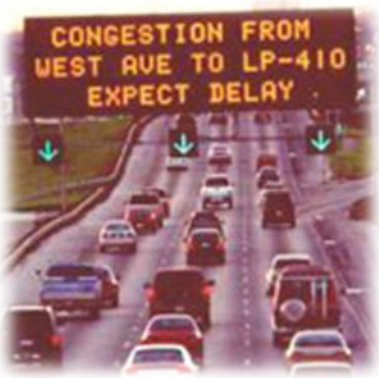
I-205 Access and Operations Study

December 2014



Southwest Washington Regional Transportation Council

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Introduction

Study Purpose

The purpose of the I-205 Corridor Study was to develop both short term and long term improvement recommendations that address rising travel demand in the I-205 corridor. Current traffic volumes on I-205 exceed the carrying capacity of the corridor. These capacity deficiencies result in mobility/safety limitations and congested/unreliable traffic flow. This trend continues and worsens into the future due to the growth forecast for East County per the adopted Clark County Growth Management Plan. These deficiencies also impact travel reliability for transit and commerce.

Revenue forecasts will likely reduce the previously anticipated level of capital investment in the corridor. Today's economic climate points to a very limited future revenue picture. Without new revenues, agencies will have to dedicate most of their funding to preservation and maintenance. This scenario of limited revenues makes it essential to first deploy operational improvements in the corridor before major capital investments are made.

Background

The I-205 Corridor Study had two phases. The first phase began with the Metropolitan Transportation Plan (MTP) list of highway and transit service improvements that have been previously identified across a series of planning studies and assessed how different sets of improvements addressed 2035 travel demand. It focused on the list of highway and transit service improvements contained in the 2011 adopted Regional Transportation (RTP) which is tied to the growth assumptions in the 20-year Growth Management Act (GMA) land use plan and its associated transportation impacts. The Phase One recommendations narrowed the full set of 20-year plan projects in the I-205 corridor to a smaller set of core projects representing the most critical capacity needs to ensure a reasonable long-term level of operation in the corridor that address both the future growth forecast and the new reality of very limited revenue.

Phase Two, known as the Access and Operations Study (AOS) identified and analyzed short term operational and system management improvements that would serve to make the transportation system operate more efficiently and predictably and could supplement or defer the timeline for I-205 freeway expansion projects described in the Regional Transportation Plan. Additionally, the AOS refined the core projects adopted in Phase One and confirmed their inclusion in the 2014 RTP update.

History of previous studies

There have been extensive planning efforts around the I-205 corridor since 1990 to address transportation mobility needs and to respond to planned future growth and land use changes in the corridor.

Over the last twenty years, RTPs for the region have identified I-205 as an important high growth corridor. The 1993 Interim Regional Transportation Plan was the first to identify the need for new access in the I-205 corridor. It analyzed current and future transportation conditions and included the assumption of a new interchange at 18th Street and I-205. The 1994 MTP also recognized the need to address I-205 mobility and capacity improvements. The MTP called for more detailed study of transportation improvement needs in the I-205 corridor between the Glenn Jackson Bridge and 83rd Street (Padden Parkway) and included an interchange in the vicinity of 18th Street.

The policy regarding the need for I-205 corridor improvements was continued with the 1996 MTP update which also incorporated the recommendations of the I-205 and East/West Arterials Study described in the next section.

The last major analysis and planning initiative in the I-205 corridor was completed in February 2002 with the publication of the I-205 Strategic Corridor Pre-Design Study/Access Point Decision Report (APDR). Previous studies included a significant amount of public and stakeholder agency involvement. The ADR effort was done with extensive involvement of stakeholder agencies. As a result, specific recommendations regarding interchange and ramp modifications, new access in the corridor, and arterial capacity improvements were included into the 2002 MTP update.

All subsequent MTPs since 2002 have included the I-205 APDR recommendations. In addition, two of the I-205 projects from the MTP have been completed or are programmed for construction. The Mill Plain Exit/112th Connector was funded by the Nickel package and was completed in 2010 and 18th Street Interchange project, providing access to and from the south, began construction in 2014 and is funded by the Transportation Partnership Account. There is no funding currently available for additional projects in the corridor. A detailed description of the Highway and Transit Studies in the corridor are contained in Appendix A.

Phase One: I-205 Corridor Study Recommendations

Phase one I-205 recommendations reduced capital costs in the I-205 corridor from $540m to $138m.

The I-205 Corridor Study recommendations, adopted by the RTC Board on November 6, 2012, identified a core set of capacity projects that address mainline corridor improvements to address future growth with limited transportation revenue. The core capital projects (see attached map) are considered the top tier capital improvements in the I-205. While the 2011 MTP identified $540 million in capital improvements for I-205; the core capital project recommendations reduced this to $138 million. These projects represent the most critical capacity needs for funding that ensure a reasonable investment level for long-term operation in the corridor.

- **I-205 Widening (SR-500 to Padden)** – Widen I-205 to three lanes in each direction.
- **SR-14 Widening (I-205 to 164th)** – Adds one new travel lane in each direction.
- **I-205 auxiliary lane (Mill Plain to SR-500)** – Adds a northbound auxiliary lane
- **Padden Interchange improvements with 72nd Avenue slip ramp** – The slip ramp bypasses the Andresen/Padden intersection for vehicles destined north on 72nd Avenue from I-205 north.
- **I-205 Park and Ride at 18th Street** – Relocates the existing Evergreen Park and Ride facility.

The study recommendations included moving forward with an I-205 Access and Operations Study for a detailed examination of short term low-cost operational strategies that included traffic operations, transit, and transportation demand management and to confirm the set of core projects with the goal of maximizing the efficiency and performance of the I-205 corridor without building new mainline capacity beyond currently funded projects and the core capital projects.

Phase Two of the Study

The Access and Operations Study analyzed both short (2022) and long term (2035) performance in the corridor and was charged to look at short-term traffic operational needs and to further refine and confirm the 2035 core projects from Phase one.

The consideration of operational strategies is consistent with Washington State Department of Transportation "Moving Washington" principles, a three tiered approach to mitigate congestion or add capacity on their facilities. Moving Washington principles are to:

- **Operate efficiently** – Get the most out of existing highways by using traffic management tools to optimize the flow of traffic and maximize available capacity.
- **Manage demand** – Shift travel times, use public transportation, or reduce the need to travel altogether, managing demand on overburdened routes to allow the system to function better.
- **Add capacity strategically** – Target the worst traffic hotspots or fill critical system gaps to fix bottlenecks that constrain traffic flow.

It is also consistent with RTP's long term strategy along I-205 to incrementally add capacity through system expansion and at selected interchanges.

Access and Operations Study Overview

The core capital projects adopted in Phase one are the top tier capital improvements for funding in the I-205 corridor. The Access and Operations Study is intended to supplement the core projects, and in the interim, address traffic merging hot-spots by implementing low cost operational improvements. These operations and system management strategies serve to make the transportation system operate more efficiently and predictably and could supplement or defer the timeline for freeway expansion.

The short term 2022 analysis assumed that only the I-205/18th Street Interchange Project is in place with no other improvements in the corridor. It is the only funded project in the corridor and is currently under construction with expected completion in 2016.

Study Process

The RTC Board and RTAC have each had three briefings on the I-205 Corridor Study in 2014 which includes attendance by members of the public. RTC has also met with representatives from the City of Vancouver, Clark County, C-TRAN, and the Washington State Department of Transportation (WSDOT) at milestones throughout the study. Information about the study was provided at an open house for the RTC Regional Transportation Plan in November 2014. In addition, WSDOT and RTC modeling staff met regularly on the regional transportation modeling and the microsimulation development and analysis needed for the operational strategies.

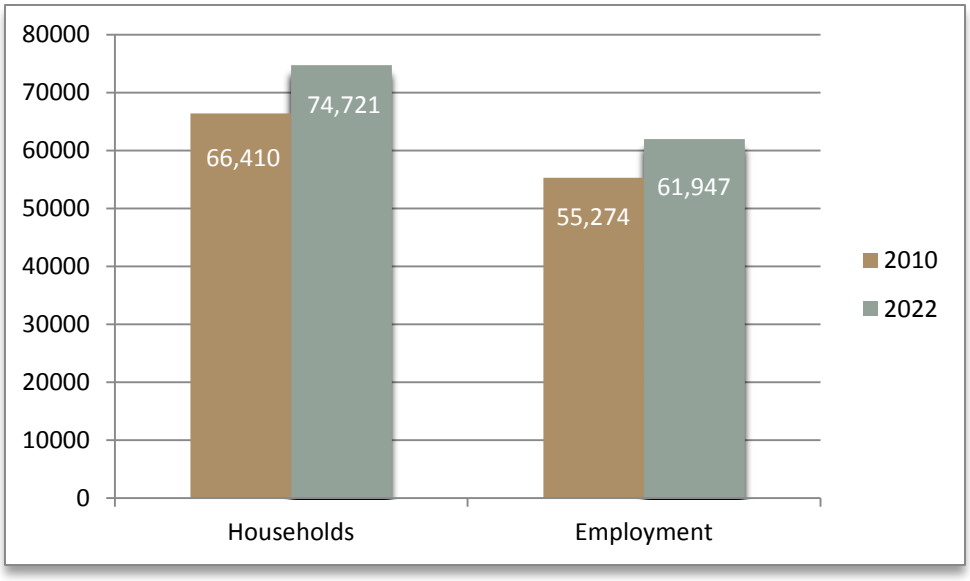
Key Assumptions – The following section summarizes the underlying assumptions and activities that drove the I-205 Corridor Study and provided the foundation for the development of the recommendations.

- Began with 2022 and 2035 RTP travel demand forecast.
- The regional model assumed that RTP projects were in place outside the I-205 corridor.
- The regional transportation analysis provided data on travel patterns, volume and delay information, and select link information.
- While the regional model anchored the analysis, it was supplemented with the VISSIM microsimulation tool to conduct the 2022 operational analysis which identifies congestion hotspots, ramp operations, merge/weave problems at freeway entrances, and lane queuing at ramps and on the freeway.
- Analysis of the individual 2022 operational projects and associated performance results were used to develop findings on the most promising options.
- Assessment of I-205 bus on shoulder potential was based on criteria identified by the Transit Cooperative Research Program (TCRP Report 151: A Guide for Implementing Bus on Shoulder Systems).

I-205 Corridor Demographics and System Performance

The I-205 corridor geographic area is defined as Andresen Road to the west, 192nd to the east, the Columbia River to the south and 134th Street to the north. Demographic information for the corridor is summarized in the chart below. Between 2010 and 2022, households are forecast to grow by 12% to 74,270 with employment growing by the same percentage to 61,950. Even with 12% growth, the I-205 corridor makes up 38.4% of the regional households and 37.8% of the regional jobs indicating its continued importance as a significant transportation corridor.

Figure 1: I-205 Corridor Households and Employment



The following table displays regional transportation system performance for 2010 and 2022. Comparisons include vehicle miles travelled, vehicle hours of delay, and freeway miles with a volume to capacity ratio of .9 or higher. The travel demand resulting from demographic growth in the corridor sees a decline in transportation system performance with capacity and performance problems emerging in the I-205 corridor.

Table 1: Corridor Performance Measures

	2010 AM	2022 AM	2010 PM	2022 PM
Vehicle Miles Travelled	94,427	137,931	106,605	121,672
Vehicle Hours of Delay	188	1,423	172	594
Lane Miles Congested	5.6	37.2	7.2	21.3

Analysis and Findings

A transportation team made up of technical staff from WSDOT, Clark County, City of Vancouver, C-TRAN and RTC met during the course of the study to discuss the type of analysis needed, the transportation modeling tools available, and the technical protocol for quality control and review of model results, and as noted earlier, identified the regional travel model and VISSIM microsimulation as the two primary transportation models to use for the operational analysis.

