridiculous. Taking unrealistic STA outputs and inputting them into the more realistic VISSIM model is a classic case of “garbage in – garbage out.” The STA outputs input into the VISSIM model are invalid, and the VISSIM model results are invalid.

In summary, the SDEIS forecast metrics are unrealistic, and cannot be relied on for planning. In addition, while transit investments could help address I-5 congestion, the SDEIS models are not reliable in evaluating transit alternatives either.

Induced Traffic from the Proposed Project Would Increase Vehicle Miles Traveled (VMT) and Greenhouse Gas Emissions

Extensive research has demonstrated that expanding congested urban freeways induces traffic growth. A review of the induced travel research by Handy and Boarnet (2014) concluded that induced travel is real, and that the magnitude is enough to prevent capacity expansion from reducing congestion:

> *Thus, the best estimate for the long-run effect of highway capacity on VMT [vehicle miles traveled] is an elasticity close to 1.0, implying that in congested metropolitan areas, adding new capacity to the existing system of limited-access highways is unlikely to reduce congestion or associated GHG [greenhouse gas] in the long-run.*[6]

The Rocky Mountain Institute has developed the SHIFT Calculator[7] to estimate the induced VMT impacts of roadway expansion based on the California-specific Induced Travel Calculator developed by the National Center for Sustainable Transportation ("NCST") and the University of California, Davis. The SHIFT Calculator uses the elasticity of 1.0 cited above. In the Portland-Vancouver-Hillsboro, OR-WA region, the SHIFT Calculator estimates that each addition lane mile of freeway capacity will result in 5 to 8 million additional VMT/year.

Most of the underlying data supporting the elasticity estimate of 1.0 is from roadways without tolls, and it is possible that tolling could affect induced travel. However, the current state of research suggests there may not be significant differences. In 2022, Volker and Handy wrote:

> Overall, the available empirical evidence suggests that new HOV and HOT lanes might have similar induced travel effects as general-purpose lane expansions. Furthermore, because HOT lanes allow more vehicles than HOV lanes (high-occupancy vehicles plus drivers willing to pay to use the lane), they would logically have at least as large induced travel effects as HOV lanes. Pure toll lanes, on the other hand, could have lower elasticities.[8]

For pure toll lanes, the induced travel effects would depend on the magnitude of the tolls. However, if the roadway is expanded, and the tolls are set to allow increased throughput relative to the base year, there clearly would be induced travel.

California's Senate Bill 743 requires highway expansion projects to mitigate their VMT impacts. It is understood that the regional travel demand models cannot be relied on for accurate estimates of induced travel. Therefore, unless the travel demand models can be shown to adequately account for induced travel, California requires that the NCST Calculator be applied.[9] The SHIFT Calculator should be applied to estimate the induced travel impacts of the IBRP.

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[6] Handy, Susan and Marlon G. Boarnet. Impact of Highway Capacity and Induced Travel on Passenger Vehicle Use and Greenhouse Gas Emissions: Policy Brief prepared for California Air Resources Board, September 30, 2014.

[7] https://shift.rmi.org/

[8] Volker, James M. B. and Susan L. Handy. Updated the Induced Travel Calculator. UC Davis Research Reports, September 1, 2022.

[9] Caltrans. Transportation Analysis Framework First Edition: Evaluating Transportation Impacts of State Highway System Projects (September 2020).

Effective Approaches to Addressing Congestion in the I-5 Corridor

The first step in effectively addressing congestion in the I-5 corridor is rejecting the misinformation that the underlying problem is lack of capacity at the bridge. This simply is not true. The congestion is caused by bottlenecks to the south—at N. Lombard in the southbound a.m. peak and at Victory Boulevard in the p.m. northbound peak--and there is no possibility that widening the bridge can address those problems. Instead, widening the bridge likely would worsen the bottlenecks to the south while doing nothing to improve traffic flow on the bridge.

The second step in effectively addressing congestion in the I-5 corridor is recognizing that these bottlenecks are largely caused by the failure to manage I-5 efficiently. I-5 has more physical capacity than is currently being used; vehicle throughput in both directions is much lower than would be possible with better management.

