New Look
The Regional Transportation Plan

2035 Regional Transportation Plan Update

Background Paper:

A Profile of Regional Street and Throughway System in the Portland Metropolitan Region

Prepared by:

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Clean air and clean water do not stop at city limits or county lines. Neither does the need for jobs, a thriving economy and good transportation choices for people and businesses in our region. Voters have asked Metro to help with the challenges that cross those lines and affect the 25 cities and three counties in the Portland metropolitan area.

A regional approach simply makes sense when it comes to protecting open space, caring for parks, planning for the best use of land, managing garbage disposal and increasing recycling. Metro oversees world-class facilities such as the Oregon Zoo, which contributes to conservation and education, and the Oregon Convention Center, which benefits the region's economy.

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2035 Regional Transportation Plan Update

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I. INTRODUCTION

Roadways are the bedrock of transportation systems. They carry people and goods so that the economic and social fabric of metropolitan areas can be sustained. They provide access to recreational and scenic destinations. In some communities a street may be as much a destination as a route while in others a route connects places miles and miles apart.

In the Portland metropolitan region of today, some parts of the roadway system were completed so long ago that the challenge is to preserve, improve, or expand them without disrupting travel too badly. In other parts, where new land is being brought into the urban growth boundary, new roads must be built to link new to old.

The combined pressure to build the new and preserve or enhance the old exerts itself at the policy-making table where limited resources must be distributed to achieve maximum benefit. The purpose of this roadway system profile is to understand what infrastructure exists, what condition it is in, and how well it is functioning.

II. BACKGROUND

Given the way that roads are woven into the fabric of our communities, it is unsurprising that they are relevant to all six of the 2040 fundamentals in the Regional Transportation Plan.

Often, we think of roads first and foremost as linked to the region's *economic vitality*. Roads carry a majority of commuters to their jobs and, since the construction of the interstate highways, an increasing share of freight has moved by truck rather than train. Traffic congestion is a perennial source of public anxiety because it imposes delay on people getting to work and goods getting to market.

Yet roads are necessary not only for economic activity but for other contributions to the general quality of life. *Vibrant Communities* depend on roads so that people can access favorite destinations, from shopping, to recreational activities, to social engagement. However, the mere presence of infrastructure is not enough because the system must be safe and convenient for people to want to use it. The ability to walk safely around a shopping district is vital for the retail community, for example.

Additionally, the roadway system is an essential ingredient in the provision of *transportation choices* around the region. Quality sidewalks and bike facilities encourage walking and cycling and the roads themselves enable our region's bus transit service.

Two of the remaining 2040 fundamentals are sometimes compromised by the roadways system and its users. The pollution generated by motor vehicles and the impacts of infrastructure on ground water and habitats mean roads can pose danger to *Environmental Health*. Roadways, like other transportation infrastructure investments, also trigger *Equity* concerns. In some cases, the concern stems from the disproportionate imposition of burdens on an economic or racial minority, such as when a highway is built through a community because its members were unable to resist it. In other cases, the inequity derives from negligence, with the benefits of transportation investments being kept from minority groups.

Finally, roads are tightly connected with *fiscal stewardship*, largely because they often represent one of the largest (re: most valuable) assets possessed by state and local governments. As discussed below, the aging of this infrastructure challenges these jurisdictions in terms of maintenance and safety.

III. TRENDS AND RESEARCH

Growing Congestion

It is said that travel speeds in the central business district of Philadelphia, Pennsylvania are the same as they were when the liberty bell rang 230 years ago: 17 miles per hour. Here, it sometimes seems our ancestors on the Oregon Trail had it better than us, from the Sunset Corridor to the Banfield or the Interstate Bridge. According to research done for the Oregon Transportation Plan, Vehicle Miles traveled increased 80% between 1980 and 2002, with a growing population counteracting a decline in per capita driving.