The regional model serves as an effective tool to examine the impact of capital intensive highway capacity and transit service project investments. The regional model provides data and analysis on vehicle miles traveled, roadway level of service (LOS), volume to capacity ratios, vehicle hours of delay, lane miles of congestion, and other performance measures. The regional model anchored this phase of the analysis, but was supplemented with a microsimulation tool to conduct the needed operational analysis.

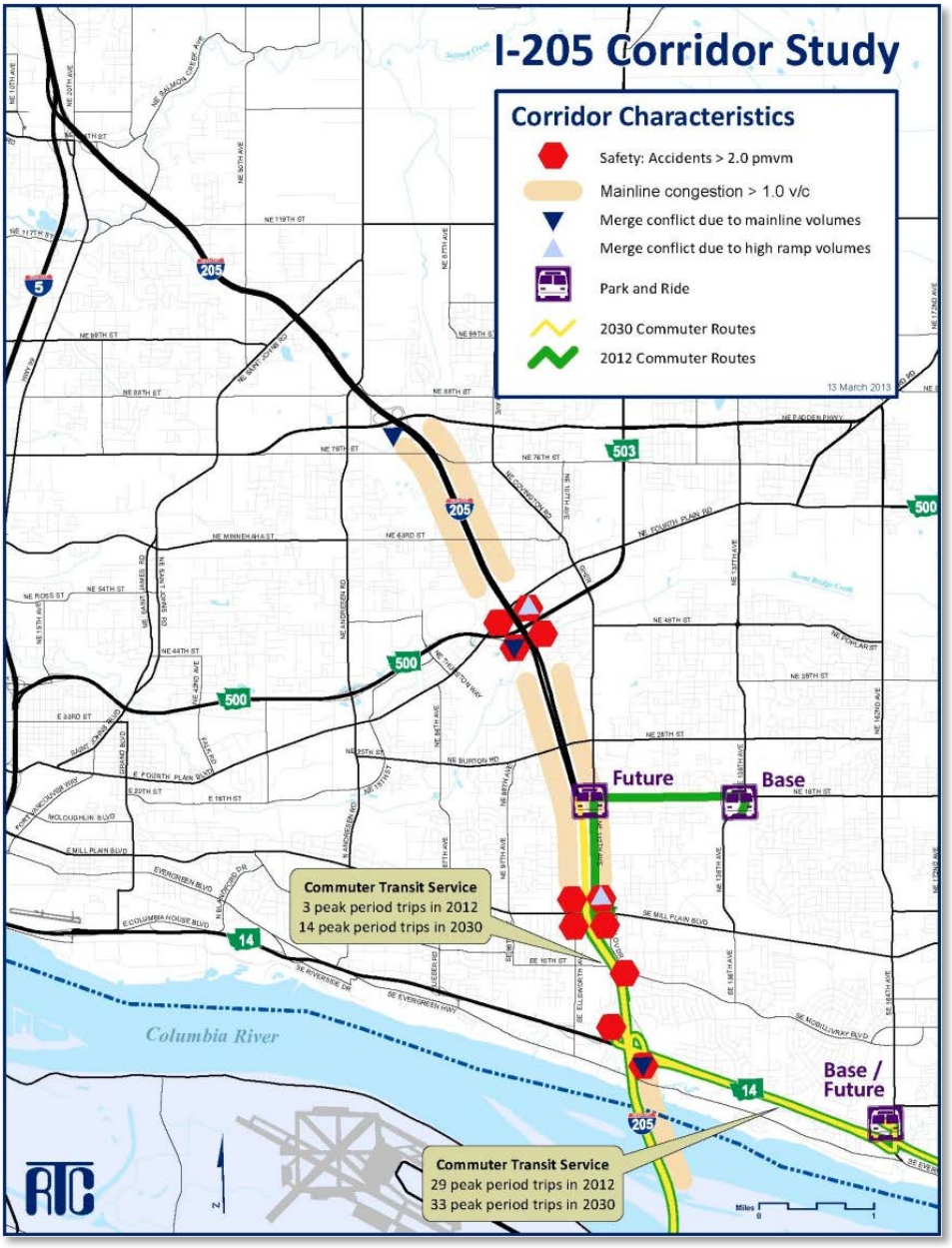
VISSIM is a transportation model application that simulates the interaction of vehicular traffic by assigning each auto, truck, and bus on the roadway its own operating characteristics. The modeling tool can identify congestion hotspots, ramp operations, merge/weave problems at freeway entrances, and lane queuing on the freeway. In addition to its operations analysis capabilities, it provides visualizations of how traffic operates. The VISSIM modeling effort was led by WSDOT with support by the partner agencies.

Identification of Operational Strategies

A workshop was held on March 19, 2013 to discuss and select operational strategies and evaluation criteria that will be used to formulate the operational recommendations for the I-205 corridor. The workshop included participation by technical advisory committee members and modeling staff from WSDOT, Clark County, City of Vancouver, and C-TRAN and provided an opportunity for participants to learn about operational issues in the I-205 corridor, the types of operational strategies, and lessons learned from other areas. The workshop mapped the operational issues and problems in the I-205 corridor and provided detailed information on a wide range of operational strategies with information about best practices, experiences in other regions, and expected benefits. A matrix of the range of operational strategies considered is in Appendix B.

Workshop participants looked at a wide range of potential evaluation measures and identified up to fifteen measures to assess the operational strategies and the performance of the corridor. The key operational measures discussed by the Committee include: I-205 mainline queuing, volume to capacity ratio by segment, merging/weaving conflicts, off-ramp delay and queue length, and congestion on adjacent arterials.

Figure 2: Corridor Characteristics



They also reviewed projects and problems in the corridor, discussed their viewpoint on the function and use of the corridor, and shared their assessment of the key issues to be addressed in the I-205 study. The following narrative provides a summary of the essential points made by each agency.

WSDOT – Views the function and use of the corridor in the context of the state's transportation policy goals. For the I-205 corridor, the top priorities are to improve safety and mobility and to preserve and improve the operation of the mainline I-205.

City of Vancouver – Adequate access to the connecting urban arterial system should be maintained. Access improvements to I-205 should also support transportation investment already made to the connecting arterials as well as support the comprehensive land use plan for this portion of East Vancouver.

Clark County – Improvements to I-205 need to consider the importance of and impact on the County's connecting regional corridors and also facilitate access to County transportation facilities.

C-TRAN – Maintain the ability to provide park and ride facilities in the south part of the I-205 corridor for good bi-state transit market capture.

At the conclusion of the workshop, the participants identified a set of low cost operational strategies to address the operational problems identified in the corridor during the workshop. The following section described the findings for the full set of strategies selected for analysis.

Strategy Findings

The 2022 analysis examined how the addition of low cost operational improvements can manage or improve vehicle flow on I-205. The refinement of strategies from the workshop has been an iterative process and was based on regional model results, information from microsimulation analysis, video observation of current conditions, and review and collaboration with WSDOT staff. RTC worked closely with WSDOT staff and other local agencies to identify the set of operational strategies and low cost projects with the best potential to manage corridor performance and improve efficiency without expanding roadway capacity.

The findings for 2022 operational strategies described below are designated as "not recommended" or "promising". The "not recommended" strategies were analyzed, but dismissed from further consideration for a variety of reasons which may include not being a low cost option, not having an operational benefit or having a negative impact on safety or the arterial system. The "not recommended" strategies are described in Appendix C. The "promising" strategies, listed below, are those that warrant further consideration by WSDOT. This designation means that the strategy has a benefit to travel performance in the corridor and that further analysis and stakeholder consultation should occur during project development.

Promising Operational Strategies

I-205 North / Mill Plain Boulevard Interchange

Ramp Meter from Mill Plain to I-205 northbound

- Smooths merging conditions at the ramp terminus by managing and breaking up vehicle platoons entering I-205.
- Further study is required to determine the feasibility of side by side storage lanes on the on-ramp, placement of the meter, as well as other details regarding the installation and operation of a "smart" ramp meter.

- Managing platoons at this on-ramp may no longer be required after I-205 is widened between Mill Plain and SR-500.

I-205 South / Padden Parkway Interchange

Maintain two merge locations and meter just the eastbound to southbound ramp

- Smooths merging conditions at the ramp terminus by managing and breaking up vehicle platoons entering I-205.
- Further study is required to determine the feasibility of side by side storage lanes on the eastbound to southbound on-ramp, placement of the meter, as well as other details regarding the installation and operations of a "smart" ramp meter.
- Managing platoons at this on-ramp may no longer be required after I-205 is widened between Padden Parkway and SR-500.

I-205 South / SR-500 Interchange

Reduce I-205 southbound from three to two lanes prior to the SR-500 overpass and allow the westbound to southbound on-ramp to become an add lane, and the eastbound to southbound on-ramp to merge downstream into this add lane.

- Creating an add lane will improve operations by reducing turbulence for vehicles entering I-205 from SR-500.
- This is a relatively low cost option that could be readily implemented.
- A two lane cross section on I-205 under SR-500 will have sufficient capacity for vehicle demand, as long as capacity is not increased upstream of this segment.
- The benefit and viability of this project would need to be reconsidered if/or when I-205 is widened from Padden Parkway to SR-500. Increased southbound volumes from north of SR-500 may require converting back to three through lanes on I-205 at SR-500. Anticipated traffic demand will be evaluated for this section in conjunction with any upstream capacity improvements.

I-205 South / 18th Street Interchange

Ramp meter from 18th Street to I-205 southbound

- Smooths merging conditions at the ramp terminus by managing and breaking up vehicle platoons entering I-205.
- Further study is required to determine the placement of the meter, as well as other details regarding the installation and operation of a "smart" ramp meter.

- On-ramp width will allow the option for a future bus (HOV) bypass lane onto I-205 south.

I-205 South / Mill Plain Boulevard Interchange

Ramp meter from Mill Plain Boulevard to I-205 southbound

- Smooths merging conditions at the ramp terminus by managing and breaking up vehicle platoons entering I-205.
- Further study is required to determine the feasibility of side by side storage lanes on the on-ramp, placement of the meter, as well as other details regarding the installation and operation of a "smart" ramp meter.

Transit Operations Assessment

One of the recommendations of the Clark County High Capacity Transit System Plan, adopted by the RTC Board in December 2008, was to consider Bus on Shoulder (BOS) operation in the I-205 corridor during congested periods. As part of the I-205 Corridor Study, RTC consulted with C-TRAN and WSDOT staff to conduct a screening assessment that on this component of the HCT recommendation to determine whether conditions in the corridor would warrant further investigation on the viability and feasibility of BOS operations on I-205. The assessment looked at several factors based on criteria identified by the Transit Cooperative Research Program (TCRP Report 151: *A Guide for Implementing Bus on Shoulder Systems*). The factors listed below comprise the bulk of the screening assessment and are summarized by a brief description of findings based on I-205 corridor characteristics:

- *Are there at least 4 buses per hour?*
  Yes. C-TRAN has 10 to 22 period buses in 2022 and 16 to 25 buses in 2035.
- *Is mainline speed less than 35 mph?*
  Yes. Peak hour congested speeds for 2022 and 2035 based on the regional travel model on I-205 from 18th Street to I-84 show potential transit travel time savings on several segments in the corridor with BOS. Actual travel time data would need to be collected in the corridor to better determine if corridor congestion warrants BOS. In addition, BOS would not be invoked during the full peak period and would only be used during times when mainline speeds are below 35 mph.
- *Are entrance and exit ramps less than 1,000 vph?*
  Some ramps are higher than 1,000 vehicles per hour, specifically at Airport Way and SR-14. Additional investigation would be needed to determine the feasibility to operate outside BOS at very high volume ramps.