The DSEIS recognizes that vehicle throughput is well below theorical capacity when it states:

> The Highway Capacity Manual (HCM) outlines a process for estimating the capacity of a freeway segment. The process begins by assuming an ideal capacity of 2,400 passenger cars per hour per lane (pc/h/ln), and then applies factors based on free-flow speed, freight mix as well as geometric elements including lane and shoulder widths, percentage of commuter drivers (understanding of the area), and interchange spacing. The application of these factors decreases the ideal capacity below 2,400 pc/h/ln. Applying the HCM process to roadways in the IBR Program Area results in estimated capacities between 2,100–2,200 pc/h/ln, approximately 10 to 15 percent less than the ideal capacity.
>
> However, the highest throughput across the Interstate Bridge (the primary bottleneck in the study area) as well as the ramp terminals just north and south of the Interstate Bridge ranges between 1,550 and 1,850 pc/h/ln. This indicates that the capacity of the Interstate Bridge is near 1,550 to 1,850 pc/h/ln, The HCM capacity estimates of 2,100 to 2,200 pc/h/ln are 20 to 30 percent higher than the capacity of the Interstate Bridge, indicating that the HCM model is not an appropriate analysis tool in this case. The HCM process is not accounting for factors that would further reduce the ideal capacity. Some possible contributing factors not accounted for by the HCM process include the influence of limited sight distance across and approaching the Interstate Bridge, closely spaced interchanges, short merge, diverge, and weaving distances. (TTR, p. 446)

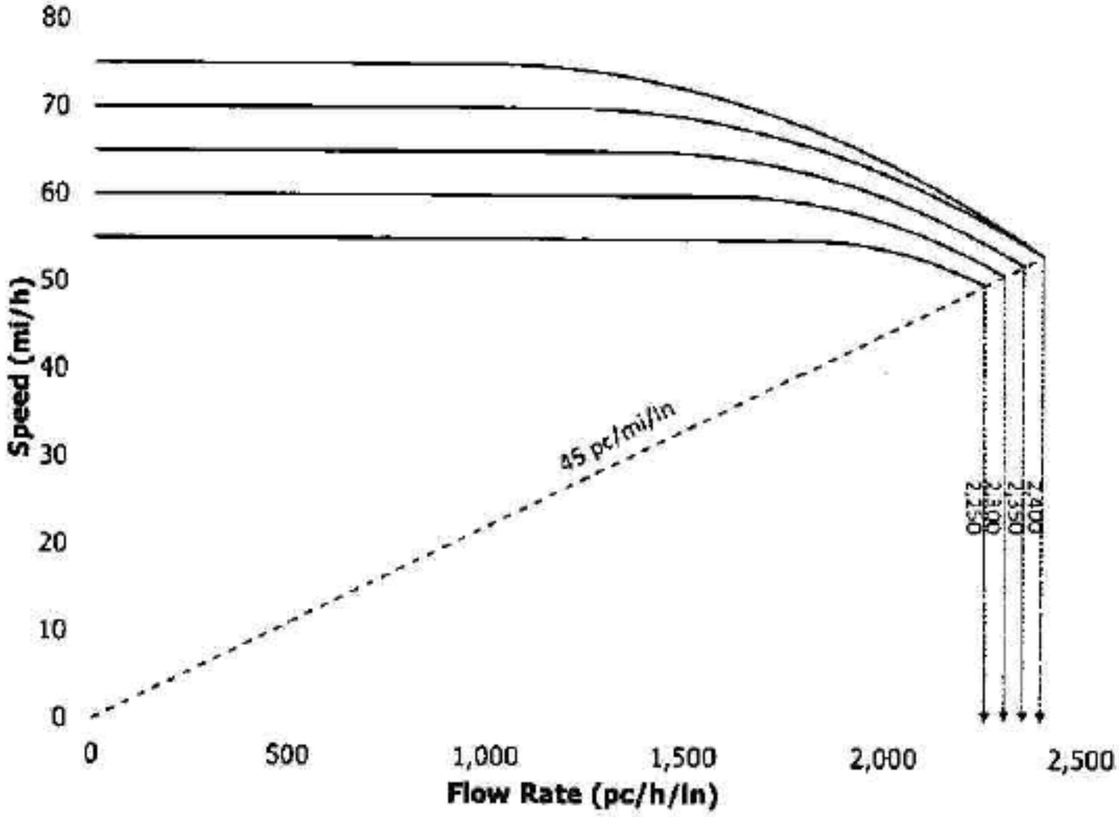
There are multiple issues with this excerpt:

1) As is demonstrated above, the Interstate Bridge is <u>not</u> "the primary bottleneck in the study area" unless the "study area" is defined narrowly as just the bridge (the SDEIS makes it clear that the study area is much larger).
2) The excerpt fails to acknowledge that throughput on the bridge is affected by upstream and downstream bottlenecks, apparently treating the STA assumption that each freeway segment is independent of every other as representative of reality.

3) The excerpt fails to acknowledge that there are three different traffic flow regimes. What it refers to as “capacity” is only relevant to the undersaturated flow state, and the range given is lower than free-flow capacity.
4) On the other hand, the 1,550 – 1.850 pc/h/ln [passenger car equivalents per hour per lane) range exaggerates the actual throughput in the corridor, because the corridor is chronically oversaturated due to the non-bridge bottlenecks and poor ramp metering.

The HCM provides a model that covers both undersaturated and oversaturated flow conditions (Figure 19). The solid lines at the top represent undersaturated flow for different free-flow speeds. With undersaturated flow shown in the horizontal lines in the top of the figure, the speed declines with higher traffic volumes by only a small amount for 55 mph freeways, and by a somewhat larger amount for higher-speed freeways.

Figure 19: HCM Exhibit 12-7 Speed-Flow Curves for Basic Freeway Segments

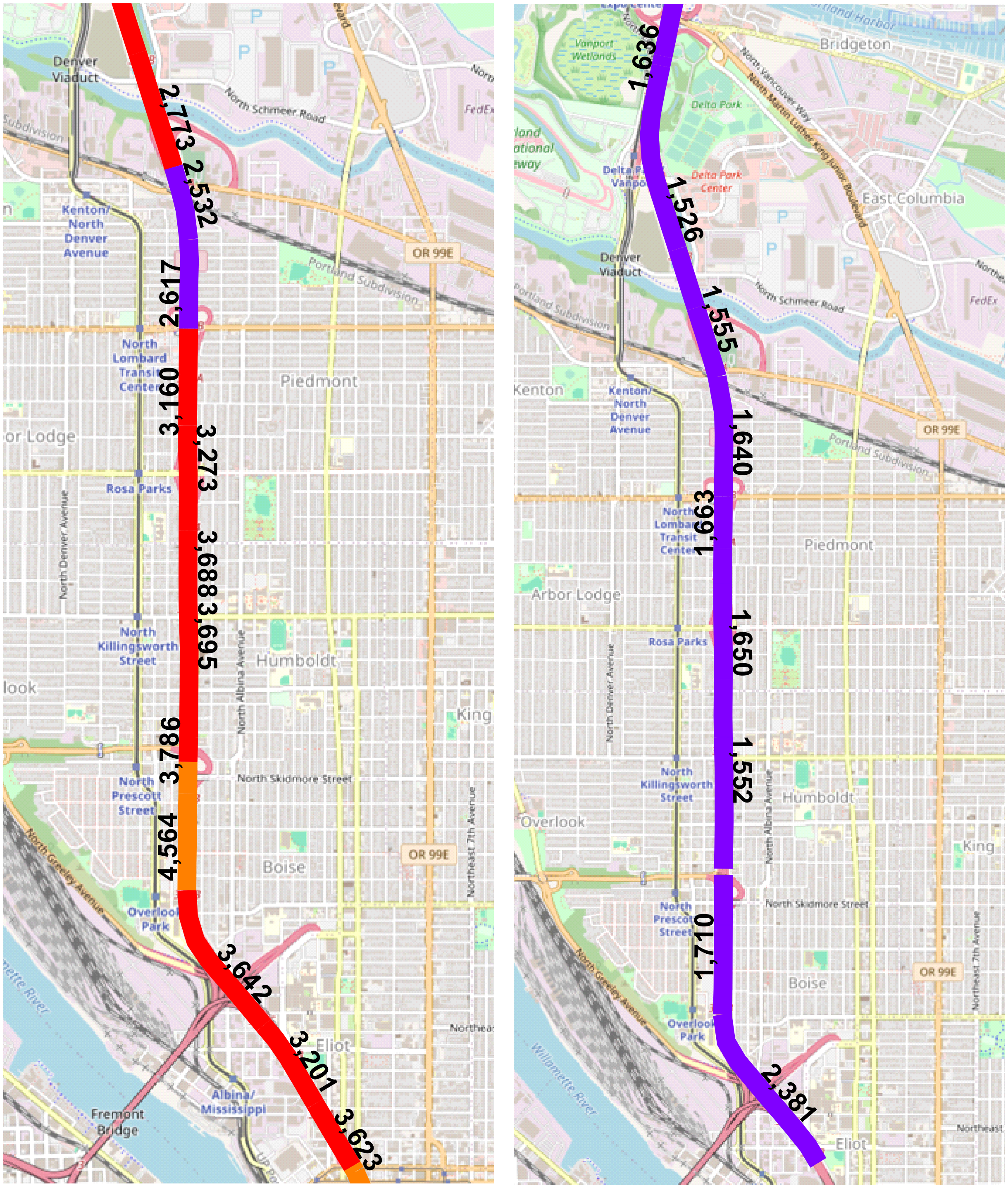


The dashed line represents oversaturated flow. The value of 45 pc/mi/ln (passenger cars per mile per lane) is the density given in the HCM for the threshold between a congested level of service (“LOS”) E condition and a failed LOS F (oversaturated) condition. At a speed of 0 mph traffic is stalled and the flow rate is also 0. At a speed of 50 mph, the flow is 45 x 50 = 2,250 for the 55-mph speed case. The intermediate values are all included on the dashed line. The estimated speed for a traffic flow of 1000 vehicles per lane is about 22 mph.

