Portland Metro Area Value Pricing Feasibility Analysis

Final

Summary of Value Pricing Concepts

Technical Memorandum #2

January 23, 2018

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Prepared for

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1 INTRODUCTION

Oregon House Bill 2017 from the 2017 Legislative session directs the Oregon Transportation Commission (OTC) to seek federal approval from the Federal Highway Administration (FHWA) to implement value pricing on the I-5 and I- 205 corridors to address traffic congestion. Value pricing, also known as congestion pricing, is a type of tolling that sets a higher price for driving when demand is higher, which is typically during the morning and evening peak commuting periods. This creates an incentive to shift travel to less congested periods of the day or take alternate modes such as transit. Those choosing to pay the toll have higher travel speeds and improved travel time reliability.

This technical memorandum serves as a basic introduction to value pricing. It begins with a discussion on the application of value pricing theory to vehicular traffic, followed by information on how value pricing has been implemented in the United States (US) and other parts of the world. Next, the memorandum introduces the initial value pricing concepts applied to I-5 and I-205 for preliminary traffic modeling and evaluation efforts. The project team introduced these value pricing concepts to the Policy Advisory Committee (PAC) at its December 7, 2017 meeting. **The I-5 and I-205 value pricing concepts listed in this memorandum do not represent proposals or recommendations – they are for testing and learning about potential effects of value pricing applications**. The memo concludes with discussion on next steps in the value pricing evaluation process. Additional information on operational policies and design considerations for pricing can be found in Appendix A and Appendix B, respectively.

1.1 Overview of value pricing

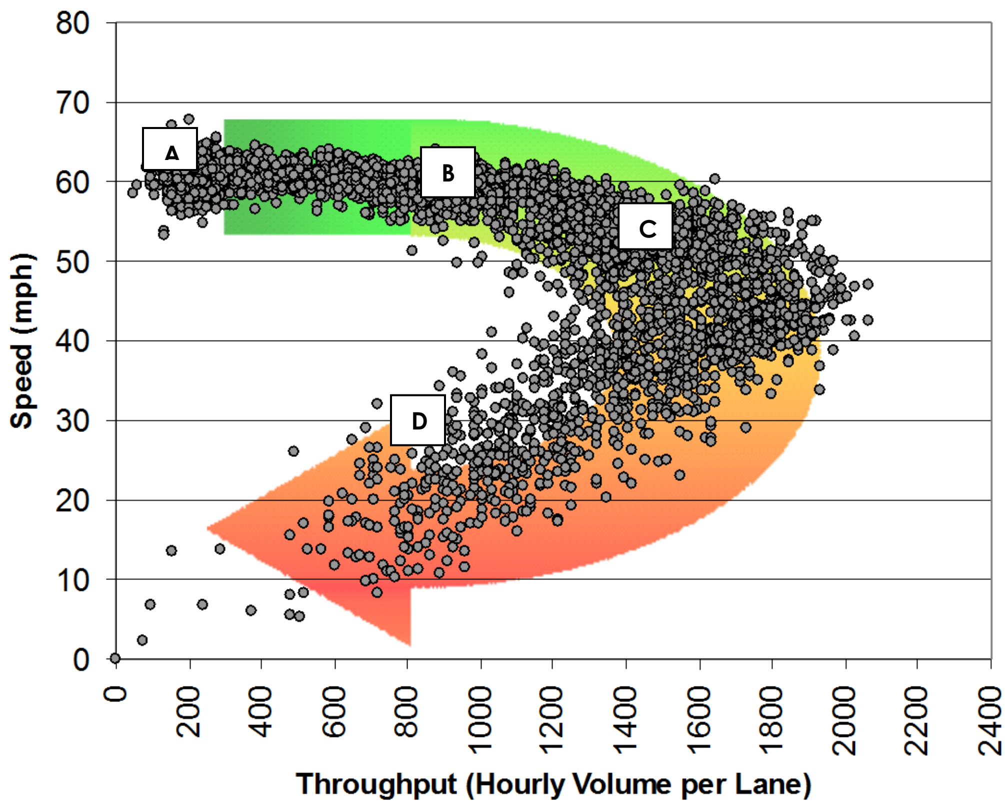
Value pricing, also known as congestion pricing, is an economics-based and market-oriented approach to managing traffic congestion on roadways. While congestion is caused by any number of factors, it is typically highest in urban areas during morning and evening commute times. At these times, demand for vehicular travel on the roadway exceeds the available capacity, leading to decreased travel speeds and significantly reduced vehicular and person throughput. Value pricing levies a fee for access to facilities (or lanes on a facility) that reflects current demand. As such, the price for access increases when there are more vehicles on the roadway. In this sense, value pricing is like pricing structures found in utility services and airline tickets, where the price increases in conjunction with demand.

One of the primary objectives of pricing is to manage demand and maintain vehicle travel speeds. This maximizes vehicular and person throughput, which means lanes are moving more vehicles and people over a given period. Figure 1 shows a typical travel speed and throughput diagram for hourly travel on a congested corridor.[1] The diagram can be viewed as tracking changes in speed and throughput throughout a typical peak period, with Point A corresponding to off-peak times and Point D corresponding to the times during the periods of heaviest congestion. At Point A, vehicle volumes are just starting to build, so while travel speeds are high only about 200 vehicles are being moved per lane per hour. A short time later, at Point B, volume has increased but travel speeds remain at about 60 mph. As such, more vehicles are being moved, roughly 1,100 vehicles per hour per lane. As volumes build, speed begins to drop to around 52 mph but throughput at Point C has still increased to 1,800 vehicles per hour per lane due to high volume and relatively high speeds. Point C is where maximum throughput is achieved.

After Point C traffic volumes begin to overwhelm existing capacity and speeds drop. Even though there is more vehicle demand on the road, by Point D speeds have dropped to less than 25 mph and only around 1,000 vehicles per hour per lane are moving. This situation is known as hyper congestion.

Pricing works to maintain high traffic speeds while allowing optimal volume to enter the facility. This maximizes throughput, represented in Figure 1 as the area near Point C.

Figure 1: Relationship among traffic volume, traffic speed, and throughput



[1] The figure cited is an example diagram and is presented for illustrative purposes only. It does not reflect actual traffic volumes on I-5 or I-205 in Portland. However, this information will be available through subsequent modeling efforts.

The effect of value pricing is to shift some travel to other transportation modes, to less congested periods of the day, or to other adjacent roadways. Some people will choose to pay a higher toll, while others will choose to not take the trip at all. Those paying a toll are moved as efficiently as possible by maintaining high travel speeds with a rate set to manage demand in one of two ways:

- **Variable pricing** involves varying rates based on a pre-determined schedule. Rates are highest when traffic volumes are expected to be highest.
- **Dynamic pricing** involves varying rates in response to real-time traffic conditions. Such applications require the continual collection and monitoring of traffic data and technology to convey price-related information to travelers. Dynamic pricing is typically more effective at managing congestion than variable pricing.

Since toll rates must vary in response to congestion levels it becomes increasingly important to convey accurate information on rates to travelers. Priced lane facilities therefore typically use traffic information systems to provide real-time toll rate information for toll paying vehicles. Drivers often receive information on price levels and travel conditions via variable message signs, as shown in Figure 2, which allows them to make the decision whether to use the priced lanes.