- *Will inside/outside shoulder support buses?*
  The majority of the asphalt pavement shoulder segments in Washington will need to be reconstructed. Shoulder depth for the Washington portion of the I-205 corridor, north of the Glenn Jackson Bridge, is generally 0.15 ft. with some locations having a pavement depth of 0.35 ft. A detailed examination to determine pavement depths and the cost of reconstruction would be needed.

- *Is inside/outside shoulder at least 10 feet (12 feet desired)?*
  Some shoulder segments may need to be modified either through reconstruction or restriping to accommodate BOS on an outside or inside lane. Shoulder width varies throughout the corridor.

Based on the findings above, BOS in the I-205 corridor may offer future opportunity for: improved transit reliability; travel time savings; expanded commuter ridership; and facilitate low-cost transit expansion in the corridor. Detailed information regarding the BOS assessment is contained in Appendix D.

Analysis Results

This section contains data summaries of the analysis for the "promising" operational strategies. The figures summarize key performance information for each of the recommended strategies. The left side of the exhibit includes data on measures of effectiveness (MOEs), key points about the strategy, and travel speeds at the ramp terminus. The right side displays a schematic of the base and proposed conditions and detailed notes of interest specific to the strategy. Definitions of the MOEs are below:

Congestion duration – Percent change in the number of hours that the segment is operating at Level of Service (LOS) E or worse.

Average gap distance – Percent change in the distance between vehicles on the mainline. Greater distance means easier merging.

Relative speed change – Percent change in the mainline speed at the ramp merge.

Peak hour Level of Service – A measure of traffic flow and turbulence on the mainline during the peak hour.

A note about the speed data

Several of the speed change charts show a slight decrease in mainline speed toward the end of the peak period when the meter is still in operation. This is due to an anomaly of the ramp metering modeling analysis. A metered ramp might allow 1,500 vehicles per hour at a steady rate of 25 vehicles per minute. During the same one hour period, an unmetered ramp might also have 1,500 vph entering the freeway; however, vehicles per minute at the uncontrolled ramp will fluctuate based on demand. Unmetered ramp volumes will be highest during the middle of the peak hour and dissipate toward the end of the peak with fewer vehicles entering the freeway compared to a metered ramp.

The result is that the metered ramp, at the end of the peak, is letting more vehicles onto the system and therefore has lower mainline speeds. During actual operation the meter would be turned off when not needed. The following charts show a representation of the comparison.

Figure 3: Ramp Meter Speed Behavior

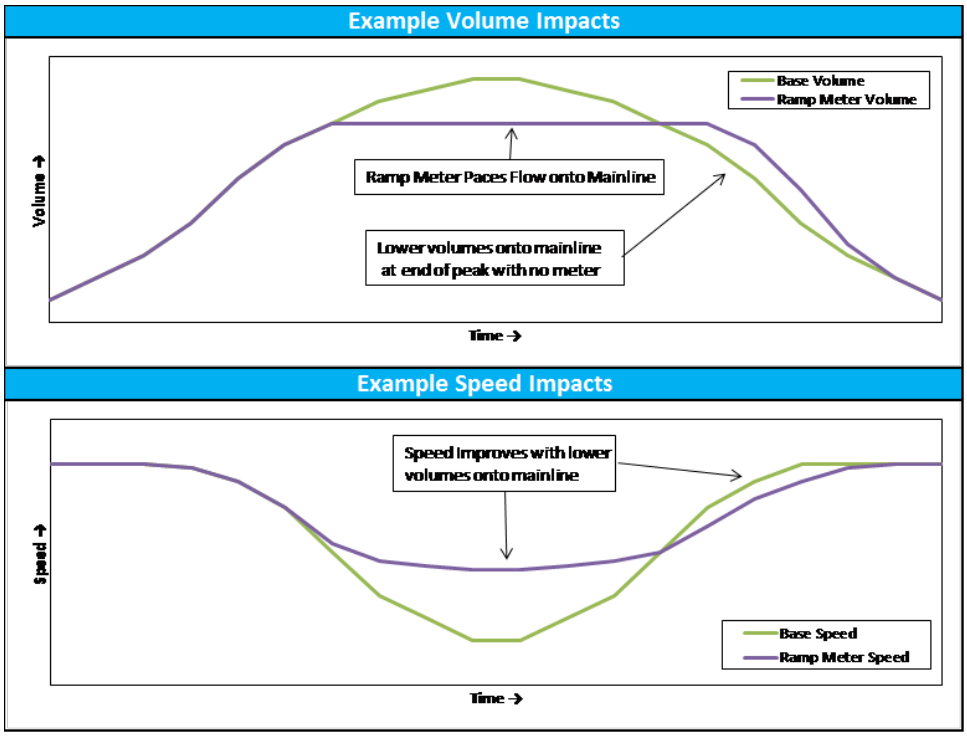


Figure 4: Ramp Meter, Mill Plain Boulevard to I-205 NB

I-205 NB: Meter from Mill Plain to I-205 NB

Project Analysis/Evaluation
2022 PM Peak Hour (4:30 PM to 5:30 PM)

Detailed Analysis
I-205 Mainline Impacts after NB Mill Plain Onramp Merge

Measure of Effectiveness	Change**
Congestion Duration* - Right Lane	- 35%~
Average Gap Distance - Right Lane	+ 10%
Average Speed after Merge	+ 4%
Impacts to Mill Plain	Yes~

*Congestion was defined as LOS E or lower

** Performance: Better Worse

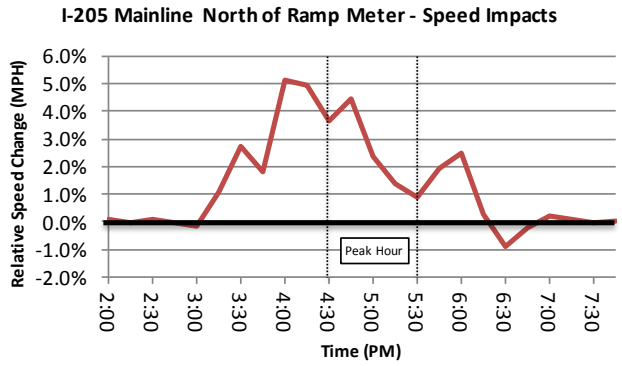
Key Points

Base Conditions

During the PM peak period, mainline congestion limits the avalable gaps for merging traffic.

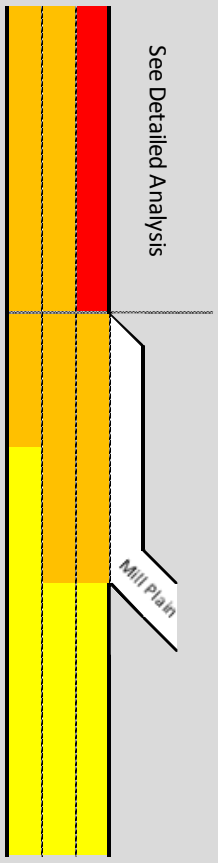
Ramp Meter Alternative

Ramp meter the northbound onramp to control the flow of traffic onto the interstate.

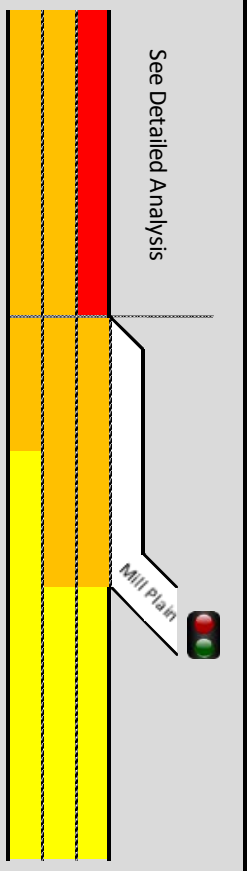


Corridor Operations - Level of Service

Base Conditions



Ramp Meter Alternative



LOS	LOS Descriptions
A	Unrestricted operations
B	Merging maneuvers noticeable to drivers
C	Influence area speeds begin to decline
D	Influence area turbulence becomes intrusive
E	Turbulence felt by virtually all drivers
F	Ramp and freeway queues form

Notes

Model assumed meter rate of 4.5 seconds per vehicle. Actual rate during design would be adjusted to prevent queuing to Mill Plain. The detailed analysis shows improvments at the merge hotspot.
~Operations in the rightmost lane is on the LOS threshold between LOS D and LOS E. Since congestion was defined as LOS E or lower, a slight improvement in the operations of this lane lead to a fairly significant change reducing the the duration of congestion in the right lanes and will ease merging operations entering the mainline. Drivers along I-205 corridor will see a slight improvement from current conditions.

Figure 5: Ramp Meter, Padden Parkway EB to I-205 SB

I-205 SB: Meter from Padden Parkway EB to I-205 SB

Project Analysis/Evaluation
2022 AM Peak Hour (7:15 AM to 8:15 AM)

Eastbound Onramp to Mainline Merge Traffic Impacts

Measure of Effectiveness	Change**
Congestion Duration*	-
Average Gap Distance	+ 11%
Average Speed in Merge Area	+ 8%
Impacts to Padden Parkway	No

*Congestion was defined as LOS E or lower

** Performance: Better Worse

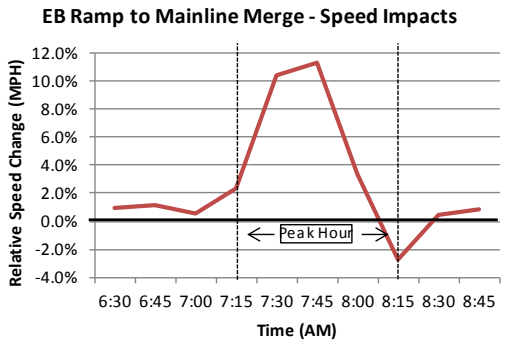
Key Points

Base Conditions

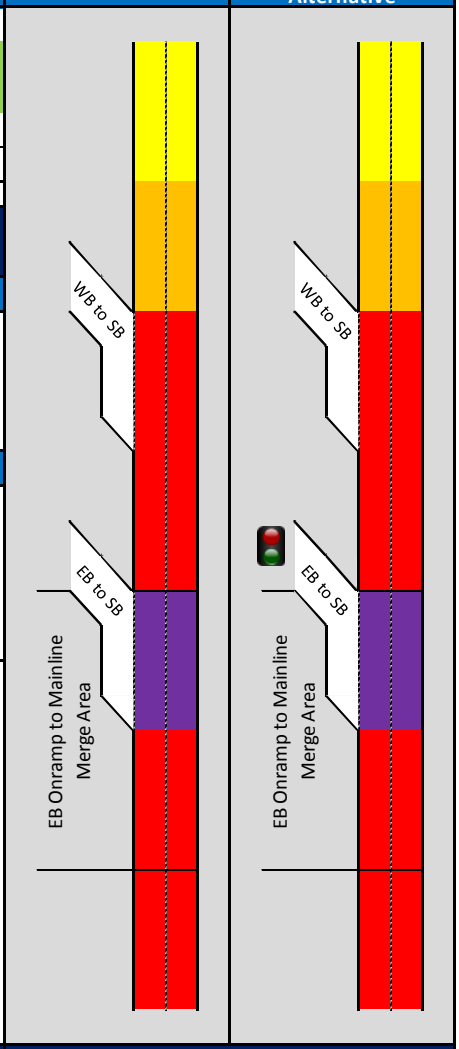
During the AM peak period, mainline congestion limits the avalable gaps for merging traffic. In addition, the Padden Parkway/Andresen Road Intersection sends vehicles to the EB to SB onramp in platoons.

Ramp Meter Alternative

Ramp meter the eastbound to southbound onramp to control the flow of traffic onto the interstate.