The capacity numbers given in the DSEIS excerpt above, 1,550 – 1,850 vehicles per lane per hour, are consistent with speeds of 30-40 mph in the HCM model (Figure 23) but are much higher than the values for the speeds observed in the bottleneck areas to the south of the bridge in both the morning and afternoon peak periods.

Figure 20 applies the HCM model shown in Figure 19 to the 2023 travel speed data mapped in Figures 2 and 4. The values shown are total for the three travel lanes in each direction. In the 8-9 a.m. hour, most of the values are less than 3,900, i.e. 1,300 per lane per hour in the peak (Southbound) direction. In the 4-5 p.m. hour, most of the values are less than 1,800, i.e. 600 per lane per hour in the peak (Northbound) direction.

Figure 20: 2023 Non-Holiday Weekday Hourly Volume Estimated from HCM Exhibit 12-7 Southbound 8-9 a.m. and Northbound 4-5 p.m.



The HCM model applied above is very simple and may underestimate vehicle throughput on some segments. However, it is very clear that the long periods of recurring oversaturated conditions represent a major failure where the I-5 system is carrying many fewer vehicles than it could during peak periods and doing so at extremely low speeds. Efficient management of I-5 requires that the roadway operate in the undersaturated flow regime rather than in this saturated flow regime. The HCM states:

> Uninterrupted-flow facilities operating in a state of undersaturated flow will typically have travel speeds within 10% to 20% of the facility's free-flow speed, even at high flow rates, under base conditions (e.g., level grades, standard lane withs, good weather, no incidents). Furthermore, no queues would be expected to develop on the facility.

I-5 could operate "within 10% to 20% of the facility's free-flow speed," i.e., greater than equal to 45 m.p.h. "even at high flow rates" as long as breakdown to oversaturated flow is prevented. Oversaturated flow can be prevented by a) ramp metering, and/or b) tolling.