Figure 2: Sign displaying rate information on MnPass Facility, Minneapolis-St. Paul, MN

1.2 Common value pricing applications

As urban areas continue to grow, regional transportation infrastructure will continue to face higher levels of demand. In most cases, the funding necessary to expand capacity is simply not available, and pricing has become an increasingly popular strategy to better manage and operate these assets. Value pricing applications include:

- **Priced roadways**: Pricing applied over all lanes along a roadway
- **Priced lanes**: Pricing applied only to certain lanes of a roadway
- **Other pricing applications:**
    - **Cordon pricing**: Pricing applied within a geographic boundary
    - **Parking pricing**: Pricing applied to vehicle parking
    - **Spot pricing**: Pricing applied at singular, discreet locations
    - **Area charging**: Pricing applied for all travel within a certain area

1.2.1 Priced roadways

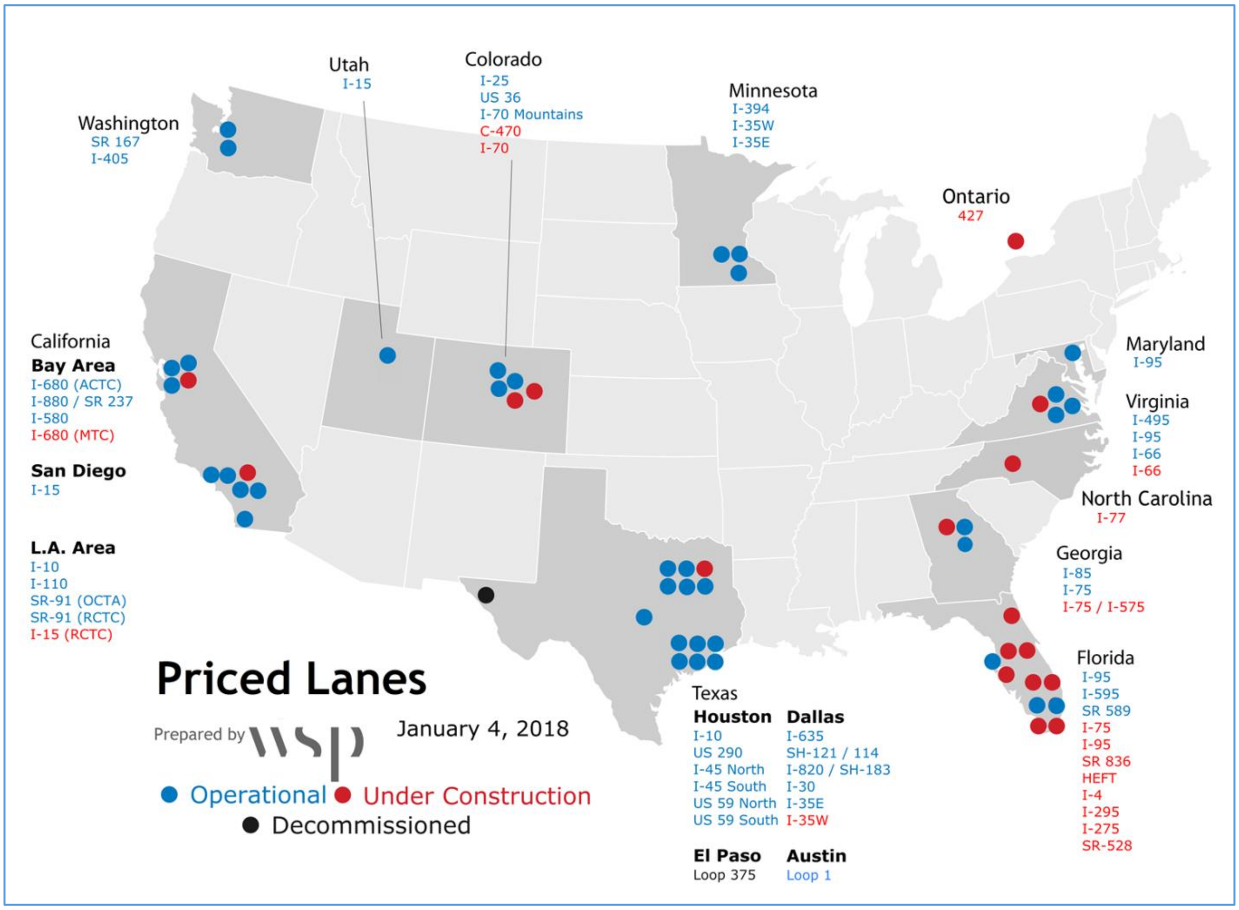
A priced roadway is a facility where all lanes of travel are assessed a price for access. Traditional toll roads, such as the E-470 in Denver or the Garden State Parkway in New Jersey, are priced roadways in that a toll is levied on every vehicle using all lanes of the facility, not just on designated lanes. However, toll roads normally charge based on distance, such as per-mile or by zone, with rates that typically do not vary based on time of day or congestion and are thus not truly value pricing applications. There are some facilities, such as the Intercounty Connector in Maryland, that levy tolls that vary based on the time of day and are thus value pricing in nature. Roadways may be priced such that tolls are assessed along the roadway or upon entry/exit to the roadway at ramps.

Priced roadways are often proposed and constructed when new capacity can reduce overall congestion on the roadway network but other funding sources for a roadway construction are not available. There are no contemporary examples of the conversion of an established urban freeway (not including segments along bridges or through tunnels) to a priced roadway. However, the idea has gained popularity in recent years to address current transportation funding challenges.

1.2.2 Priced lanes

Pricing may also be applied to specific lanes within a roadway, leaving any number of general purpose lanes open to general purpose traffic while providing a fast and reliable travel alternative for those willing to pay a toll and those who are eligible for discounted or free access. Also referred to as managed lanes, these facilities are among the most common forms of value pricing in the US. Implementing a priced lane may involve constructing a new lane, converting an existing High Occupancy Vehicle (HOV) lane, converting an existing lane from general purpose operation, or converting a shoulder for special use. There are currently close to 40 priced managed lanes in operation in the US, with over 10 additional facilities under project development (Figure 3).

Figure 3: Priced lane facilities in the United States



Specific examples of priced lane facilities include:

- **High occupancy toll (HOT) lanes**: Many priced lane facilities in the US evolved from High Occupancy Vehicle (HOV) lanes, which were composed of separated lanes that could only be used by vehicles carrying two or more occupants (HOV 2+), transit, and other special vehicle classes like vanpools. In many cases these HOV facilities were underutilized with very few multi-occupant vehicles using them while congestion persisted on adjacent general purpose lanes. With a HOT configuration, this excess capacity is priced such that vehicles with a single occupant, known as Single Occupant Vehicles (SOV), could also use the separated lanes with the payment of a toll. Congestion pricing is used to manage SOV demand during peak traffic periods to ensure that the lane maintains a high level of service and does not become degraded. Qualifying HOVs may still use these limited-access lanes for free or at a reduced cost. Drivers in vehicles that do not meet occupancy requirements may choose between the general-purpose lanes or paying for premium conditions in the managed lanes. A common objective of HOT lanes is to maximize person throughput on a corridor or maintain travel time savings for HOV modes including transit. HOT lanes are among the most common examples of priced lanes in the US.