Corridor Operations - Level of Service



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F	Ramp and freeway queues form

Notes

Merging operations will be improved at the entry to the mainline which can be seen in the measures of effectiveness. Increasing corridor speeds with a ramp meter may also lead to improved operations at upstream locations, such as the WB onramp merge. Vehicle density at the EB onramp merge is LOS F due to demand exceeding capacity with and without the ramp meter.

Figure 6: Interchange Modification, I-205 SB and SR-500

I-205 SB: SR 500 Interchange Modifications

Project Analysis/Evaluation
2022 AM Peak Hour (7:15 AM to 8:15 AM)

Analysis Findings

Base Conditions

Congestion occurs where the SR 500 EB and WB ramps merge together. The rightmost lane of I-205 is underutilized during peak conditions, due to drivers avoiding heavy onramp merge.

Add Lane Alternative

- Removes mainline merge
- Reduces, but does not remove the ramp to ramp merge issue(**2**) Queue continues to extend into segment (**3**)

Location	Measure	Change**
(**1**) EB and WB Onramp to Mainline *Add Lane*	Congestion Duration*	-4%
	Average Gap Distance	N/A^
	Average Speed in Merge Area	+3%
(**2**) EB Onramp to WB Onramp *Merge*	WB to SB Ramp Queue (Average)	-30%
	WB to SB Ramp Queue (95th %ile)	-15%
	Queuing into Weaving Segment (**3**)	Yes

*Congestion was defined as LOS E or lower

^Onramp traffic no longer has to find a gap in the mainline to merge

** *Performance:* *Better* *Worse*

Split Ramp Alternative

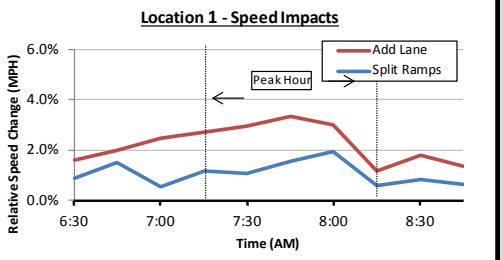
- Takes advantage of underutilized mainline capacity
- Removes mainline merge for WB onramp traffic with add lane
- WB onramp traffic merges with the mainline prior to EB onramp traffic (**2**)

Location	Measure	Change**
(**1**) EB Onramp to Mainline *Merge*	Congestion Duration*	-
	Average Gap Distance	-1%
	Average Speed in Merge Area	+2%
(**2**) EB Onramp to WB Onramp *Merge Removed*	WB to SB Ramp Queue (Average)	N/A^
	WB to SB Ramp Queue (95th %ile)	N/A^
	Queuing into Weaving Segment (**3**)	No

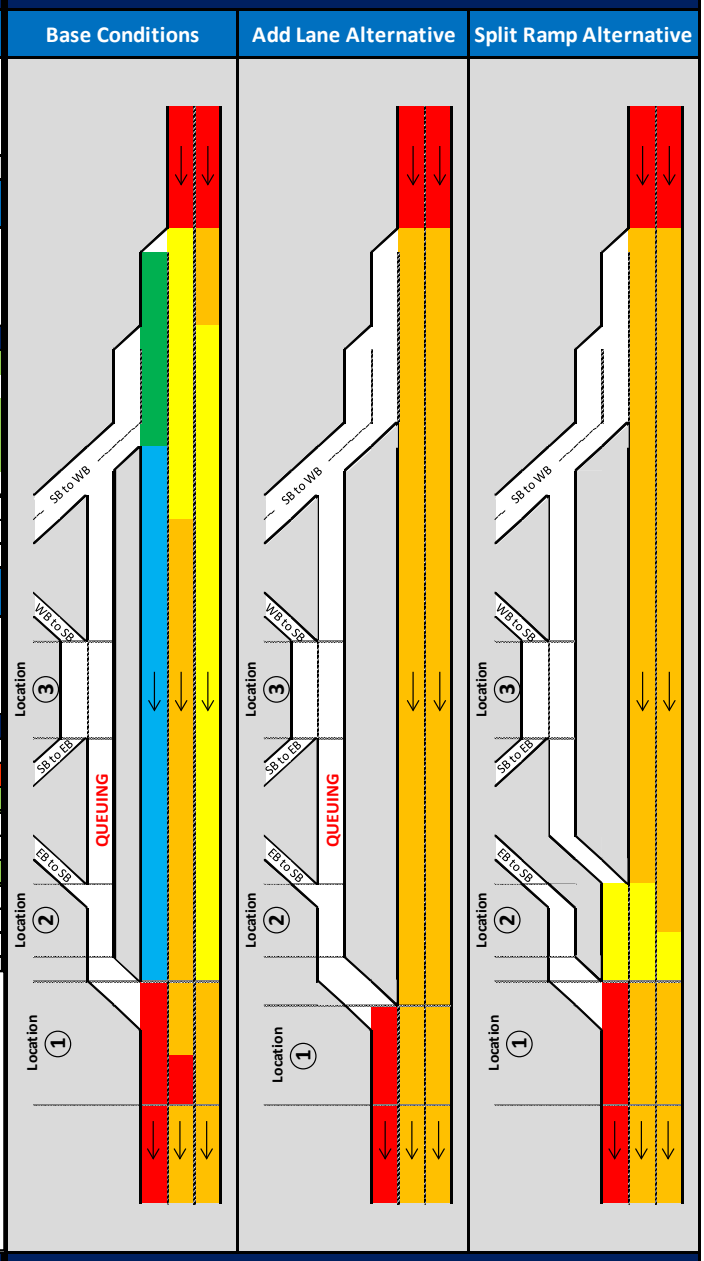
*Congestion was defined as LOS E or lower

^The ramp to ramp merge no longer exists with this alternative.

** *Performance:* *Better* *Worse*



Corridor Operations - Level of Service



LOS	LOS Descriptions
A	Unrestricted operations
B	Merging maneuvers noticeable to drivers
C	Influence area speeds begin to decline
D	Influence area turbulence becomes intrusive
E	Turbulence felt by virtually all drivers
F	Ramp and freeway queues form

Notes

There should be sufficent capacity along I-205 under the SR 500 interchange as the upstream segment (Padden to SR 500) limits the volume in this location. Both alteratives remove a merge condition from the interchange, however specific benefits differ. The Add Lane Alternative removes the SR-500 Ramp to Mainline Merge (1) and the Split Ramp Alternative removes only the WB Ramp to Mainline Merge (1) and the SR-500 EB Ramp to WB Ramp Merge (2) . WSDOT will conuct further analysis on which option to implement. When additional capacity is added between Padden Parkway and SR 500 or between SR 500 and Mill Plain, these configurations may require some adjustments.

Figure 7: Ramp Meter, Mill Plain and 18th Street to I-205 SB

I-205 SB: Mill Plain and 18th Street Ramp Meter

Project Analysis/Evaluation
2022 AM Peak Hour (7:15 AM to 8:15 AM)

Analysis Findings

Location	Measure of Effectiveness	Change**
(**1**) 18th Street *Ramp Meter*	Congestion Duration*	-
	Average Gap Distance	+ 2%
	Average Speed in Merge Area	+ 3%
	Impacts to 18th Street	Yes~
(**2**) Mill Plain *Ramp Meter*	Congestion Duration*	-
	Average Gap Distance	+ 2%
	Average Speed in Merge Area	+ 1%
	Impacts to Mill Plain	No

*Congestion was defined as LOS E or lower

** *Performance:* *Better* *Worse*

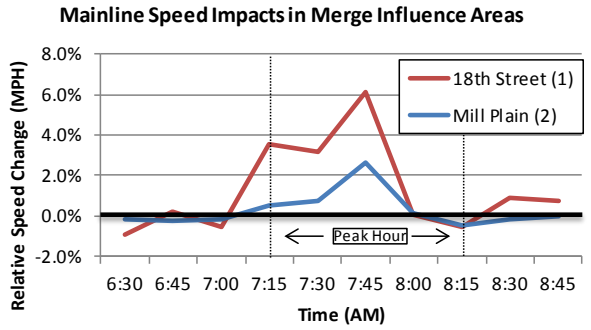
Key Points

Base Conditions

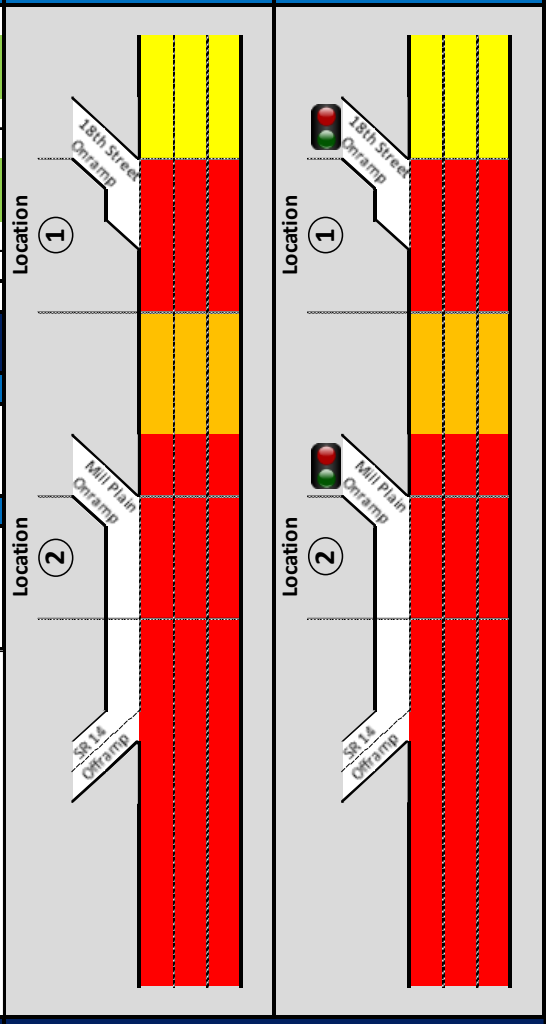
During the AM peak period, mainline congestion limits the available gaps for merging traffic.

Ramp Meter Alternative

Ramp meter the southbound onramps to control the flow of traffic onto the interstate.



Corridor Operations - Level of Service



LOS	LOS Descriptions
A	Unrestricted operations
B	Merging maneuvers noticeable to drivers
C	Influence area speeds begin to decline
D	Influence area turbulence becomes intrusive
E	Turbulence felt by virtually all drivers
F	Ramp and freeway queues form

Notes

~Placement of the ramp meter will determine if operations along 18th Street could be impacted as well as the feasibility of a bus bypass lane. Further study will be conducted after traffic patterns adjust to the new on-ramp for final evaluation of ramp meter need and to identify where on the ramp the meter would be located.

Queues from the Mill Plain ramp meters are not anticipated to impact the local system. The ramps appear to be long enough to accomodate the queues.

Cost

The operational strategies described above are all low cost projects. Order of magnitude costs for the strategies are summarized in the table below. The estimated ramp meter cost components include rebuilding the ramp shoulder to allow higher vehicle volumes, restriping, loop or radar detection, and communications.

Table 2: Capital Costs for Operational Projects

	Estimated Cost
Ramp meter from Mill Plain Boulevard to I-205 north	$400,000
Ramp meter from eastbound Padden Parkway to I-205 south	$400,000
I-205 lane modification at SR-500, for either add or split lane option	$500,000
Ramp Meter from 18th Street to I-205 south	$400,000
Ramp Meter from Mill Plain Boulevard to I-205 south	$400,000

Study Recommendations

The RTC Board adopted I-205 corridor recommendations on November 4, 2014 and have three primary components. The roadway recommendations are comprised of the 2035 core projects that will be in the RTP as well as the short term operational projects to be developed by Washington State Department of Transportation (WSDOT) in coordination with local agencies. The transit improvement recommendations call for a feasibility study of the technical, policy, and engineering opportunities and constraints of bus on shoulder operations in the I-205 corridor. The operational policies describe how to consider operational improvements in freeway corridors and to guide the implementation of ramp meters.