In theory, aggressive ramp metering would be sufficient to assure undersaturated flow. There are practical challenges including managing queue vehicles waiting to enter the facility, and there also are equity issues concerning how ramp wait times are distributed to different subareas. However, as I-5 has ramp meters, it should be operating better than it is. Paradoxically, constraining vehicle entrance more aggressively than is done presently would improve vehicle throughput significantly, and this would, in turn, decrease ramp meter wait times – a win-win The ramp metering system should be audited to determine why it is functioning so poorly, and operations should be improved.

The ramp meter system can be improved, but it likely will be impractical to rely solely on ramp metering to achieve uninterrupted undersaturated flow on I-5. Variable tolling certainly can achieve uninterrupted flow on I-5. The sum of the monetary value of the resulting time savings would be far greater than the out-of-pocket toll expenses, and equity issues could be addressed through investments in non-auto travel modes and with targeted rebates.

ODOT's Regional Mobility Pricing Project analysis of three different options (September 11, 2023) confirms that variable pricing would improve both throughput and travel speeds on I-5. It found:

- All options result in average speeds near 45 mph and through-trip travel time savings with comparable trip costs.
- All options show reductions in vehicle miles traveled (VMT) and vehicle hours traveled (VHT) and mode shifts at the regional level, but option 1 shows the greatest mode shift.
- All options show limited diversion on a regional scale to non-tolled highways and arterials/collectors. Option 2a shows the least amount of total VMT increase on arterials and collectors.
- All options result in decreased freight traffic on local roads (tolling improves present-day freight diversion onto arterials).[10]

Implementing system-wide tolling on I-5 would be a game changer that actually would address the I-5 congestion that the IBR project falsely claims to address. It should be the centerpiece of one or more IBR alternatives.

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[10] https://www.oregon.gov/odot/tolling/Documents/RMPP_covermemo_9-2023.pdf

Resume

NORMAN L. MARSHALL, PRESIDENT

nmarshall@smartmobility.com

EDUCATION:

Master of Science in Engineering Sciences, Dartmouth College, Hanover, NH, 1982
Bachelor of Science in Mathematics, Worcester Polytechnic Institute, Worcester, MA, 1977

PROFESSIONAL EXPERIENCE: (37 Years, 23 at Smart Mobility, Inc.)

Norm Marshall helped found Smart Mobility, Inc. in 2001. Prior to this, he was at RSG for 14 years where he developed a national practice in travel demand modeling. He specializes in analyzing the relationships between the built environment and travel behavior and doing planning that coordinates multi-modal transportation with land use and community needs.

Regional Land Use/Transportation Scenario Planning

Portland Area Comprehensive Transportation System (PACTS) – the Portland Maine Metropolitan Planning Organization. Updating regional travel demand model with new data (including AirSage), adding a truck model, and multiclass assignment including differentiation between cash toll and transponder payments.

Loudoun County Virginia Dynamic Traffic Assignment – Enhanced subarea travel demand model to include Dynamic Traffic Assignment (Cube). Model being used to better understand impacts of roadway expansion on induced travel.

Vermont Agency of Transportation-Enhanced statewide travel demand model to evaluate travel impacts of closures and delays resulting from severe storm events. Model uses innovate Monte Carlo simulations process to account for combinations of failures.

California Air Resources Board – Led team including the University of California in $250k project that reviewed the ability of the new generation of regional activity-based models and land use models to accurately account for greenhouse gas emissions from alternative scenarios including more compact walkable land use and roadway pricing. This work included hands-on testing of the most complex travel demand models in use in the U.S. today.

Climate Plan (California statewide) – Assisted large coalition of groups in reviewing and participating in the target setting process required by Senate Bill 375 and administered by the California Air Resources Board to reduce future greenhouse gas emissions through land use measures and other regional initiatives.

Chittenden County (2060 Land use and Transportation Vision Burlington Vermont region) – led extensive public visioning project as part of MPO’s long-range transportation plan update.

Flagstaff Metropolitan Planning Organization – Implemented walk, transit and bike models within regional travel demand model. The bike model includes skimming bike networks including on-road and off-road bicycle facilities with a bike level of service established for each segment.

Chicago Metropolis Plan and Chicago Metropolis Freight Plan (6-county region)— developed alternative transportation scenarios, made enhancements in the regional travel demand model, and used the enhanced model to evaluate alternative scenarios including development of alternative regional transit concepts.