- **Express toll lanes (ETL)**: ETL facilities feature priced lanes where all vehicles, including HOVs, must pay a toll to gain access. Although traffic performance improvements are intended with this approach, these lanes do not incentivize ride sharing or person throughput to the extent of HOT lanes. Revenue generation or maintaining high travel speeds for all vehicles is a greater priority. These lanes are also easier to enforce than HOV or HOT lanes as there are no occupancy requirements.
- **Bus toll lanes (BTL):** BTLs are priced managed lanes where capacity is first dedicated to bus transit. Other vehicles may pay a toll to use the lanes, but performance is maintained by variable pricing to ensure good operating conditions for transit vehicles. These lanes value person-throughput as a higher priority than ETLs, and may also be implemented in coordination with transit agencies that serve the roadway.

1.2.3 Other pricing applications

The pricing applications presented thus far are used along stretches of freeway. However, there are other pricing applications within the US and internationally that apply value pricing outside of a freeway setting. These include cordon pricing, parking pricing, spot pricing and area charging.

1.2.3.1 Cordon pricing

Cordon pricing involves establishing a cordon or boundary around a geographic area and charging a fee/toll for entering and/or exiting that area. This pricing approach manages traffic volumes on all roadways with the objective of addressing congestion within a geographic network, not on specific roadways. The concept has been considered for implementation within New York City but never materialized and it has otherwise never been implemented in the US. Cordon pricing has been applied in the European cities of London, Stockholm and Gothenburg as well as Singapore. The central London congestion charging plan was first implemented in 2003 and required drivers to pay a charge for entering the Central London area between 7 AM and 6 PM. The objective of the program was to reduce the number of private vehicles entering the area during the day and promote transit use. During the first year of operation transit usage in the area increased by 37 percent and, by 2006, congestion in the area was reduced by 26 percent.

1.2.3.2 Parking pricing

Parking pricing applies the value pricing concept to parking by raising and lowering parking fees in response to demand. The San Francisco Municipal Transportation Agency (SFMTA) recently tested parking pricing as part of its SF*park* program. Rates for meters and parking in the program area varied in response to demand with rates increasing as the supply of available parking decreased. The SF*park* program collected and distributed real-time information to area drivers through several mechanisms so that they could find available parking and know what the price for that space would be. Over the course of the program the average hourly rate at meters decreased by 11 cents and the average hourly rates at SF*park* garages decreased by 42 cents. The amount of time that there were no available spaces along priced blocks fell by 16 percent and the amount of time it took for most people to find a space decreased by 43 percent.

1.2.3.3 Spot pricing

Spot pricing involves the application of a toll at a single location for accessing a facility. Rates are commonly flat but, in a value pricing application, may vary based on the time of day or downstream and/or local traffic conditions. Examples of spot pricing include:

- **Bridge tolls:** The most common form of spot pricing is the tolling of vehicles on bridges, where all lanes of traffic are charged a toll. Toll discounts, exemptions, or toll premiums may also be applied to different vehicle classes depending on local policy priorities (i.e. HOV vehicles, or multi-axle trucks). Variably priced bridge tolls are common in many regions throughout the US. Examples include the Bay Bridge in the San Francisco Bay Area and the SR 520 bridge in Seattle. The Bay Bridge charges tolls in one direction to westbound drivers inbound to San Francisco, depending on time of day. All vehicles are charged a toll of $6.00 during weekday peak periods (5-10 AM and 3-7 PM), $5.00 on weekends, and $4.00 during other times. Large trucks with over two axles are charged a premium of $5.00 per axle. The SR 520 bridge was previously free, but now charges a variably priced toll to all vehicles that changes based on a set hourly schedule throughout the day.
- **Ramp meter bypass:** Although it has yet to be implemented, another potential opportunity for spot pricing includes the tolling of vehicles on ramp meter bypass lanes. In several regions, some metered entrance ramps are equipped with special use bypass lanes that allow specific vehicle classes, such as qualifying HOV vehicles, transit buses, or other vehicle types, to bypass ramp meter queues and gain quicker access to the freeway facility. For example, several facilities in Seattle, such as I-5, SR 520, I-90, I-405 and SR 167, are metered. Some of these feature an HOV bypass lane (with diamond lane markings) that allow buses, carpools and vanpools to enter the freeway without waiting at the meter. This strategy is viewed as providing an additional incentive to carpool and may offer an opportunity to introduce pricing. Drivers could choose to pay a toll to utilize the special use lane, bypass the ramp meter queue, and save time on an overall trip. As part of this system, the toll rate to use the bypass lanes could vary based on the mainline condition of the freeway and the number of vehicles waiting at the entrance ramp meter. Although this concept has yet to be evaluated in detail for the US, a priced ramp meter bypass system could have potential to improve corridor congestion as part of a comprehensive coordinated ramp metering and freeway management system.

1.2.3.4 Area charging

Area charging involves levying a fee on every mile travelled in a designated area. While there are many ways this might be accomplished, in general the concept relies on in-vehicle equipment that collects travel information and transmits it to a back office for processing and issuing of an invoice. Pricing application concept types selected for initial analysis

1.3 Pricing application concept types selected for initial analysis

To begin assessing potential pricing application types for the Portland metro area, specifically I-5 and I-205, the project team first conducted a high-level assessment of those pricing concept types that are most likely to meet the intent of Oregon House Bill 2017. **The I-5 and I-205 value pricing concepts listed in this memorandum do not represent proposals or recommendations – they are for testing and learning about potential effects of value pricing applications**. HB 2017 directed the Oregon Transportation Commission (OTC) to seek approval from the Federal Highway Administration (FHWA) to implement value pricing on the I-5 and I-205 corridors, from the state line to their intersection in Oregon, as a means of reducing congestion in the Portland metropolitan region. As such, the project team utilized two primary criteria during this initial selection of potential pricing concept types:

1. Can the concept type be applied to (and only to) I-5 and I-205?
2. Is the concept type effective at reducing (or addressing) congestion?

As seen in Table 1-1 below, several pricing concept types were eliminated from further consideration for this feasibility analysis based on this initial assessment. Priced roadway and priced lane concept types passed the initial screening as they can be applied specifically to I-5 and I-205 and are effective at addressing congestion.

Table 1-1. Initial screening of pricing concept types

Concept type	Meets Legislative intent	
	Can it be applied to I-5 and I-205 in Portland Metro Area?	Is it effective for reducing congestion?
I-5 and I-205: priced roadway (all lanes)	YES	YES
I-5 and I-205: priced lanes - convert general purpose lane	YES	YES
I-5 and I-205: priced lanes – construct new lane or convert shoulder	YES	YES
I-84, Hwy 217, and/or another regional highway: priced roadway or lane	NO	
Regional arterials: priced roadway or lane	NO	
Spot pricing	NO	
Cordon pricing	NO	
Parking pricing	NO	
Area charging	NO	

Other pricing concept types were struck from subsequent analysis as follows:

- **Priced roadway or lanes on I-84, Hwy 217, and/or another regional highway:** Congestion can be found on other regional highways and roadways, particularly on I-84 and Hwy 217. Value pricing may be useful in addressing congestion on these facilities but they are not included in the charge provided by Oregon House Bill 2017. As such, the pricing of other regional facilities besides I-5 and I-205 was not considered for more detailed analysis.
- **Regional arterials – priced roadway or lane:** Similarly, congestion on regional arterials can be significant and contribute to increased travel times for regional drivers. However, the pricing of arterials and major surface streets is not included in the charge of Oregon House Bill 2017 and was therefore not considered for more detailed analysis as part of this feasibility analysis.
- **Spot pricing**: Spot pricing (e.g. on bridges) could be applied on select areas of I-5 and I-205. However, this approach would not constitute a comprehensive solution to or mitigation measure for congestion on the I-5 and I-205 corridors. It should be noted that the pricing of bridges may be included as part of roadway or lane pricing concepts moving forward.
- **Cordon pricing**: A priced cordon could be deployed that would capture travel on I-5 and I-205. However, the cordon would also capture travel on all other roadways leading into and out of the cordoned area. As such, a cordon pricing application falls outside of the charge of the Oregon Legislature.
- **Parking pricing**: Parking pricing has never been applied in a freeway setting and has only been explored as a solution for congested parking conditions in central business districts and similarly dense city tracts. As such, it is not a concept type that could be applied to I-5 and I-205 and was not advanced for additional analysis.
- **Area charging**: Area charging would, like cordon charging, capture and price for travel on the I-5 and I-205 corridors. However, this approach is not specific to those corridors and would price travel on all roads within the priced area. Furthermore, area charging is currently being explored as a transportation funding mechanism, not a congestion management solution. As such, area charging was not advanced for further analysis.