Roadway Improvements

- *Add 2035 Core Projects into the 2014 RTP as capacity improvements for I-205*
- *WSDOT lead to implement short term operational improvements*

Transit Operations

- *Bus on Shoulder assessment found time savings, reliability, and improved commuter ridership potential*
- *Recommend feasibility study in 2015 to address viability, engineering, costs, and constraints*

Operational Policies

- *Policies for regional freeways*
- *Analysis factors for considering strategies*
- *Implementation policies for ramp metering*

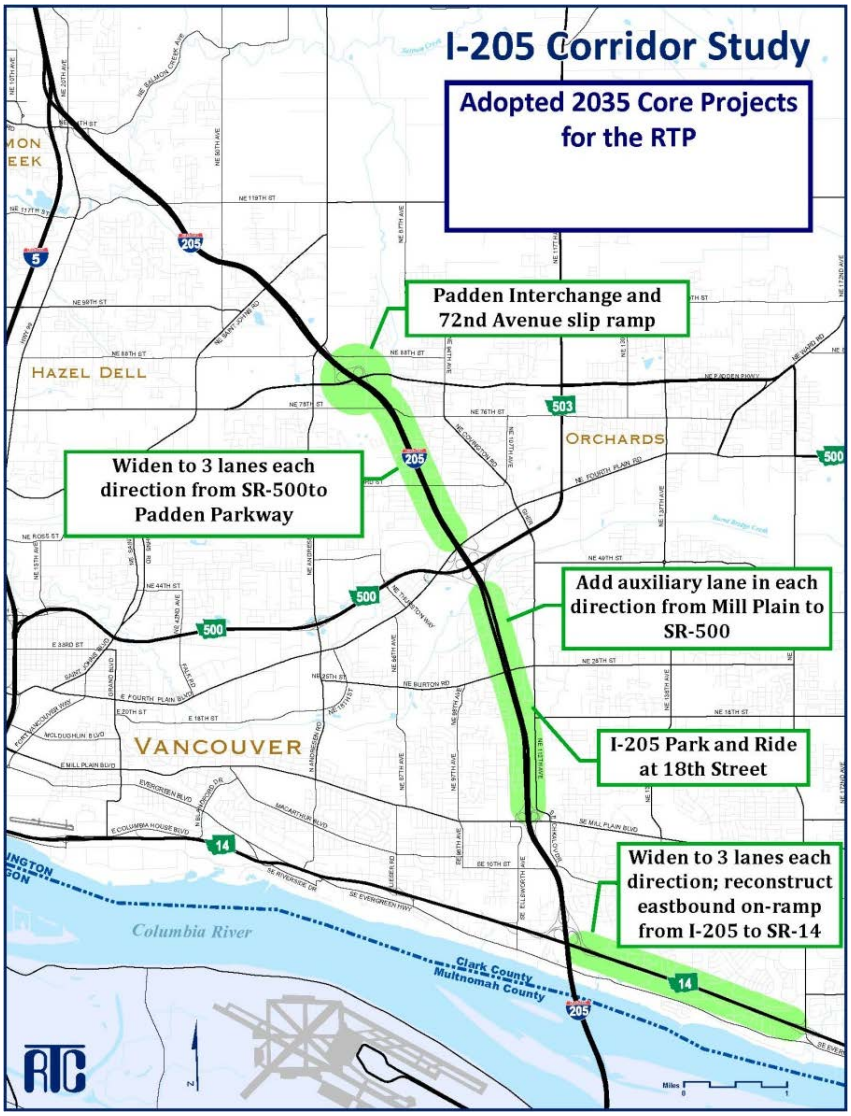
Roadway Improvements

2035 Core projects

The core project capacity improvements are identified as the most critical set of projects to ensure reasonable long-term level of operation of the corridor and make up the I-205 corridor improvements listed in the 2014 RTP.

- I-205 Widening (SR-500 to Padden)
- SR-14 Widening (I-205 to 164th)
- I-205 auxiliary lanes between Mill Plain Boulevard and SR-500
- Padden Interchange improvements with 72nd Avenue slip ramp
- I-205 Park and Ride at 18th Street

Figure 8: Adopted Core Projects

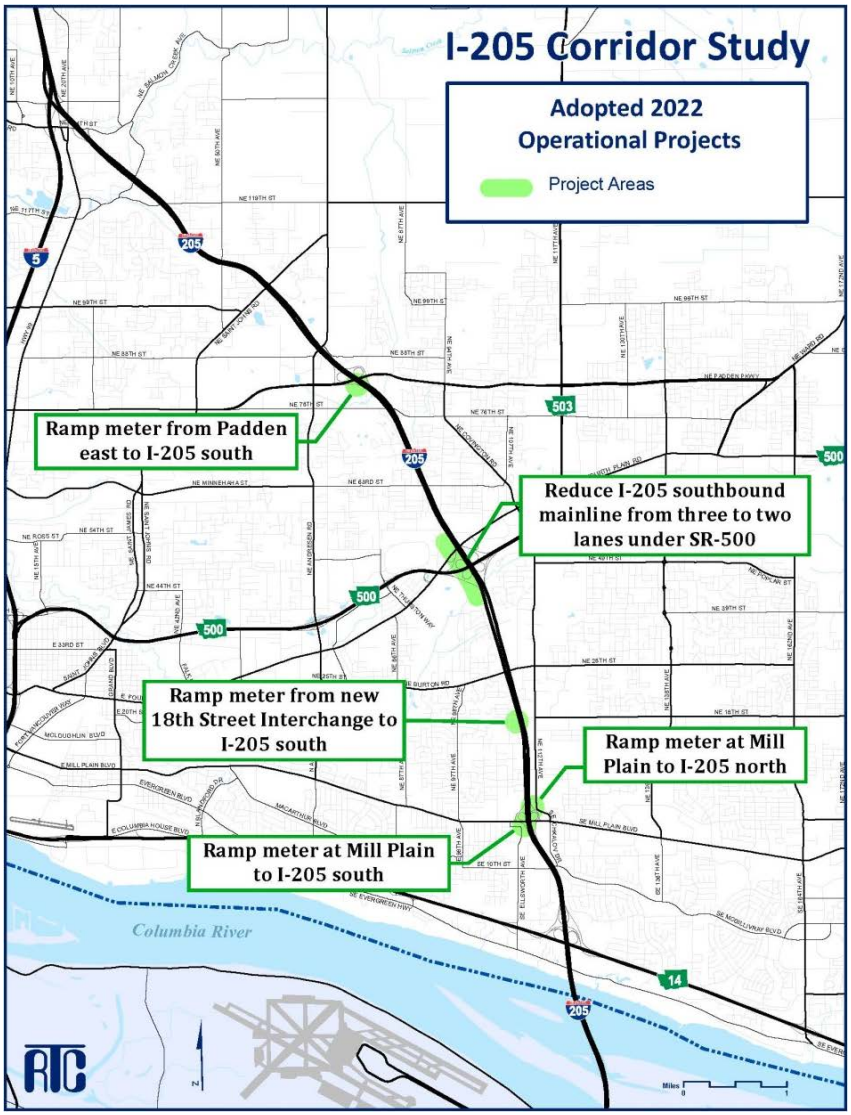


2022 Operational Strategies

The following operational improvements have a benefit to travel performance in the corridor and are recommended for further analysis and development.

- Ramp meter from Mill Plain Boulevard to I-205 northbound
- Ramp meter from eastbound Padden Parkway to I-205 southbound
- I-205 mainline modification to two lanes under SR-500 to provide an add lane at SR-500 southbound on-ramp
- Ramp meter from 18th Street to I-205 southbound
- Ramp meter from Mill Plain Boulevard to I-205 southbound

Figure 9: Adopted Operational Projects



Transit Operations

Over a two year period in Minneapolis, transit routes using BOS saw a 9.2 percent increase in ridership compared to a 6.5 percent decrease in total system ridership during the same period.

The screening assessment for bus on shoulder operation in the I-205 corridor found that it offers the opportunity for: improved transit reliability, travel time savings, and expanded commuter ridership and should be studied further to determine its viability. A feasibility study is recommended that would:

- Conduct detailed travel time studies of the I-205 mainline between Mill Plain Boulevard and I-84 to determine freeway speeds by segment, time of day, and duration.
- Evaluate operational issues associated with outside bus on shoulder including the impacts of high freeway ramp volumes on feasibility and possible ramp or shoulder modifications.
- Evaluation should include inside shoulder feasibility and issues associated with the ability to maneuver transit vehicles to and from the inside median to enter and exit at freeway ramps.
- Conduct an engineering analysis of physical improvements and shoulder reconstruction required for either outside or inside BOS operations and an order of magnitude cost estimate for both options.

Regional Operational Policies

The operational policies described below provide guidance for how to consider low cost improvements for operating freeways more efficiently and optimizing traffic flow. They consist of three components: specific operational policies, analysis factors to consider for operational strategies, and policies to direct ramp meter implementation.

Operational Policies for Freeways

- Provide for the management of limited access freeway corridors through the development of operational strategies that address recurring congestion, traffic bottlenecks, and incidents.
- Consider operational strategies in limited access freeway corridors where congestion levels are high and where there is potential for improved corridor flow, efficiency and expanded person throughput.
- Implementation of operational strategies should include incident management, intelligent transportation systems, ramp metering, expanded transit services, and other traffic management tools.
- Design considerations which complement operational strategies and which promote efficiency (such as ramp bypass) should also be considered to enhance person throughput and freight efficiency.

Analysis Factors

The assessment of specific operational strategies in a corridor should also consider and balance the following.

- The short and long term cost and life-cycle of the operational improvement.
- If the operational improvement has a positive impact on traffic flow, person/freight throughput, or safety.
- If the operational improvement complements, defers, or replaces a future RTP capital improvement.
- If an RTP capital improvement is funded and replaces the need for the operational improvement.

Implementation Policies for Ramp Metering

Prior to the implementation of ramp metering in the I-205 corridor:

- All affected agencies will be consulted.
- Metering needs to consider mainline travel flow and reliability as well as impact to adjacent arterial operations.
- Ramp meters should be "smart" to achieve freeway/arterial balance and meters would be turned off when not needed.
- Ramp bypass should be considered where feasible to support transit, freight, and person throughput.

Appendix A: Abstracts of Previous Studies

The following are a description of the Highway and Transit Studies in the corridor over the past 25 years.

Highway

Bi-state Transportation Study (1992) – The 1992 Bi-state Transportation Study analyzed current and future traffic conditions in the I-5 and I-205 corridors and assumed, based on the need to provide better access to East County, that a new interchange should be built at 18th Street and I-205.

Metropolitan Transportation Plan (1994) – Called for more detailed study of transportation improvement needs in the I-205 corridor between the Glenn Jackson Bridge and 83rd Street.

I-205 and East/West Arterials Study (1996) – Was the first to recommend a split diamond interchange at 18th and 28th as well as arterial improvements on 18th and Burton/28th to relieve SR-500 and Mill Plain interchanges and to support improved traffic circulation in the area. These improvements were also identified in the 1996 MTP update and led to the I-205 Strategic Corridor Pre-Design Study.

I-205 Strategic Corridor Pre-Design Study (2000) – Expanded upon the I-205 and East-West Arterials Study conducted in 1995/96. The focus of the Study was on operational analysis of mainline I-205 and connections to it between the Glenn Jackson Bridge and the interchange with the Padden Parkway. Among the findings of the Study was that planned land use objectives in the corridor and in east Vancouver could not be achieved without the provision of additional access on I-205, in particular, between SR-500 and Mill Plain Boulevard. The I-205 Strategic Corridor Study established the foundation for the last major analysis in the corridor, the Access Decision Report.