"Rush hour" traffic tends to get worse in three ways. First, peak periods last longer – more hours of the day are marked by congestion on the roadway system. Second, peak conditions affect a greater portion of the network. Third, the severity of the congestion during the peak is greater. For example, congestion on I-5 northbound to the Columbia River often starts to form by three o'clock in the afternoon and sometimes even earlier. According to the Cost of Congestion study, completed by Metro, the Port of Portland and the Portland Business Alliance in 2005, by 2040, the average household in the metropolitan region will spend an extra 50 hours a year stuck in traffic.[1]

Recently, the transportation profession has refined its focus on the issue of travel time reliability[2]. The concept of reliability recognizes that whether a trip is short or long, a traveler is aggravated by not knowing how long it is going to take from one day to another. This is related in large part to "non-recurring" congestion which, in contrast to chronic bottlenecks, occurs as a result of incidents (breakdowns, crashes, etc.), construction, weather, and others.

The emphasis on travel time reliability in addition to travel time means that there are more tools at the disposal of transportation planners and traffic managers, including solutions that do not involve major capital investments and capacity expansion. These tools include mitigation strategies for incidents and construction zones as well as communication tools that keep travelers informed about traffic conditions.

[1] The Cost of Congestion study is online: *www.metro-region.org/article.cfm?ArticleID=16673*
[2] FHWA, 2006. Travel Time Reliability: Making it there on time, every time.

Aging Infrastructure

The Interstate Bridge is approaching its 90th birthday. The Marquam Bridge 10 miles south is merely 40 years old. For most metropolitan areas, as infrastructure ages, an increasing share of transportation funding is often redirected to operations and maintenance.

The challenge for the Portland metropolitan area is that the infrastructure is aging at the same time that the region is facing tremendous population growth. That growth means that new infrastructure is needed to support development in parts of the region. Transportation infrastructure is often one of the largest assets owned by cities, towns and counties, which means these jurisdictions face financial as well as engineering challenges.

Innovative Finance

From many directions come hints that the way transportation infrastructure is financed will be changing. A premise of the 2035 RTP is that the federal role in funding transportation is on the decline. Long gone are the days of federal funding for 90% of construction and 80% of maintenance of highways. Furthermore, more federal funding is spent through earmarks rather than formulas, making it harder to invest strategically in the preservation and enhancement of the roadways.

The two most recent rounds of federal transportation legislation, TEA-21 and SAFETEA-LU, indicate the federal government is favoring public-private partnerships more and more. At both the federal and state level, there is a conspicuous lack of support for raising gas taxes. ODOT has recently begun experiments with alternatives. In one, drivers would pay by the miles they drive instead of the amount of fuel they consume. In another, private companies would assume a role in financing, building and operating highways, a scenario that would include tolls or other user fees.

Among other things, "unconventional" funding sources may force a change in the way that transportation is planned. To date, funding decisions are determined by public agencies and in Oregon these decisions are structured by consistency requirements in state law. A growing private role in financing could affect public policy that depends on the reliance on public finance for infrastructure.

Older Drivers

In addition to the infrastructure, our drivers are getting older. Besides social security and other issues, the baby boomer generation is already affecting public safety on the roads. Boomers drove more than earlier generations throughout their lives and are expected to continue driving into their later years.

What it takes to ensure safety for older drivers is not new but the extent of that accommodation is unprecedented. From the visibility of road signs to stopping distances and reaction times, the needs are well known. Furthermore, other modes are also addressing these issues, from ensuring compliance with ADA on sidewalks to considering transit service attributes.

Increasing Emphasis on Management (Demand and System)

In response to the cost of providing additional capacity to address the mounting congestion described above, the national trend is toward greater reliance on strategies that make existing infrastructure more productive or effective, in contrast to simply making more infrastructure. In the 1990's, the emphasis was placed directly on the much-touted ability of technology, also referred to as Intelligent Transportation Systems or ITS, to solve traffic problems, from congestion to safety and air quality. By comparison, today's thinking focuses more on management strategies whereas ITS technologies are valued in a supporting role.