2 INITIAL PRICING CONCEPTS

Based on the initial high level screening of concept types for conformity with Legislative intent, four "bookend" concepts were developed for further refinement and analysis. They are intended to demonstrate the full spectrum of impacts of pricing and serve as a launching point for technical analysis and public discussion. Though one of these concepts could end up as all or part of the Policy Advisory Committee (PAC) recommendation or in the Oregon Transportation Commission (OTC) report to the Federal Highway Administration (FHWA), project staff expects to refine the concepts through analysis of individual segments of I-5 and I-205. This refined analysis will occur after reviewing the preliminary analysis with the PAC and the public. The four "bookend" concepts are discussed in more detail within this section and include the following:

- Baseline: no tolls on any lanes or roadways
- Priced Roadway: toll all lanes on I-5 and I-205
- Priced Lane Conversion: convert one existing general purpose lane on I-5 and I-205 to a priced lane in each travel direction
- Priced Lane Construction: construct a new priced lane on I-5 and I-205 in each travel direction

Recognizing that different pricing concept types will have different effects and are likely to have different implementation challenges and impacts, the team developed four combination concepts to examine using regional transportation models to help inform understanding about the potential range of impacts. As these concepts are simply different combinations of the bookend concepts applied to I-5 and I-205 separately, they are not discussed in more detail within this section. Combination concepts are as follows:

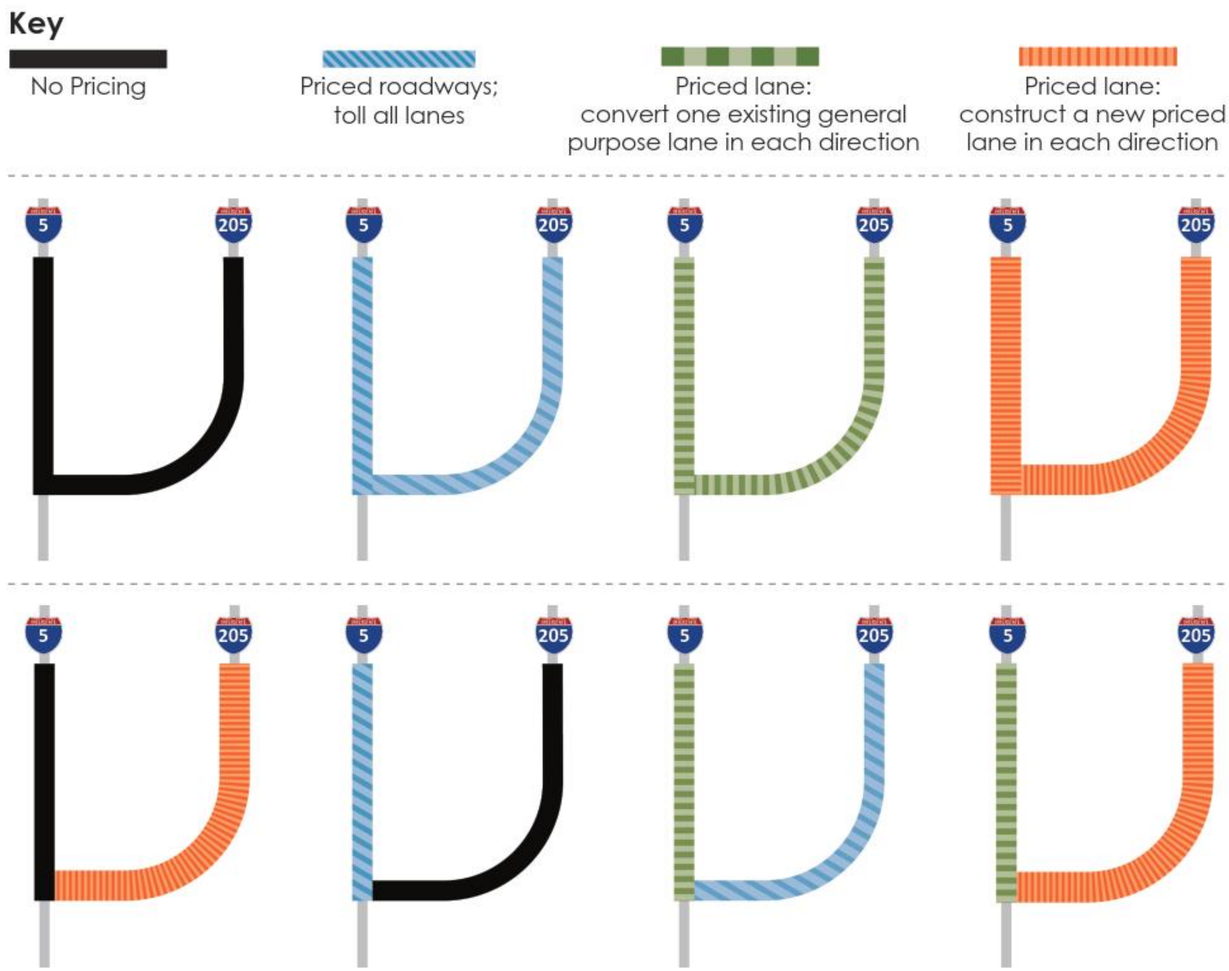
- Baseline (no pricing) on I-5 with Priced Lane Construction on I-205
- Priced Roadway on I-5 with Baseline (no pricing) on I-205
- Priced Lane Conversion on I-5 with Priced Roadway on I-205
- Combination: Priced Lane Conversion on I-5 with Priced Lane Construction on I-205

The bookend and combination pricing concepts for preliminary analysis are shown in Figure 4 below. As stated previously, the I-5 and I-205 value pricing concepts do not represent proposals or recommendations – they are for testing and learning about potential effects of value pricing applications. To account for the potential impact of future projects, changes in land use, and changes in travel demand over time, all of the scenarios assume population growth forecasts, employment growth forecasts, and include transportation projects identified in the Portland Metro's Regional Transportation Plan (RTP).[2] Assumed projects include those identified in the financially constrained project list through year 2027. The year 2027 was selected due to the availability of modeling data, including anticipated land use and travel demand, for that time horizon from Metro planners and modelers. This list includes three high-priority projects that the Oregon Legislature identified in House Bill 2017 for project development and construction: OR 217 northbound and southbound widening, Interstate 205 Stafford Road to OR 213 widening and the Interstate 5 Rose Quarter Improvement Project. In total, the project list includes over 700 regional multimodal transportation investments that were submitted by transportation agencies in the region and have been approved by Metro Council.[3]

[2] Oregon Metro. 2018 Regional Transportation Plan. https://www.oregonmetro.gov/public-projects/2018-regional-transportation-plan/call-projects

[3] The March 2018 RTP update will include an adjustment moving the construction timeline for a project to expand I-205 and Abernethy Bridge between I-5 and Oregon City to the 2018-2027 period. The concepts were all analyzed with this project assumed to be constructed by 2027.