I-205 Access Decision Report (2002) – Conducted in response to a specific requirement by the Federal Highway Administration when access or modification to existing Interstate interchange on/off ramps is being considered. The ADR detailed significant highway capital investment in the corridor to address mobility, improve safety, and reduce weaving. It supported a break in access and recommended a phasing plan and an extensive set of improvements including interchange and ramp modifications, new access in the I-205 corridor, and arterial capacity improvements which were adopted into the 2002 MTP.

Transit

Clark County High Capacity Transit Study (1991) – Was conducted to determine the most appropriate HCT options and alignments to address both internal Clark County travel and regional bi-state travel between Clark County and the Portland metropolitan area. The study findings concluded that bus related HCT options, including bus rapid transit, should be evaluated in the I-205 corridor.

South/North I-5/I-205 HCT Pre-AA Study (1994) – Revisited this issue and confirmed the policy decision that bus rapid transit was the most appropriate level of HCT investment in the I-205 corridor.

Clark County High Capacity Transit Study (2008) – Was completed in 2008 and developed an HCT System for the region, including the I-205 corridor. Recommendations for I-205 corridor are consistent with the previous studies. It did not recommend full bus rapid transit in the I-205 corridor, but does contain several elements to improve transit travel times and reliability. The HCT Study calls for incremental improvements in the I-205 Corridor consisting of: all-day limited stop service between Salmon Creek and Gateway; direct access ramps, flyer stops, and bus-on-shoulder operations in congested freeway segments; new park and ride facilities at Central County and the vicinity of 18th Street; and improved service from Salmon Creek and Van Mall park and ride facilities.

Appendix B: Candidate Operational Strategies

The tables below list the candidate operational strategies considered at the March 19, 2013 Operational Strategies Workshop

Flow Control

Strategy	Description	Potential Application
Ramp metering	Ramp metering is a method of limiting the rate at which traffic can enter the freeway so that capacity downstream of the onramp is not exceeded in order to reduce mainline bottlenecks.	Specific opportunities are available to apply ramp metering in the I-205 corridor. Potential ramp meters at Mill Plain to I-205 northbound and Padden Parkway to I-205 southbound.
Limited Access Meter Connector	Freeway-to-freeway metering regulates traffic flow between onramps connecting two limited access roadways.	Used at freeway to freeway interchange bottlenecks. Potential locations include: I-205 southbound to SR-14 eastbound (only with SR-14 widening?), SR-500 westbound to I-205 southbound and SR-500 westbound to I-205 northbound.

Active Traffic Management

Strategy	Description	Potential Application
Dynamic Lane Control	Dynamic lane control is the use of overhead electronic message sign panels displaying symbols indicating whether lanes ahead are open or closed (ex: green arrows or red x's). A typical use is to provide advance warning of a lane closure due to an incident.	The committee noted the application of this strategy in the Puget Sound area. A 'light' version could use VMS messages rather than full gantry deployments upstream for notice of critical bottlenecks. Could also be used to encourage through traffic to use inside lane near high volume exit ramps.
Variable Speed Control	Variable speed control also uses overhead gantries with electronic message sign panels to post dynamic speed limits that can change in response to current traffic conditions.	Variable speed limits provide a traffic smoothing effect to reduce incidents caused by drivers unexpectedly encountering a bottleneck. Application of this strategy is in the Puget Sound area, and potentially in Oregon.

Arterial Signal Strategies

Strategy	Description	Potential Application
Ramp/Arterial Signal coordination	Coordinating ramp meter signals with nearby arterial signals to reduce traffic backups from I-205 ramps onto arterials.	Candidate locations include Mill Plain Blvd, Fourth Plain/SR-500 Blvd, and Padden Parkway. In coordination with ramp meters?
Detour Route Signal Timing	Modified signal timing plans that can be implemented in the event of an incident that is diverting freeway traffic to arterials.	This strategy may build upon existing incident plans in the corridor, as well as recent traffic signal system updates by the City and County.
Integrated Corridor Management	Partner agencies manage the transportation corridor as a system-rather than the more traditional approach of managing individual assets. An ICM concept typically includes multiple technical and operational strategies and multiple modes and routes.	A key candidate corridor for is 112th Avenue running parallel to I-205 for much of its congested length.

Traveler Information

Strategy	Description	Potential Application
Static Guide signs	Traditional highway guide signs directing through traffic to stay in the mainline lanes to reduce bottlenecks at entrance/exit points.	Low cost approach to encourage through traffic to merge left away from ramp weave traffic. May apply to I-205 northbound south of SR-14 off ramp.
DMS Route Travel Times	Dynamic message signs provided in advance of a freeway interchange providing the travel time to a common destination along two parallel routes, helping to divert traffic to the less-congested route.	Regional efforts are already underway to provide travel time information in the I-5 and I-205 corridors.

Geometric Strategies

Strategy	Description	Potential Application
Auxiliary Lane Extensions	Provide an auxiliary lane connecting key entrance and exit locations to counter congestion caused by high volumes, short ramp spacing, and weaving maneuvers.	Ideas include auxiliary lane from SR-500 WB from 112th to I-205 NB ramp. One of the core projects is an auxiliary lane on I-205 from Mill Plain Boulevard to SR-500.
Weave Lane Extensions	Extending merge areas to provide more space for drivers to find acceptable gaps during congested conditions.	WSDOT has identified specific opportunities in the I-205 corridor including extending the merge lane onto I-205 SB from SR-500.
Mainline Restriping	Restriping mainline lanes for more efficient use of existing capacity or to balance with high volume on ramps.	Ideas include modifying I-205 left side drop lane north of SR-500 to right side drop lane and carrying only two lanes under SR-500 southbound so that southbound on-ramp from SR-500 can be an add lane.
Ramp Restriping, Reconfiguration, Extensions	Engineering improvements to interchanges that streamline movements between roadways, such as restriping ramps to allow two lanes and/or eliminating merge points	Ideas include restriping SB on-ramp from Mill Plain to two lanes at ramp entrance and extending SB on-ramp from SR-500 to I-205.

Transit/Transportation Demand Management

Strategy	Description	Potential Application
Peak Shoulder Running - Transit	Use of existing shoulders to allow transit vehicle use during peak hours with the most significant congestion to improve transit speed and reliability.	Could increase operational reliability for C-TRAN. Needs further investigation to determine threshold transit service frequency and operational impacts.
Rideshare Programs	Support for programs that provide ride-matching programs for commuters in private cars or vanpools, such as Rideshare Online.	Social media outreach to corridor commuters/employers noted as a potential option.

Appendix C: Strategies Not Recommended

The following strategies have been evaluated and are not recommended as near term improvements. Some of these alternatives could have benefit, but require other improvements be constructed prior to their implementation, and, therefore may be reconsidered in the future in conjunction with an I-205 core project or other corridor improvement.

I-205 NB at SR-14

Convert the SR-14 off-ramp to exit only drop lane with 3 through lanes continuing north of the exit.

- As a stand-alone project there is limited benefit to mobility and safety. Both states see some benefit for unfamiliar drivers and driver expectation along with a possible reduction in turbulence at the exit, but it is hard to quantify.
- The benefit may be minor in the short term; however, this strategy or a variation should be reconsidered and analyzed in detail when SR-14 is widened from I-205 to 164th. As part of the SR-14 widening, the I-205 NB to SR 14 ramp would be reconfigured to carry two lanes of traffic. The rightmost lane of I-205 would be an exit only lane and the adjacent lane would be an option lane. This could lead to improved lane utilization. Additional analysis is required to evaluate the potential impacts.
- Converting the right lane to an exit only will reduce the cross section north of the exit to three lanes and offers the opportunity to reconfigure the SR-14 WB to I-205 NB ramp connection. An alternatives analysis for this on-ramp has yet to be conducted.

Padden Parkway to I-205 south

Remove the westbound merge location to create a single merge onto I-205 for the westbound and eastbound ramps and meter the combined ramps.

- The removal of the WB to SB merge does eliminate one merge location onto I-205; however, the high combined WB/EB volumes merging at a single location intensify merging issues, leading to decreased operations along I-205.
- Extensive queuing on the WB to SB ramp due to the ramp meter at this location would back up around the loop ramp resulting in safety issues.

Maintain two merge locations and meter only the westbound to southbound ramp.

- Extensive queuing due to the ramp meter at this location would back up around the WB to SB Padden Parkway loop ramp resulting in safety issues.

On-ramp lane extension from Padden to I-205 South.

- A lane extension does not solve the problem at this location. I-205 mainline is only two lanes south of Padden Parkway. The number of vehicles using this segment is more than the facility can accommodate. This creates a bottleneck along the I-205 corridor. The underlying issue with this on-ramp merge is a lack of mainline capacity. Extending the on-ramp will only relocate the bottleneck further to the south unless the extension goes all the way to the SR- 500 Interchange.

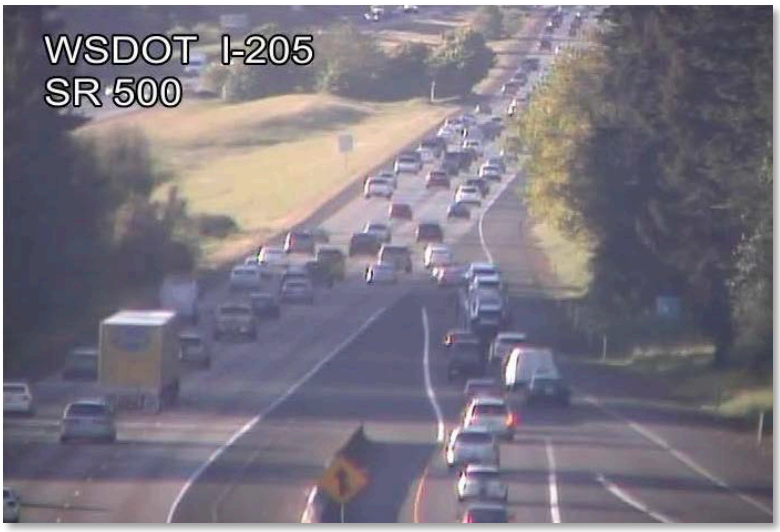
SR-500 and I-205 south

Ramp meter SR-500 eastbound and/or westbound to I-205 south

- WSDOT has consulted with FHWA about ramp meter strategies at this location. Neither WSDOT nor FHWA will support any freeway to freeway ramp meter in the I-205 corridor at this time.

Extend the length of the southbound EB ramp and WB ramp merge area to create a two lane on-ramp from SR-500 to I-205 south

- This option improves operations and reduces turbulence at the merge, improving flow onto I-205.
- This option could be incorporated into the to the SB portion of the new auxiliary lane from SR-500 to Mill Plain identified as part of the I-205 core project list.
- While is does have a benefit, the project it is not a low capital short term improvement. Estimated cost for the project is $5 to $8 million depending upon whether or not it's tied into the 18th Street Interchange improvement. Extending it to the new Mill Plain off-ramp, constructed as part of the 18th Street Interchange, requires widening the Burton Road overcrossing at a total cost of $8 million. Extending the on-ramp to just south of the Burton Road overcrossing would reduce the cost to $5 million.