For example, a lane blockage on a highway (break down or incident, e.g.) represents a temporary loss of capacity. As the table below shows, if the vehicle is blocking one of three lanes of traffic, 51% of the built capacity is being sacrificed.[3] A system management strategy might focus on detecting the incident more quickly so that a response – ambulance, tow truck, etc. – can be dispatched. In this example, technology can play a valuable role.

Exhibit A: Impact of Incidents on Highway Capacity (% built capacity lost)

Number of Lanes	Shoulder Blocked	One Lane Blocked	Two Lanes Blocked	Three Lanes Blocked
2	19%	65%	100%	N/A
3	17%	51%	83%	100%
4	15%	42%	75%	87%

The increasing emphasis on management strategies therefore encompasses at least two sub-trends. First, transportation operating agencies (mainly DOTs and transit properties) are increasingly relying on these management strategies as an alternative or complement to capital investments. Second, the emphasis has shifted from "technology for its own sake" to technology in the service of management strategies and performance goals.

Homeland Security

SAFETEA-LU separated "safety and security" – a single planning factor under TEA-21 into separate factors. USDOT and its modal agencies as well as the Department of Homeland Security and its Transportation Security Administration have been working on an array of programs to improve the security of transportation infrastructure. While the overwhelming emphasis has been on aviation security and, to a lesser extent, maritime

[3] Highway Capacity Manual, 2000.

port security, these agencies have been pushing for security to be considered in all areas, including highway.

For the most part, this has become a matter of assessing vulnerability, which in the context of roadways mainly means identifying “critical” infrastructure. Infrastructure may be a potential target either because of its significance in the system or because of some symbolic value. Nevertheless, transportation agencies, in the near term at least, have to be more attentive to the security of its critical assets.

IV. POLICY AND REGULATORY FRAMEWORK

Federal

The primary driver from the federal government is the six-year authorizing legislation. SAFETEA-LU, passed in August 2005, is the law currently in place, preceded by TEA-21 (1998) and ISTEA (1991). The next legislation is due in 2009. In contrast to previous rounds, there was little in the way of new policy direction in SAFETEA-LU, although some feel that language regarding public-private financing and high-occupancy toll lanes are major changes. The most notable trend about the legislation overall was that it shifted even more from formula funding to earmarked allocations. The Oregon delegation did fairly well in getting earmarks but the rational planning process generally benefits from more formula funding, not less.

Aside from the legislation, roadway planning will be influenced by the metropolitan planning regulation that was proposed in mid-2006 and finalized in early 2007. Again, without major changes in the law, the main changes codified in the regulation were ones that reflected evolutionary changes that had occurred since the last regulation was adopted more than ten years ago. There are some changes to the environmental review process but not that have a large impact on the infrastructure that results or how it is managed. The rulemaking does add emphasis to the management of congestion and the promotion of non-expansion solutions.

Finally, there is guidance that accompanies the law and the regulation. With regard to roadways, USDOT is expected to issue guidance with respect to the Congestion Management Process and Transportation System Management/Operations Strategies requirements. Both of these are likely to influence the ways that MPOs and DOTs plan, priorities and implement projects.

State

Oregon Transportation Plan

The Oregon Transportation Plan (OTP), adopted in September 2006, is the state’s guide for transportation policy and long-range, comprehensive planning for the multimodal transportation system. Developed by the Oregon Department of Transportation (ODOT), the plan builds on the polices drafted in the 1992 plan and emphasizes maintaining the assets in place, optimizing the existing system performance through technology and better system integration, creating sustainable funding and investing in strategic capacity enhancements. The ideals ODOT has created are laid out as a collection of six Key Initiatives:

- Maintain the existing transportation system to maximize the value of the assets. If funds are not available to maintain the system, develop a triage method for investing available funds.
- Optimize system capacity and safety through information technology and other methods.
- Integrate transportation, land use, economic development and the environment.
- Integrate the transportation system across jurisdictions, ownerships and modes.
- Create a sustainable funding plan for Oregon transportation.
- Invest strategically in capacity enhancements.