Figure 4: Initial value pricing concepts for preliminary analysis



2.1 Baseline (no tolls)

The baseline concept does not reflect a pricing or tolling system on either I-5 or I-205. As described, the baseline conditions reflect population and employment growth forecasts and transportation projects identified in the Portland Metro's Regional Transportation Plan (RTP). The transportation projects include those identified in the financially constrained project list through year 2027 for consistency with the regional plan. Baseline is a representative concept to present the effects of not tolling I-5 and I-205 and will be used for comparative purposes.

2.2 Priced roadway

This concept would convert all general-purpose lanes on I-5 and I-205 within the study boundaries to congestion-priced lanes. Lanes could be used with the payment of a variably or dynamically priced fee structured to prevent congestion within the lanes. This concept would not affect the overall corridor footprint but some technology installations, such as overhead tolling equipment gantries and rate information signs, would be required to properly assess and collect toll payments. At this stage of the analysis there are no assumptions about the location of specific tolling zones where drivers would pay for their access and use of the facility.

2.2.1 Potential improvements

Pricing all lanes on I-5 and I-205 could yield improvements as follows:

- **Congestion reduction** – Pricing is one of the most effective mechanisms for managing demand for infrastructure. By pricing all lanes of travel, this concept offers the greatest level of pricing control and would be effective at reducing congestion for all drivers on I-5 and I-205 in the Portland metro area.
- **Travel time improvement** – By pricing all lanes and more effectively managing demand on all lanes of travel, the priced roadway concept has the greatest potential for improving travel time reliability and efficient operation for all I-5 and I-205 users.
- **Increased throughput** – Pricing all lanes means that higher travel speeds can be maintained on all lanes of the facility. Pricing also prevents volumes on the facility from exceeding its capacity, meaning that person throughput and vehicular throughput can be maximized during peak periods.
- **Minimize construction requirements** – Converting all lanes would have a minimal construction impact relative to concepts that would add additional capacity.

2.2.2 Potential implementation issues

Pricing all lanes on I-5 and I-205 could yield unique implementation issues, including:

- **Public acceptance** – The implementation of pricing itself faces significant public acceptance challenges. However, these challenges are magnified when considering pricing all lanes of a facility that was previously paid for by taxpayers.
- **USDOT approval** – The conversion of all general-purpose lanes on an interstate highway will require concurrence and approval from the US Department of Transportation (USDOT).
- **Geometric constraints** – Despite the potential for pricing to address congestion, the I-5 and I-205 corridors are still physically constrained from a roadway geometry perspective. Bottlenecks occurring due to physical features of the roadway, such as sharp curves or bridge supports that narrow the travel lane area, would reduce the overall effectiveness of the concept to address congestion.
- **Diversion** – Pricing all lanes would mean that there would be no toll-free adjacent lanes for drivers who do not wish to pay the toll. This could encourage drivers to divert trips to alternative unpriced corridors including arterials and surface streets.

2.3 Priced lane: convert one existing general purpose lane

This priced lane concept would involve the conversion of the existing leftmost general purpose lane (lane closest to the median barrier) on I-5 and I-205 to a priced lane. Access to the lane would be permitted with the payment of a variably or dynamically priced toll that would be set to prevent congestion within the priced lane. Other types of vehicles, such as transit and/or HOV and vanpools, may be allowed to use the priced lanes for free. The conversion of a general-purpose lane to a priced lane would likely require, at a minimum, restriping for separation from the general-purpose lanes and accommodation for any other lane adjustments within existing shoulders. This concept does not provide any new capacity. At this stage of the analysis there are no assumptions about the location of access and exit points for the priced lane or the location of tolling points. There are also no assumptions made about how the priced lanes would be separated from the adjacent general purpose lanes.

2.3.1 Potential improvements

Converting an existing general purpose lane in each direction of I-5 and I-205 to pricing could yield the following improvements, including:

- **Travel time reliability** – The price for access to the toll lane would be set to manage demand for that lane, not for the facility as a whole. As such, the pricing of one lane along a facility would result in improvements in travel speed, travel time reliability and efficiency for the users of that lane.
- **Increased throughput** – Similarly, by pricing to manage demand and maintain travel speeds in that lane, person throughput and vehicle throughput would be maximized in that lane.

2.3.2 Potential implementation issues

Converting an existing general purpose lane in each direction of I-5 and I-205 to pricing could face the following implementation issues:

- **Capacity loss** – The conversion of a general-purpose lane to priced operations would result in a loss of vehicle carrying capacity on the general-purpose lanes. This could increase the hours of congestion for general purpose lanes, which would increase diversion to adjacent routes.
- **Public acceptance** – There would likely be public resistance to the idea of converting a general-purpose lane that was previously "free" and open to use by all drivers.
- **USDOT approval** – The conversion of a general-purpose lane on an interstate highway requires concurrence and approval from the USDOT.
- **Geometric constraints** – The I-5 and I-205 facilities have physical constraints on their geometry that could impact the overall effectiveness or pricing at addressing congestion. Furthermore, the conversion of a general-purpose lane to pricing would not be possible in segments with only two travel lanes in each direction. Having only one general purpose lane adjacent to a priced lane

presents numerous operational changes that render this option infeasible along certain segments of I-5 and I-205.

- **Truck access** – The priced lane in this configuration would most likely be converted from the innermost (left side) lane in each direction. Current Oregon restrictions require trucks over 10,000 pounds to travel in the right lane.

2.4 Priced lanes: construct a new priced lane

This priced lane concept would involve the construction of a new priced lane along I-5 and I-205. Access to the new lane would be granted with the payment of a variably or dynamically-based toll set to prevent congestion in the new priced lane. Certain classes of vehicles, such as transit and/or HOV vehicles, could be allowed to access the priced lane for free or at a discounted rate. The new lane would be accommodated through any combination of construction or restriping, potentially using existing shoulder space to accommodate the new lane. New capacity is typically implemented on the leftmost side of each direction (closest to the median barrier). At this stage in the analysis there are no assumptions about where construction, restriping, or other activities necessary to accommodate the new lane would occur. Furthermore, there are no assumptions about access and exit points for the new priced lane or locations for tolling assessment.

2.4.1 Potential benefits

Constructing a new priced lane along I-5 and I-205 could result in the following improvements:

- **Travel time reliability** – The price for access to the new lane would be set to manage demand for that lane, not for the entire facility (all lanes). As such, the pricing of one lane along a facility would result in improvements in travel speed, travel time reliability and efficiency for the users of that lane. By maintaining existing general purpose capacity and offering a new priced alternative, there could also be potential improvement in travel time reliability and efficiency for general purpose lane users, but it would be far less significant than the improvement in travel time reliability for priced lane users.
- **Increased throughput** – Similarly, by pricing to manage demand and maintain travel speeds in the new lane, person throughput and vehicle throughput would be maximized in that lane. As general purpose capacity is not reduced and a new, faster and more reliable travel option is present, general purpose lanes could see increased person and vehicular throughput.
- **USDOT approval** – The pricing of new capacity is allowed under Section 129 of Title 23 of the US Code.