Developed multi-class assignment model and used it to analyze freight alternatives including congestion pricing and other peak shifting strategies.

Municipal Planning

City of Grand Rapids – Michigan Street Corridor – developed peak period subarea model including non-motorized trips based on urban form. Model is being used to develop traffic volumes for several alternatives that are being additional analyzed using the City's Synchro model

City of Omaha - Modified regional travel demand model to properly account for non-motorized trips, transit trips and shorter auto trips that would result from more compact mixed-use development. Scenarios with different roadway, transit, and land use alternatives were modeled.

City of Dublin (Columbus region) – Modified regional travel demand model to properly account for non-motorized trips and shorter auto trips that would result from more compact mixed-use development. The model was applied in analyses for a new downtown to be constructed in the Bridge Street corridor on both sides of an historic village center.

City of Portland, Maine – Implemented model improvements that better account for non-motorized trips and interactions between land use and transportation and applied the enhanced model to two subarea studies.

City of Honolulu – Kaka'ako Transit Oriented Development (TOD) – applied regional travel demand model in estimating impacts of proposed TOD including estimating internal trip capture.

City of Burlington (Vermont) Transportation Plan – Led team that developing Transportation Plan focused on supporting increased population and employment without increases in traffic by focusing investments and policies on transit, walking, biking and Transportation Demand Management.

Transit Planning

Regional Transportation Authority (Chicago) and Chicago Metropolis 2020 – evaluated alternative 2020 and 2030 system-wide transit scenarios including deterioration and enhance/expand under alternative land use and energy pricing assumptions in support of initiatives for increased public funding.

Capital Metropolitan Transportation Authority (Austin, TX) Transit Vision – analyzed the regional effects of implementing the transit vision in concert with an aggressive transit-oriented development plan developed by Calthorpe Associates. Transit vision includes commuter rail and BRT.

Bus Rapid Transit for Northern Virginia HOT Lanes (Breakthrough Technologies, Inc and Environmental Defense.) – analyzed alternative Bus Rapid Transit (BRT) strategies for proposed privately-developing High Occupancy Toll lanes on I-95 and I-495 (Capital Beltway) including different service alternatives (point-to-point services, trunk lines intersecting connecting routes at in-line stations, and hybrid).

Roadway Corridor Planning

I-30 Little Rock Arkansas – Developed enhanced version of regional travel demand model that integrates TransCAD with open source Dynamic Traffic Assignment (DTA) software, and used to model I-30 alternatives. Freeway bottlenecks are modeled much more accurately than in the base TransCAD model.

South Evacuation Lifeline (SELL) – In work for the South Carolina Coastal Conservation League, used Dynamic Travel Assignment (DTA) to estimate evaluation times with different transportation alternatives in coastal South Caroline including a new proposed freeway.

Hudson River Crossing Study (Capital District Transportation Committee and NYSDOT) – Analyzing long term capacity needs for Hudson River bridges which a special focus on the I-90 Patroon Island Bridge where a microsimulation VISSIM model was developed and applied.

PUBLICATIONS AND PRESENTATIONS (partial list)

DTA Love: Co-leader of workshop on Dynamic Traffic Assignment at the June 2019 Transportation Research Board Planning Applications Conference.

Forecasting the Impossible: The Status Quo of Estimating Traffic Flows with Static Traffic Assignment and the Future of Dynamic Traffic Assignment. *Research in Transportation Business and Management* 2018.

Assessing Freeway Expansion Projects with Regional Dynamic Traffic Assignment. Presented at the August 2018 Transportation Research Board Tools of the Trade Conference on Transportation Planning for Small and Medium Sized Communities.

Vermont Statewide Resilience Modeling. With Joseph Segale, James Sullivan and Roy Schiff. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

Assessing Freeway Expansion Projects with Regional Dynamic Traffic Assignment. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

Pre-Destination Choice Walk Mode Choice Modeling. Presented at the May 2017 Transportation Research Board Planning Applications Conference.

A Statistical Model of Regional Traffic Congestion in the United States, presented at the 2016 Annual Meeting of the Transportation Research Board.