To realize the Key Initiatives, a series of seven goals has been outlined. The goals are reinforced with policies to further define focus and intent. Two of the seven goals deal with the mobility and management of the roadway system.

The aim of the first goal (Mobility and Accessibility) is to “enhance Oregon’s quality of life and economic vitality by providing a balanced, efficient, cost effective and integrated multimodal transportation system that ensures appropriate access to all areas of the state, the nation and the world, with connectivity among modes and places.” The OTP identifies three policies to help achieve this goal:

1. Development of an Integrated Multimodal System
2. Equity, Efficiency and Travel Choices
3. Relationship of Interurban and urban mobility

The aim of the second goal (Management of the System) is to “improve the efficiency of the transportation system by optimizing the existing transportation infrastructure capacity with improved operations and management.” The document notes that “demand and system management can enhance capacity at generally less cost than adding new infrastructure.” In particular, the OTP identifies two supportive policies:

1. Capacity and Operational Efficiency
2. Management of Assets

Goals 3, 4 and 5 (Economic Vitality, Sustainability, and Safety and Security) articulate the most important reasons why improving mobility and access are public priorities. Goal 6 (Funding the Transportation System) lays out various funding mechanisms that are utilized. In goal 7 (Coordination, Communication, Cooperation), the OTP addresses both the importance of interagency collaboration and the need for an effective stakeholder process with respect to planning and implementing all kinds of transportation projects.

The newly-adopted OTP has many profound effects on regional transportation planning, in no small part because the state’s Transportation Planning Rule (TPR) requires consistency between state, metropolitan and local plans. The main policy features of the OTP center around the emerging trend of demand/supply management of the roadway system, which is captured in the second goal. As noted above in the trend section, transportation agencies are increasingly attentive to the strategies they can use to make existing infrastructure work better.

Transportation Planning Rule

The Land Conservation and Development Commission adopted the Transportation Planning Rule (TPR) (OAR 660-012) in 1991 to implement Statewide Planning Goal 12. The rule requires the state, the four metropolitan areas (Medford, Eugene, Salem and Portland), and all other cities and counties to adopt Transportation System Plans (TSPs). Each TSP is required to determine transportation needs and plans for roadway, transit, bicycle, pedestrian, air, rail, water, and pipeline facilities. TSPs in larger jurisdictions also are required to address transportation system management, demand management, parking, and finance. The TPR requires the development of modal system plans, including those for road, rail, and aviation systems.
Among other things, the TPR:

- Requires the Oregon Department of Transportation (ODOT) to prepare a State Transportation System Plan (TSP) and identify a system of transportation facilities and services adequate to meet identified state transportation needs;
- Directs counties and metropolitan organizations to prepare regional transportation system plans that are consistent with the state TSP;
- Requires counties and cities to prepare local transportation system plans that are consistent with the regional plans.

Section 1.1(e) of the TPR promotes the current upkeep and well-being of the roadways along with their continued preservation:
"Protect existing and planned transportation facilities, corridors and sites for their identified functions"

Section 2.4 looks to the evolving nature of our transportation system and the future alternatives for which the roadway could be used:
"In MPO areas, regional and local TSPs shall be designed to achieve adopted standards for increasing transportation choices and reducing reliance on the automobile. Adopted standards are intended as means of measuring progress of metropolitan areas towards developing and implementing transportation systems and land use plans that increase transportation choices and reduce reliance on the automobile."

Oregon Highway Plan

The Oregon Highway Plan (OHP), adopted in 1999, focuses specifically on Oregon's state highway system. The plan emphasizes efficient system management, partnerships with regional and local agencies, connecting land use and transportation, access management, connectivity between modes, and environmental and scenic resources.