Appendix D: VISSIM Calibration Summary

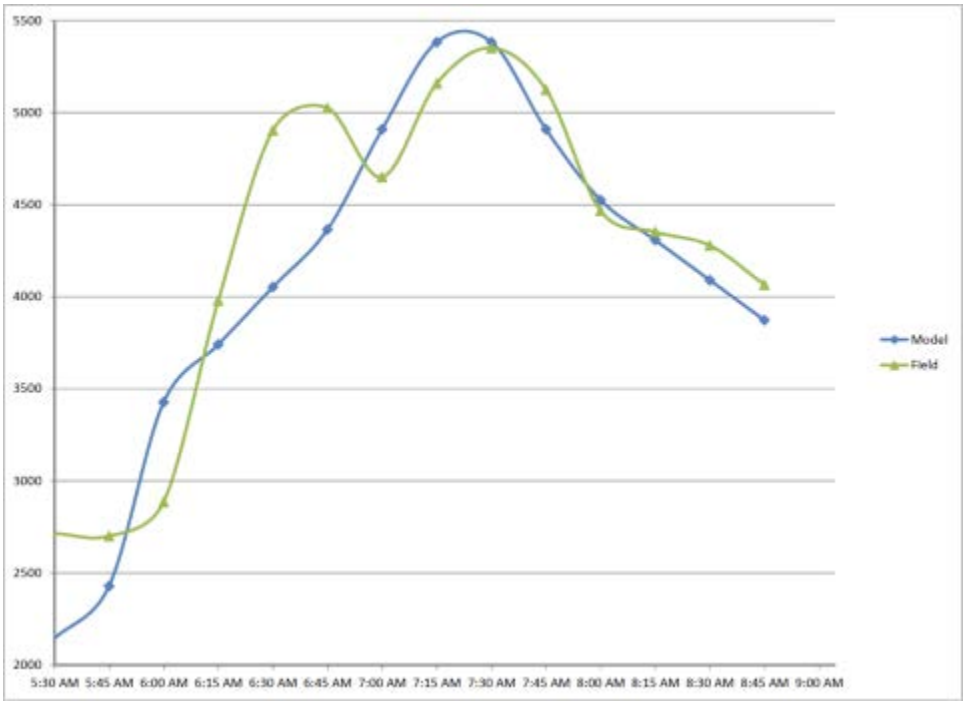
The following table represents an example of the validation process during the development of the VISSIM microsimulation model. The starting point is the raw demand volume from the travel model for a 2010 base year and a 2022 forecast. The 2010 raw demand volume is compared to actual 2010 vehicle volumes to calculate estimated 2022 volumes used for the VISSIM analysis. The two basic methods were to determine 2022 volumes on the growth rate or the difference between the 2010 and 2022 model volumes to find the best fit for the post processed volume. Exceptions to this approach are described at the bottom of the table.

Reference Number	Freeway and/or Ramp Condition	Origin/Destination	Raw Travel Demand Model Volume		Growth - Rate (2022 PM Peak)	Growth - Volume (2022 PM Peak)	PM Peak Hour					
							2010	2022				
			2010	2022			7 to 8	Growth Rate Method	Difference Method	Average	Adjustment	Post Processed
23	I-5 NB	South of 134th	1731	2287	2.68%	556	1327	1754	1883	1818	-57	1762
24	I-5 NB Offramp	134th Street	285	133	-4.43%	-151	543	254	391	323		323
63	I-5 NB Offramp	139th Street	0	389	N/A	389	0	N/A	389	389		389
19	I-5 NB Offramp	179th Street	258	797	17.46%	540	181	559	720	640		640
19	I-5 NB Onramp	179th Street	147	261	6.51%	115	121	216	236	226		226
20	I-5 NB	North of 179th	2885	3792	2.62%	907	2158	2837	3065	2951	57	3007
20	I-5 SB	North of 179th	4747	5626	1.54%	879	3244	3845	4123	3984	89	4073
21	I-5 SB Offramp	179th Street	126	142	1.09%	16	104	117	120	119		119
21	I-5 SB Onramp	179th Street	765	1520	8.21%	754	595	1181	1349	1265		1265
62	I-5 SB Onramp	139th Street	0	807	N/A	807	0	N/A	807	807		807
22	I-5 SB Onramp	134th Street	746	314	-4.82%	-432	989	417	557	487		487
23	I-5 SB	South of 134th	3612	4854	2.87%	1242	2996	4026	4238	4132	-89	4043
36	SR 14 EB	West of Ellsworth	1644	2059	2.10%	414	1594	1996	2008	2002	-2	2000
37	SR 14 EB Offramp	Ellsworth	124	121	-0.21%	-3	104	101	101	101		101
4	SR 14 EB Offramp	164th Avenue	834	890	0.56%	56	775	827	831	829		829
4	SR 14 EB Onramp	164th Avenue	325	407	2.09%	82	181	227	263	245		245
5	SR 14 EB	East of 164th	1493	2049	3.11%	556	1239	1701	1796	1748	2	1751
5	SR 14 WB	East of 164th	3449	3729	0.68%	280	3000	3244	3281	3263	43	3306
6	SR 14 WB Offramp	164th Avenue	471	456	-0.28%	-16	396	383	381	382		382
6	SR 14 WB Onramp	164th Avenue	1060	944	-0.91%	-116	1229	1094	1113	1103		1103
35	SR 14 WB Onramp	Ellsworth	888	917	0.28%	30	662	684	691	688		688
36	SR 14 WB	West of Ellsworth	2814	3233	1.24%	419	3431	3943	3851	3897	-43	3854
1	I-205 NB	South of Airport Way	4651	5168	0.93%	517	3954	4393	4471	4432	37	4469
2	I-205 NB Offramp	Airport Way (WB)*	1190	1156	-0.23%	-33	943	916	909	913		913
3	I-205 NB Offramp	Airport Way (EB)*	802	613	-1.97%	-190	560	428	371	399		399
3	I-205 NB Onramp	Airport Way*	835	1388	5.52%	553	708	1177	1261	1219		1219
42	I-205 NB Offramp	SR 14 (EB)	706	874	1.97%	167	588	728	755	742		742
41	I-205 NB Offramp	SR 14 (WB)	723	964	2.78%	241	613	817	854	835		835
57	I-205 NB Onramp	SR 14 (EB)	163	207	2.20%	43	305	386	348	367		367
44	I-205 NB Onramp	SR 14 (WB)	649	655	0.07%	5	590	595	595	595		595
7	I-205 NB Offramp	Mill Plain (EB)	485	497	0.20%	11	474	485	485	485	-81	404
8	I-205 NB Offramp	Mill Plain (WB)	207	186	-0.86%	-21	134	120	113	116	81	197
9	I-205 NB Offramp	112th Avenue	188	26	-7.19%	-162	209	29	47	38	0	38
60	I-205 NB Offramp	18th Street	0	366	N/A	366	0	N/A	366	366	0	366
10	I-205 NB Onramp	Mill Plain	1156	1390	1.69%	235	744	894	978	936		936
11	I-205 NB Offramp	112th/Gher	314	276	-1.01%	-38	219	193	181	187		187
46	I-205 NB Offramp	SR 500 (EB)	467	564	1.74%	97	403	487	500	494		494
45	I-205 NB Offramp	SR 500 (WB)	794	869	0.80%	76	612	670	688	679		679
48	I-205 NB Onramp	SR 500 (WB)	365	334	-0.70%	-31	302	277	272	274		274
53	I-205 NB Onramp	SR 500 (EB)	88	59	-2.76%	-29	117	79	88	83		83
14	I-205 NB Onramp	Fourth Plain	157	184	1.41%	27	96	112	123	118		118
15	I-205 NB Offramp	Padden (EB)	37	26	-2.58%	-12	154	106	143	125		125
16	I-205 NB Offramp	Padden (WB)	603	632	0.40%	29	393	412	422	417		417
17	I-205 NB Onramp	Padden	669	883	2.66%	214	417	550	631	591		591
18	I-205 NB Offramp	134th Street	962	1093	1.14%	131	731	831	862	846		846
18	I-205 NB Onramp	139th Street	293	435	4.06%	143	233	347	376	362		362
49	I-205 NB	I-5	1550	2563	5.45%	1014	1433	2371	2447	2409	-37	2372
50	I-205 SB	I-5	2520	3270	2.48%	750	1729	2243	2479	2361	109	2470
25	I-205 SB Offramp	134th Street	679	646	-0.41%	-33	350	333	317	325		325
25	I-205 SB Onramp	134th Street	1142	1129	-0.10%	-13	1072	1060	1059	1060		1060
26	I-205 SB Offramp	Padden	654	849	2.48%	195	409	531	604	568		568
26	I-205 SB Onramp	Padden (WB)	78	73	-0.58%	-5	691	643	686	664		664
27	I-205 SB Onramp	Padden (EB)	1017	876	-1.16%	-141	948	817	807	812		812
28	I-205 SB Offramp	Fourth Plain	402	394	-0.18%	-9	148	145	139	142		142
52	I-205 SB Offramp	SR 500 (WB)	284	65	-6.41%	-218	310	72	92	82		82
51	I-205 SB Offramp	SR 500 (EB)	193	261	2.95%	68	260	352	328	340		340
47	I-205 SB Onramp	SR 500 (WB)	1403	1294	-0.65%	-109	1241	1144	1132	1138		1138
54	I-205 SB Onramp	SR 500 (EB)	556	622	0.99%	66	754	844	820	832		832
32	I-205 SB Onramp	Fourth Plain	306	301	-0.15%	-5	187	184	182	183		183

Reference Number	Freeway and/or Ramp Condition	Origin/Destination	Raw Travel Demand Model Volume		Growth - Rate (2022 PM Peak)	Growth - Volume (2022 PM Peak)	PM Peak Hour					
			2010	2022			2010	2022				
							7 to 8	Growth Rate Method	Difference Method	Average	Adjustment	Post Processed
N/A	I-205 Mainline	18th Street PTR	4809	5348	0.93%	539	5145	5721	5684	5702		5702
33	I-205 SB Offramp	Mill Plain	1112	1096	-0.12%	-16	972	958	956	957		957
61	I-205 SB Onramp	18th Street	0	1115	N/A	1115	0	N/A	1115	1115	194	1309
33	I-205 SB Onramp	Mill Plain (WB)	1286	748	-3.49%	-538	1324	770	785	777	33	811
34	I-205 SB Onramp	Mill Plain (EB)	396	405	0.20%	9	559	572	568	570	-227	342
56	I-205 SB Offramp	SR 14 (WB)	17	63	22.57%	46	479	1775	525	1150	-625	525
55	I-205 SB Offramp	SR 14 (EB)	679	828	1.82%	149	672	819	821	820		820
43	I-205 SB Onramp	SR 14 (WB)	2202	2274	0.27%	72	1565	1616	1637	1626		1626
58	I-205 SB Onramp	SR 14 (EB)	740	900	1.80%	160	612	744	772	758		758
38	I-205 SB Offramp	Airport Way*	2083	2263	0.72%	180	1743	1894	1923	1909		1909
38	I-205 SB Onramp	Airport Way (WB)*	100	93	-0.61%	-7	182	169	175	172		172
39	I-205 SB Onramp	Airport Way (EB)*	136	0	-8.33%	-136	373	0	238	119	119	238
1	I-205 SB	South of Airport Way	5780	6634	1.23%	854	5894	6765	6748	6757	-8	6748
30	SR 500 EB	West of Thurston Way	1378	1490	0.68%	113	1692	1830	1804	1817	8	1825
31	SR 500 EB Offramp	Thurston Way	349	345	-0.09%	-4	166	164	162	163		163
31	SR 500 EB Onramp	Thurston Way	443	506	1.19%	63	311	355	374	364		364
11	SR 500 EB Offramp	112th/Gher	532	608	1.18%	75	553	631	628	630		630
11	SR 500 EB Onramp	112th/Gher	121	159	2.61%	38	135	178	173	175		175
12	SR 500 EB	East of 112th/Gher	1076	1347	2.10%	271	1210	1514	1481	1498	-8	1490
12	SR 500 WB	East of 112th/Gher	2531	2781	0.82%	250	2358	2590	2608	2599	2	2600
13	SR 500 WB Offramp	112th/Gher	318	337	0.52%	20	151	161	171	166		166
13	SR 500 WB Onramp	112th/Gher	1428	1304	-0.72%	-124	1288	1176	1164	1170		1170
29	SR 500 WB Offramp	Thurston Way	1136	1143	0.05%	7	626	630	633	631		631
29	SR 500 WB Onramp	Thurston Way	328	230	-2.49%	-98	192	135	94	114		114
30	SR 500 WB	West of Thurston Way	2143	2141	-0.01%	-2	2439	2437	2437	2437	-2	2435

Notes:
Rows highlighted in GREEN indicate that only the difference growth method was usec
Rows highlighted in BLUE indicate mainline volumes based on a PTR locatior
Rows highlighted in YELLOW indicate that the volumes were derrived from previous segment:
Rows highlighted in PURPLE indicate adjusted volumes based on a previous study
Cells highlighted in ORANGE indicate a new ramp location

The graph below displays travel speeds from the calibrated VISSIM model for 2010 compared to actual AM travel volumes from the WSDOT detection station at 18th Street. During the 4 hour AM peak period, the modeled southbound volumes compare favorably to traffic counts with almost an exact match from 7 a.m. to 8:15 a.m.