2.4.2 Implementation issues

Constructing a new priced lane along I-5 and I-205 could face the following implementation challenges:

- **Public acceptance**: There would likely be acceptance challenges given that pricing has not been implemented in the Portland metro area. Some people may worry about environmental or community impacts of adding new capacity. The addition of new priced capacity would require concurrence with long range transportation planning efforts.

- **Geometric constraints:** I-5 and I-205 feature physical geometric constraints that could require costly and impactful reconstruction efforts. The construction of a new lane may, in fact, be cost prohibitive in some areas.
- **Truck access:** In many locations, the priced lane in this concept could be provided by converting the innermost (left side) shoulder in each direction. As such, Oregon's requirement that trucks over 10,000 pounds travel in the right lane would likely apply in these instances, and would need to be modified to allow trucks to access the priced lane. Alternately, construction of a new lane, as opposed to a shoulder conversion, means that the lane could be constructed to better accommodate trucks.

3. CONCLUSION

Value pricing involves the application of a toll for access to a travel lane or roadway that varies in amount based on demand. When traffic volumes increase, so does the amount of the toll. This incentivizes travel during less congested periods of the day, the use of alternate modes (such as transit), or diversion to other routes, while improving travel time and travel time reliability for the priced facility's drivers. Pricing can be applied in any number of ways, but priced roadways and priced lanes offer the most significant congestion management opportunities while still meeting Oregon's Legislative requirements to limit pricing to I-5 and I-205.

As such, three "building block" pricing treatments have been selected for refinement and regional transportation modeling: tolling all lanes on I-5 and I-205 (priced roadway), converting one existing general purpose lane in each direction of I-5 and I-205 (priced lane conversion), and constructing a new priced lane in each travel direction (priced lane construction or shoulder conversion). These treatments will be evaluated alongside a baseline scenario that reflects growth forecasts and projects identified in the Portland Metro's Regional Transportation Plan (RTP) through 2027. Furthermore, four combination treatments have been developed that reflect differing combinations of building block treatments on I-5 and I-205 separately. These combination treatments will also be evaluated as part of regional transportation modeling efforts.

These treatments do not represent proposals or recommendations. They are for testing and learning about potential effects of value pricing applications and were developed to portray the broadest range of potential value pricing application in the Portland metro area. This establishes the foundation for subsequent technical concept evaluation and conversation with the public. The concept evaluation stage will provide additional information that will help determine what pricing applications work best and where. The project team will assess the baseline, building block and combination treatments with consideration of factors such as:

- Traffic operations improvement on I-5 and I-205

- Diversion of traffic
- Transit service and active transportation
- Equity impacts
- Roadway safety
- Impacts on the community, economy and environment
- Public input

Appendix A POTENTIAL OPERATIONAL POLICIES

This appendix provides an overview for background only of the various operational parameters and policies that could be deployed as part of a future value pricing implementation project. The operational policies presented in this section are generally implemented by the operating agency at the local, municipal or regional level to reflect the goals and objectives of the region. However, these policies may also be implemented pursuant to state and/or federal regulation. In particular, priced facilities that are part of the Federal Aid Highway System are subject to federal requirements on issues like pricing structure and vehicle eligibility. The different pricing configurations presented in this memorandum do not assume any particular operational policy, but such assumptions would be required for future analysis and evaluation efforts.

A.1 Toll collection

Open Tolling System

Oregon is entering the tolling conversation at a time when people and infrastructure are becoming increasingly connected to vehicles. The Oregon Department of Transportation (ODOT) is investigating new technologies and options for tolling systems.

This includes researching an open tolling system in which users could leverage the technology they activate or decide to put in their vehicles to pay tolls. An open tolling system could allow several connected car companies to bundle tolling with other services — like by- the- mile insurance, road assistance, parking, engine diagnostics and more. These services might be provided through devices that connect to On-board Diagnostic (OBD) ports (Figure 5). Many of these devices have GPS capability and may be used as Mileage Reporting Devices (MRD) for area charging systems.

Figure 5: Installation of an OBD-based MRD

In addition, an open tolling system could allow for the eventual phasing out of transponder-based technology and transponder/toll tag reader infrastructure on roadways. ODOT is currently in the process of engaging private industry to investigate a potential open system while also developing the system requirements Oregon will need for any tolling system, open or conventional (as described below).

Conventional Tolling System

Facilities with value pricing currently use electronic toll collection (ETC) technology in the form of windshield mounted transponders or sticker tags and electronic readers installed on gantries over the roadway for toll collection. The use of ETC on priced managed lanes is essential for safety issues, and to avoid the travel delay and congestion associated with manual toll collection at booths or toll plazas. Toll booths accepting cash are not used and ETC has become the preferred means for tolling and enforcement of priced managed lanes throughout the country.

Drivers are generally required to have some sort of in-vehicle mounted transponder or "sticker" toll tag equipped with radio frequency identification (RFID) technology to use an ETC facility. Automatic vehicle identification (AVI) and transponder/toll tag readers mounted over the roadway detect the vehicle and unique identification of all vehicles passing toll collection points. This equipment communicates with a back-office system and initiates a toll transaction, typically against a pre-established toll account. License-plate cameras and optical character recognition (OCR) technology are often used for enforcement and have been shown to enhance the capabilities of capturing toll payments (and violations) from vehicles traversing priced managed lanes or other toll facilities. In fact, license plate tolling using OCR technology may be used to initiate toll transactions in lieu of a transponder or toll tag. In this case, the image of the license plate is captured and used to assign the toll to another record, such as a vehicle registration, or to issue a violation notice. This can broaden the base of customers who do not have transponders. However, license plate tolling is typically viewed as a secondary means of collection and enforcement due to the higher cost associated with image processing and verification. As such, a toll premium is typically charged to offset the additional processing costs

A.2 Eligibility

Depending on the various operational goals and objectives for a facility, operators may choose to allow certain classes of vehicles to access the priced facility for free or at a discounted rate. Transit vehicles are very common class of exempt vehicles as they carry more passengers per vehicle and can improve person throughput on the facility. Allowing transit vehicles to use priced facilities for free can also address equity concerns by providing an option for lower income travelers, as those without a vehicle or those without a toll account benefit from the priced lanes.

Another vehicle class that is commonly allowed privileged access to priced facilities is High Occupancy Vehicles (HOV) carrying two (HOV2) or more (HOV2+ or HOV3+) passengers. This category also includes vanpools. An agency may elect to charge HOV2 vehicles if they are anticipated to comprise a significant percentage of traffic volume. Finally, some agencies provide exemptions for clean air vehicles, multi-axle trucks, public and commercial buses, and motorcycles.

Providing exemptions requires a mechanism to identify exempted vehicles as well as those who are subject to a toll. This is generally accomplished in one of two ways. The traditional method involves lane-based declaration, such as on the SR-91 in Southern California, where exempt vehicles or discounted vehicles are physically separated from toll-paying vehicles in toll-zones by creating a separate lane at tolling infrastructure (Figure 6). Enforcement personnel can then visually inspect the vehicle to confirm occupancy and eligibility status. This reduces enforcement costs by reducing the total number of users that enforcement personnel must verify. However, the separation also requires significant amounts of right-of-way, which is not always feasible in practice due to physical constraints. Additionally, lane separation may increase weaving ahead of toll-zones, leading to increased congestion.