The plan outlines the State Highway System under Goal 1: Policy 1A. The purpose is to breakdown the macro classification system of the roads to guide ODOT priorities for system planning, management, and investment. It is divided into two main policy categories:

- *Use the following categories of state highways, and the list in Appendix D, to guide planning, management, and investment decisions regarding state highway facilities.*
- *By action of the Oregon Transportation Commission upon consultation with affected local governments, classify and/or develop Expressways as a subset of Statewide, Regional and District Highways.*

By creating a system of Highway Mobility Standards, Policy 1F, the State of Oregon holds its system to acceptable and reliable levels of mobility by using these main criteria:

- *Identifying state highway mobility performance expectations for planning and plan implementation;*
- *Evaluating the impacts on state highways of amendments to transportation plans, acknowledged comprehensive plans and land use regulations pursuant to the Transportation Planning Rule (OAR 660-12-060); and*
- *Guiding operations decisions such as managing access and traffic control systems to maintain acceptable highway performance*

Regional

Metro Charter

In 1979, the voters in this region created Metro, the only directly elected regional government in the nation. In 1991, Metro adopted Regional Urban Growth Goals and Objectives (RUGGOs) in response to state planning requirements. In 1992, the voters of the Portland metropolitan area approved a home-rule charter for Metro. The charter identifies specific responsibilities of Metro and gives the agency broad powers to regulate land-use planning throughout the three-county region and to address what the charter identifies as "issues of regional concern." Among these responsibilities, the charter directs Metro to provide transportation and land-use planning services. The charter also directed Metro to develop the 1997 Regional Framework Plan that integrates land-use, transportation and other regional planning mandates.

Regional Framework Plan

Updated in 1995 and acknowledged by the Land Conservation Development Commission in 1996, the RUGGOs establish a process for coordinating planning in the metropolitan region in an effort to preserve regional livability. The 1995 RUGGOs, including the 2040 Growth Concept, were incorporated into the 1997 Regional Framework Plan to provide the policy framework for guiding Metro's regional planning program, including development of functional plans and management of the region's urban growth boundary. The Regional Framework Plan is a comprehensive set of policies that integrate land-use, transportation, water, parks and open spaces and other important regional issues consistent with the 2040 Growth Concept. The Framework Plan is the regional policy basis for Metro's planning to accommodate future population and employment growth and achieve the 2040 Growth Concept.

2040 Growth Concept

The 2040 Growth Concept text and map identify the desired outcome for the compact urban form to be achieved in 2040. It envisions more efficient land use and a diverse and balanced transportation system closely coordinate with land use plans. Bicycling is an important element of the transportation concept envisioned in Region 2040. The 2040 Growth Concept has been acknowledged to comply with statewide land use goals by the Land Conservation and Development Commission (LCDC). It is the foundation of Metro's 1997 Regional Framework Plan.

2004 Regional Transportation Plan

The RTP implements the goals and policies in 1995 RUGGOs and the 1997 Regional Framework Plan, including the 2040 Growth Concept. The region's planning and investment in the regional public transportation system are directed by current RTP policies and objectives for the regional public transportation system. The current update of the Regional Transportation Plan (2004) articulates its policies in Chapter 1. Of the 20 policies included in the RTP, some deal directly with roads while others establish context and other influences. Some of the most direct policies are:

Exhibit B: Street and Throughway-Related Policies from the 2004 RTP

- **Policy 4: Consistency Between Land-Use and Transportation Planning.**
- **Policy 11: Regional Street Design.**
- **Policy 12: Local Street Design.**
- **Policy 13: Regional Motor Vehicle System.**
- **Policy 18: Transportation System Management.**
- **Policy 20.2: Transportation System Maintenance and Preservation.**

Other policies in the RTP bear a strong relationship to the road system such as Transportation Safety and Education ("Improve the safety of the transportation system"), Regional Public Transportation Performance ("Provide transit service that is fast, reliable…"), Regional Freight System ("Provide efficient, cost-effective and safe movement of freight…") and Peak Period Pricing ("manage and optimize the use of highways in the region to reduce congestion, improve mobility and maintain accessibility…").