Appendix E: I-205 Bus on Shoulder Assessment

Operating transit vehicles on freeway shoulders in a congested corridor has the potential to provide faster and more reliable transit commutes and can promote and increase transit ridership. The Minnesota Department of Transportation has extensive bus on shoulder operations in the Twin Cities metro region with 300 miles of freeways that allow bus only operations.

The preliminary screening criteria below is based on the findings of the Transit Cooperative Research Program Report 151 regarding successful bus on shoulder projects and provides a starting point for the bus on shoulder assessment. Most, but not all bus on shoulder projects, have been on the right side shoulder.

Bus on Shoulder Screening criteria

- Are there at least 4 buses per hour?
- Is mainline speed less than 35 mph?
- Are entrance and exit ramps less than 1,000 vph?
- Will inside/outside shoulder pavement depths support buses?
- Is inside/outside shoulder at least 10 feet (12 feet desired)?

The Twin Cities region does not note ramp volume limitations for outside bus on shoulder, but does indicate that metered ramps, to regulate flow, improves the ability of buses to merge with entering freeway traffic.

Bus Volumes

As shown in the table below, 2022 and 2035 C-TRAN bus volumes in the corridor are high enough to warrant bus on shoulder consideration.

C-TRAN Bus Volumes in I-205 Corridor

	2022		2035	
Segment	**Peak hour**	**Peak period**	**Peak hour**	**Peak period**
18th to Mill Plain	6	10	10	16
Mill Plain to SR-14	6	10	10	16
SR-14 to Airport Way	11	21	13	25
Airport Way to Killingsworth	11	21	13	25
Killingworth to I-84	8	15	9	18

Ramp Volumes

The next two tables show peak hour ramp volumes for 2022 and for the 2035 MTP. Several locations in the AM and PM period are significantly higher than the 1,000 vph volume threshold as recommended by TCRP 151, especially at Airport Way and SR-14. Additional investigation would be needed to determine the feasibility to operate BOS at very high volume ramps.

Peak Hour Ramp Volumes

AM Southbound	2022	2035
Mill Plain on-ramp	1,750	1,260
SR-14 off-ramp	570	750
SR-14 on-ramp	2,750	2,820
Airport Way off-ramp	2,170	2,700
Airport Way on-ramp	180	280
Killingsworth off-ramp	790	920
Killingsworth on-ramp	1,270	1,020
I-84 off-ramp	1,650	1,550

PM Northbound	2022	2035
I-84 on-ramp	1,680	1,520
Sandy Blvd off-ramp	790	610
Killingsworth off-ramp	620	530
Sandy on-ramp	1,020	1,520
Airport Way off-ramp	410	540
Airport Way on-ramp	2,140	3,180
SR-14 off-ramp	2,140	3,040
SR-14 on-ramp	1,140	860
Mill Plain off-ramp	1,700	1,680

Travel Time Savings

The following tables display congested speeds based on the regional travel model on I-205 from 18th Street to I-84 and shows potential transit travel time savings with bus on shoulder. All but two of the segments are higher than the 35 mph threshold noted by TCRP 151and recommended by the Minnesota DOT, however, many are between 35 to 40 mph. Actual travel time data would need to be collected in the corridor to better determine if corridor congestion warrants bus on shoulder. In addition, BOS would not be invoked during the full peak period and would only be used during times when mainline speeds are below 35 mph.

AM Southbound	2022	Distance	Auto Travel Time	Transit Travel Time Savings
18th to Mill Plain	38	0.65	1.03	0.29
Mill Plain to SR-14	37	1.25	2.03	0.58
SR-14 to Airport Way	37	2.4	3.89	1.12
Airport Way to Killingsworth	40	0.95	1.43	0.39
Killingsworth to I-84	38	2.1	3.32	0.94
	Corridor Travel Time		*11.69*	*3.32*
				28%

PM Northbound	2022	Distance	Auto Travel Time	Transit Travel Time Savings
I-84 to Killingsworth	36	0.95	1.58	0.47
Killingsworth to Airport Way	50	0.95	1.14	0.19
Airport Way to SR-14	47	2.4	3.06	0.66
SR-14 to Mill Plain/18th	43	1.25	1.74	0.45
	Corridor Travel Time		*7.53*	*1.77*
				24%

Transit 15 mph over auto speed (maximum 60 mph)
Calculation not limited to segments < 35 mph

While most of the assessment above applies to outside shoulder operations, inside shoulder operations could be employed under the same freeway operating speed conditions as an outside shoulder option, but would not have the constraint of merge/weave conflicts at high volume freeway ramps. An inside shoulder operation may offer the opportunity for significant travel time savings and increased reliability, however the additional time to maneuver transit vehicles to and from the inside median could offset some of the savings.

Shoulder Width

WSDOT

The outside shoulder width on I-205 from Mill Plain to the Glenn Jackson Bridge is 10 feet wide with some segments at 12 feet, while the outside shoulder is 12 feet on the bridge and is wide enough to accommodate BOS. The inside shoulder between 18th St. and Mill Plain is approximately 6 feet. At the Mill Plain undercrossing the shoulder width increases to 10 feet, and then there is a segment just before the I-205 Bridge where it widens 12 feet and then briefly to 15 feet. On the bridge the

shoulder narrows to 8 feet where the bike path begins. The 8 feet width continues south across the bridge. The travel lanes on the Glenn Jackson Bridge would have to be restriped in order to accommodate a 12-foot inside shoulder and result in an 8 foot outside shoulder on the bridge.

ODOT

The outside shoulder is 12 wide from the Glenn Jackson Bridge to I-84 except at on-off ramps where the shoulder is 6 feet. Shoulder is 6 feet between ramps if they are close together. The inside shoulder is 10 feet wide from Glenn Jackson Bridge to Airport Way (SB) and 12 feet from Airport Way to I-84.

Shoulder Depth

There are no specific standards for pavement thickness for BOS operations. TCRP 151 says that, "State and local transportation agencies, either using internal experts or by contracting with consultants, should assess the suitability of a pavement cross section to accommodate the specified amount and weight of bus traffic." When the Minnesota DOT first began implementing BOS, many shoulders had only 2 inch (.167') thickness. Over time, they have set a standard of 7 inches (.58'), primarily to reduce maintenance and increase shoulder life.

WSDOT

In the Washington portion of the I-205 corridor, the shoulder pavement thickness beyond the limits of the I-205 Bridge is generally 0.15' inches with some locations where the pavement is 0.35'.

ODOT

The inside and outside shoulders of I-205 in Oregon are constructed with concrete and meet at least the minimum depth requirements for bus on shoulder operations.

Appendix F: RTC Board Questions and Answers

During the June 2013 RTC Board meeting, there were several questions from Board members related to the I-205 Corridor Study. RTC staff prepared responses to the questions which were presented at the July 2013 Board meeting. Questions from the Board and responses are listed below.

Is there a Washington State Department of Transportation policy for a maximum number of general purpose lanes?

There is no policy regarding maximum through lanes. The Washington Highway System Plan envisions no more than three through lanes on I-5 and I-205. All other facilities are no more than two general purpose lanes.

In addition, Moving Washington principles established by WSDOT uses a three tiered approach to mitigate congestion or add capacity on their facilities. Moving Washington principles are to:

Operate efficiently – Get the most out of existing highways by using traffic management tools to optimize the flow of traffic and maximize available capacity.

Manage demand – Shift travel times, use public transportation or reduce the need to travel altogether, managing demand on overburdened routes to allow the system to function better.

Add capacity strategically – Target the worst traffic hotspots or filling critical system gaps to fix bottlenecks that constrain traffic flow.

Why not have high occupancy vehicle lanes in the I-205 corridor?

According to WSDOT HOV Policy and Guidelines, converting an existing general-purpose lane for an HOV lane is not prohibited, but is also not desirable. It may, however, be justified when the conversion provides greater people-moving capability on the roadway.

In addition, experience in the Puget Sound region and with the I-5 Vancouver HOV Pilot project has shown HOV lanes are most effective in long corridors and connected to a larger regional HOV system.

Is the I-205 Corridor Study being coordinated with Oregon Department of Transportation?

RTC has met with ODOT staff to brief them on the I-205 Corridor Study and have agreed to coordinate as projects or strategies that affect bi-state travel are considered. There are two ODOT projects that RTC will pay attention to.

Airport Way Interchange Project – Is underway and will be completed in the fall of 2014. The project elements include:

- A new free-flowing right-turn ramp from westbound Airport Way to I-205 northbound.
- Two turn lanes for eastbound drivers turning left to I-205 north who will no longer share signal time with westbound to northbound right-turning vehicles.
- Extending the merge lanes to I-205 northbound.

Congestion Bottleneck Operational Study – Identified several projects in the I-205 corridor that add auxiliary lanes at key locations to smooth traffic flow and reduce queuing on the mainline. They include the following auxiliary lanes between Stark/Washington and the Glenn Jackson Bridge:

- I-84 eastbound south to the Stark/Washington Street ramp.
- I-84 westbound on-ramp north to Sandy and Columbia Boulevard ramps.
- Stark/Washington interchange north to Glisan Street

Will analysis evaluate benefits of core projects as they affect or change the need for other capital projects in the MTP, such as SR-14 to Mill Plain braided ramps?

Study will look at how the core projects and the addition of operational strategies affect corridor performance and the future need for other major capital investment in the corridor including the braided ramps between SR-14 and Mill Plain Boulevard.

Why not build four lanes on SR-14? How was it determined that only three lanes are needed? What is the additional cost of adding a fourth lane?

SR-14 from I-205 to 164th is one of the core projects in the I-205 Corridor Study. The project adds an auxiliary lane in each direction to the existing general purpose lanes. The I-205 Corridor Study determined that this segment of SR-14 has enough future capacity for 2035 traffic demand which is consistent with the findings of the Washington State Highway System Plan and the Metropolitan Transportation Plan. The I-205 core project analysis will evaluate traffic operations at the east and west ends of the segment with the new auxiliary lanes in place.

Other issues affecting the capacity on SR-14 will be determined by the capacity of the Glenn Jackson Bridge feeding into SR-14 as well as right of way availability and cost.

It would be beneficial to conduct sensitivity analysis of transit service at higher levels than that assumed in the adopted MTP.

RTC staff is meeting with C-TRAN staff to determine what levels of future transit service should be tested for the I-205 Corridor Study.

I-205 Core project map needs to include location and costs of 18th Street Park and Ride

The 18th Street Park and Ride location and capital cost will be included in the update to the I-205 Core Project map.