Figure 6: Lane Based Declaration

Agencies may also use transponder-based declaration strategies where the in-vehicle toll transponder can be used to declare eligibility. “Switchable Transponders,” as implemented on express lanes in Los Angeles, Colorado, Virginia, and Washington, provide a technical method for drivers to declare eligibility status. As shown in Figure 7, these devices allow drivers to self-declare the vehicle status as SOV, HOV, HOV2 or HOV3+, etc. (depending on local occupancy policies), and will automatically be charged the appropriate toll-rate. Under this method, enforcement is focused on verifying the occupancy of vehicles with transponders set to “HOV.” If no transponder is present in the vehicle, then overhead cameras may be used to capture license plate images as a secondary means of enforcement and tolling to ensure full toll payment from the user. Some newer facilities, such as the LBJ Express in Dallas, rely on smart phone applications for carpool registration, essentially serving the same purpose as an RFID transponder.

Figure 7: Switchable Transponders

A.3 Pricing models

Another important aspect of priced managed lanes to consider during the planning process is the preferred pricing model. Managed lane projects throughout the country have showcased multiple pricing mechanisms, including time-of-day and dynamic pricing, as well as other considerations such as segment pricing and differentiated payment classes. These different models are summarized below:

- **Time of day pricing** is variable pricing based on a set time schedule. This model is currently used on SR-91 in Southern California and all express lanes in the Denver and Houston areas. Although prices are fixed based on a time of day schedule, drivers are charged differently based on direction, day of travel, and hour. This method provides a level of price certainty and predictability for drivers. The most effective applications of this method involve a high degree of variability by time of day and day of the week, and a system for altering toll rates over time. On the SR-91 Express Lanes, performance is monitored daily, with evaluation and adjustments to pricing made every three months.
- **Dynamic pricing** applications are based on real-time traffic conditions and are widespread across the US. This practice is enabled by vehicle detectors that provide a stream of traffic performance data, and tolling algorithms that determine appropriate toll rates based on real-time managed lane and general-purpose lane conditions. This method allows the greatest level of control and flexibility for corridor traffic operations, as the rate can be raised or lowered based on real-time demand to maximize the performance of the lane.
- **Segment Pricing** sets a specific toll for a specific segment of roadway. Any given toll facility can have one segment, or multiple segments. The segments are usually defined by freeway ingress and egress points, by minimum or maximum distance thresholds, or by spatial relation to an important decision point or common destination. From an operations perspective, segment pricing allows segments with higher demand to be better managed through higher toll rates. On the I-15 Express Lanes in Salt Lake City, segmental pricing has been shown to be easily understood by the public, and to reduce weaving in and out of toll points.

A.4 Hours of operation

The time periods that a priced managed lane facility operates are another important policy consideration for the development of a tolling strategy. Depending on factors such as traffic conditions and performance goals for different corridors, agency priorities, and public perceptions, it may be sensible for managed lanes to operate 24/7 or just during peak periods. For instance, about half of all HOV lanes in the US operate only during peak periods. This is intended to provide reliability and time savings to carpoolers during the most congested times, while ensuring the lane is not unnecessarily underutilized at other times. However, the integration of toll-paying SOVs into a managed lane can allow a facility to be more fully utilized during expanded periods, ensuring reliability and time savings are maintained outside of traditional peaks.

There are advantages and disadvantages to either part-time or full-time managed lane hours of operation. Operating managed lanes that are priced only in the peak periods could result in lower operations and maintenance costs, and possibly fewer public challenges since the operation would only be part-time. However, part-time operations can also cause confusion among drivers, and limit the ability to effectively manage demand outside of peak periods. Full-time 24/7 managed lane operations often results in less confusion among drivers, enables revenue collection throughout the day, and provides an option that could provide a reliable trip time at any time of the day.

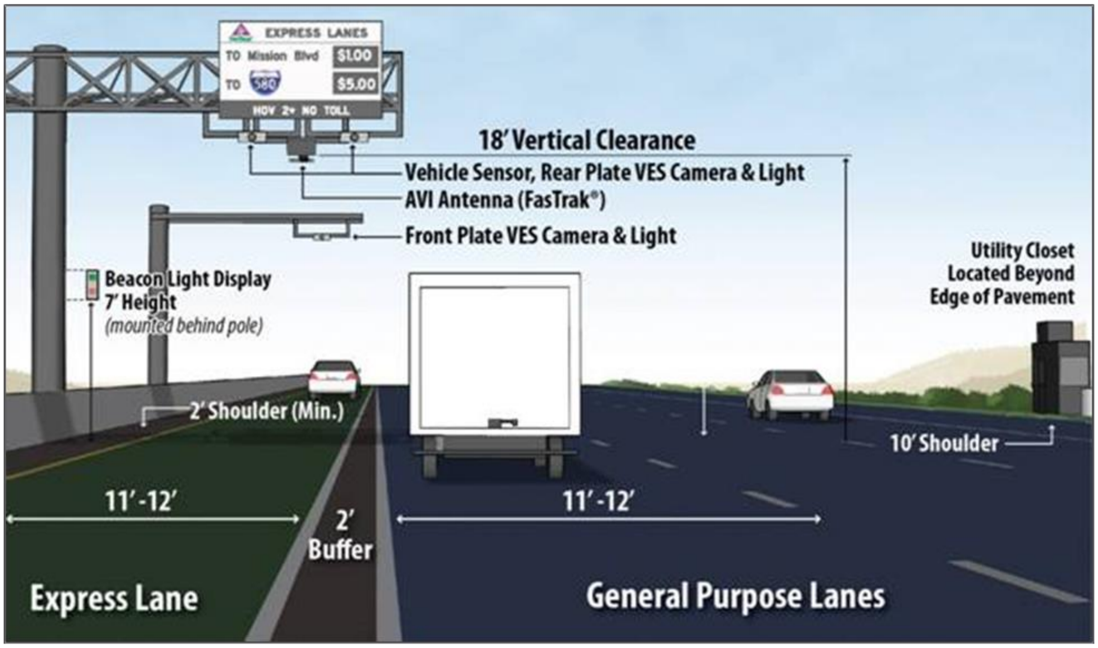
Most priced managed lanes in the US operate full-time. Exceptions include the I-680 in Northern California's East Bay and SR-167 in Seattle, which operate during "daytime" hours (e.g., 5 a.m. to 7 p.m.), and the reversible I-15 and I-25 Express Lanes in San Diego and Denver. There also are part-time facilities that utilize priced shoulder lanes on the I-35W in Minneapolis, and the I-70 Mountain Corridor in Colorado.

A.5 Enforcement

Enforcement is another important element to consider as part of a regional tolling strategy. On priced managed lanes, enforcement systems are necessary to mitigate violations and reduce revenue leakage, and to facilitate secondary license plate tolling, if applicable. Video enforcement systems and manual enforcement areas should be considered early in the planning process for any priced facility.

- **Video enforcement system**: Any effective electronic toll collection system should include roadside video enforcement system elements, such as cameras and lighting mounted on overhead structures, as well as colored LED enforcement beacons to aid enforcement personnel. Figure 8 provides an example of a managed lane toll zone with these elements. During operation of most typical systems, an image is captured of every vehicle's rear license plate as it traverses the toll zone. If a valid transponder is not detected, License Plate Recognition (LPR) software reads the vehicle's license plate and matches information to a customer database. If there is a positive match, a toll is charged to the account. If no match is made, the image and associated time stamp is stored and sent to the back office for violation processing.

Figure 8: Typical Toll Zone Design



- **Enforcement observation areas**: Current technologies for vehicle occupancy detection have not yet proven to be reliable enough for automated enforcement. Manual enforcement of HOV occupancy is still standard on contemporary managed lane facilities. As such, priced managed lane facilities should include locations from which enforcement officers can monitor traffic and identify unauthorized vehicles. The areas should be wide enough to accommodate safety enforcement action, and located near tolling points, allowing officers to monitor traffic and enforcement beacons, and provide a visual deterrent to potential violators (Figure 9).

Figure 9: I-45 Enforcement Area in Houston, TX

Appendix B **DESIGN CONSIDERATIONS**

This appendix provides a basic overview of design considerations for priced lanes and priced roadway facilities with the objective of providing context for the geometry-based assessment and associated analyses that will be conducted as part of evaluation efforts.

B.1 Separation

Priced managed lanes typically operate at higher speeds than adjacent general-purpose lanes during congested periods, and effective strategies for separating managed lanes from other lanes are important for corridor safety. Different types of separations have different impacts on operations and constructability, as well as maintenance, enforcement, and incident management. These factors, and the local context of individual project corridors, will ultimately determine which separation treatment is most appropriate. However, the pros and cons of each method should be considered early in the planning process to understand the impacts of potential design tradeoffs later in project development. Most priced managed lane facilities in the US use painted buffers or striping, vertical traffic channelizers, concrete barriers, or various combinations. These options are summarized below:

- **Painted line/buffer:** Multiple priced managed lane corridors, including the US-36 Express Lanes between Denver and Boulder, use a painted buffer separation indicated by solid double white lines that provide a four-foot (or sometimes less) buffer to the general purpose travel lanes. This option is the least expensive in terms of capital and maintenance costs, and provides the greatest flexibility for operations and access to emergency vehicles. However, this option also is shown to have the lowest traffic reliability and performance due to friction with general-purpose lanes, and potential turbulence from of vehicles illegally crossing the painted lines. Enforcement resources are necessary to minimize buffer crossing violations.
- **Channelizer/delineator:** Priced managed lane facilities such as the I-95 in Miami, SR-91 in Orange County, California, and I-10 in Houston employ traffic channelizers, also called delineators, as a separation method. Channelizers are placed at frequent intervals within a buffer area to create a perceived physical barrier to prevent drivers from exiting or entering the managed lanes at undesignated areas. This configuration reduces the risk of buffer crossings and associated revenue leakage, while also allowing emergency vehicle access. However, this option also has the highest ongoing maintenance cost. On the I-95 and SR-91 facilities, illegal buffer crossings and vehicle strikes require 30 to 50 percent of channelizers to be replaced annually.
- **Concrete barrier or grade separated:** Some priced managed lane projects use concrete barriers or grade separations to designate priced lanes from general-purpose lanes. This option is usually deployed only on reversible or contra-flow facilities due to the major implication of buffer crossings. The I-25 Express Lanes in Denver are an example. Barrier or grade separation is also part of large-scale

corridor reconstruction efforts such as the LBJ Express in Dallas. Operationally, this option allows for the highest speed differential from general-purpose lanes, prevents buffer crossings and revenue leakage, and has relatively low maintenance costs. However, this option is also the most expensive due to capital and right-of-way costs. Access and egress is also more complicated. This option can complicate incident management and allows little flexibility for future operational changes.

B.1.1 Access to lanes

Access control is primarily a concern for priced lane concepts. Considerations include direct connections, at-grade weave zones, and continuous access to lanes.

The development of a regional tolling strategy should consider appropriate methods for drivers to access and egress priced managed lanes. Existing priced managed lane facilities provide several examples of options for regulating entry and exit, which are related in part to the planned separation treatment for the facility. The two major types of express lane access treatments are limited access, which regulate where vehicles may enter and exit the facility, and continuous access, which allow customers to enter and exit the facility at any point. The pros and cons of two limited access options and one continuous access option are described below.

- **Direct connector (limited access)**: Direct connector ramps provide direct access to manage lanes through ramps merging near the median (Figure 10) from overpasses or from direct freeway-to-freeway connections. Direct connectors provide greater efficiency, safety and capacity, while greatly reducing the operational impacts of weaving and merging movements. However, direct connector ramps have high capital costs, significant right-of-way impacts, and can require accommodation on arterial overpasses. As such, best practices suggest they should only be considered where there is substantial general-purpose lane congestion that would complicate weaving, or a significant amount of local demand for access to or from the managed lanes.

Figure 10: Direct access ramp to HOV lanes in Seattle

- **At-grade weave (limited access)**: Most existing priced managed lane facilities use at-grade access and egress treatments. In this approach, access points represent breaks in designated locations within physical barrier or striped separations. The design of these at-grade weaves is normally accommodated through striping, and there are multiple configurations currently used such as a striped single-line, striped transition or weave lane, or slip ramps. The Manual on Uniform Traffic Control Devices (MUTCD) provides guidance for these types of access/egress points. At-grade access and egress points reduce toll evasion and provide additional access control at a relatively low cost. However, the dedicated locations result in a concentrated area of weaving that can result in traffic conflicts. They also require adequate enforcement resources to lessen access violations.
- **Continuous access**: Continuous access allows drivers to enter the priced managed lane facility at nearly any point, with separation from general-purpose lanes normally provided by a single striped or solid line. With continuous access, there are no designated access or egress locations, which results in potentially lower cost, reduced weave concentrations, and greater operational flexibility. However, this method also has the highest potential for toll violations and revenue leakage, and requires significant enforcement resources. Existing continuous access facilities are relatively rare, with only I-35W in Minneapolis and SR 167 (Figure 11) in Seattle currently using this access method.

Figure 11: Continuous Access on SR 167

B.1.2 Signage

Priced managed lanes include many unique aspects that must be clearly communicated to users and future users of the facility. These include entry and exit locations, occupancy requirements, operating hours, costs, and violations. Accurate and informative signage is necessary to ensure that operational procedures are easily understood and to enable efficient and productive use of the priced facility. Effective signage provides drivers with adequate time and information to decide to use the managed lane facility, and how to access it safely. The MUTCD provides guidance on signage for managed lanes of all types, and FHWA is currently concluding a report on signage for managed lanes networks.

- **Access and egress signage:** Adequate signage is critical to direct drivers to access and egress points for the managed lane facility. Signage for the start of a managed lane facility and entrance points should include a combination of advance overhead advance overhead signs and Variable Message Signs (VMS) to let drivers know that they are approaching a managed lane entrance. Signage should also provide information on the price to travel in the managed lane, transponder requirements, and HOV and vehicle eligibility. In addition, static signage is necessary to inform drivers of upcoming managed lane exits, as well as local freeway exits if applicable. Example entrance signage is shown in Figure 12 below.

Figure 12: Express Lane Entrance Signage

- **Variable message signs:** The current pricing level to access and use managed lanes is one of the most important pieces of information to share with drivers and potential customers. Nearly all existing priced managed lanes use overhead pricing signs to display the toll amount to a given downstream location, and to convey HOV requirements and discounts, if applicable. Variable message elements can be used to indicate variable or dynamic toll rates. Typically, VMS signs used to display toll pricing information are either a combination of static signs with VMS insets or full matrix VMS (Figure 13). Each sign type provides toll rates for downstream destinations, but has various advantages and disadvantages. Static signs are generally less expensive and can be more readable. Fully changeable VMS signs provide messaging flexibility, but can be less readable and costlier to deploy.

Figure 13: Variable Message Signage