These policies all bear the stamp of the State of Oregon's policy framework, namely the emphasis on consistency among plans and the integration of transportation with land use. In light of the priorities established in SAFETEA-LU and the OTP, the regional policies that appear most pressing include the regional motor vehicle system (13), transportation system management (18), and transportation system maintenance and preservation (20.2). Below, the descriptions and objectives spelled out in the 2004 RTP are reproduced.

Exhibit C: RTP Policy 13.0 Regional Motor Vehicle System

Provide a regional motor vehicle system of arterials and collectors that connect the central city, regional centers, industrial facilities, and other regional destinations, and provide mobility within and through the region.

1. Objective: Provide for statewide, national and international connections to and from the region, consistent with the Oregon Transportation Plan
2. Objective: Provide a system of principal arterials for long distance, high speed, interstate, inter-region and intra-region travel.
3. Objective: Provide an adequate system of arterials that supports local and regional travel.
4. Objective: Provide an adequate system of local streets that supports localized travel, thereby reducing dependence on the regional system for local travel.
5. Objective: Maintain an acceptable level of service on the regional motor vehicle system during peak and off-peak periods of demand, as defined in Table 1.2.
6. Objective: Minimize the effect of improved regional access outside the urban area.
7. Objective: Minimize the impact of urban travel on rural land uses. Limit access to and minimize urban development pressure on rural land uses and resource lands by maintaining appropriate levels of access to support rural activities, while discouraging urban traffic.
8. Objective: Implement a congestion management system to identify and evaluate low cost strategies to mitigate and limit congestion in the region.

Exhibit D: RTP Policy 18.0 Transportation System Management

Use transportation system management techniques to optimize performance of the region's transportation systems. Mobility will be emphasized on corridor segments between 2040 Growth Concept primary land-use components. Access and livability will be emphasized within such designations. Selection of appropriate transportation system techniques will be according to the functional classification of corridor segments.

1. Objective: Provide for through travel on major routes that connect central city, regional centers, industrial areas and intermodal facilities.
2. Objective: Implement an integrated, regional advanced traffic management system that addresses freeway management, arterial signal coordination, transit operation, multi-modal traveler information.
3. Objective: Work with local, regional and state jurisdictions to develop access management plans for urban areas that are consistent with regional street design concepts. For rural areas, access management should be consistent with rural reserve and green corridor land-use objectives.
4. Objective: Integrate traffic calming elements into new street design as appropriate consistent with regional street design guidelines, and as a method to optimize regional street system operation without creating excessive local travel on the regional system.
5. Objective: Continue to restripe and/or fund minor reconstruction of existing transportation facilities consistent with regional street design concepts to address roadway safety and operations.

Exhibit E: Policy 20.2 Transportation System Maintenance and Preservation

Emphasize the maintenance, preservation and effective use of transportation infrastructure in the selection of the RTP projects and programs.

1. Objective: Place the highest priority on projects and programs that preserve or maintain the region's transportation infrastructure and retrofit or remove culverts identified in the region's fish passage program.
2. Objective: Place a high priority on projects and programs that preserve or maintain the region's transportation infrastructure
3. Objective: Place less priority on projects and programs that modernize or expand the region's transportation infrastructure.

V. ROADWAY SYSTEM PROFILE

Introduction

There are four aspects of the roadway system that were originally going to be covered in this profile: asset condition, travel behavior, safety, and congestion. A lack of data prevented effective reporting on asset conditions while both travel behavior and safety have been covered in other profile reports developed for this RTP update process (see Regional Travel Options and Safety reports, respectively). Therefore, the profile that follows concentrates solely on the issue of roadway congestion.

A note about data and performance measures

Data for this report come from two sources, each of which is described in more detail as it is used. The first is the regional travel demand model, which is a theoretical simulation of travel activity based on household and employment information. The second is an archive of real-time traffic monitors, generated by the Oregon Department of Transportation and maintained by Portland State University. In addition to creating a much more comprehensive set of data, this archive also enables analysis of more intuitive performance measures, such as speed and travel time. The main limitation is that this real-time data is only available for the area's limited access freeways and not for the arterial network.

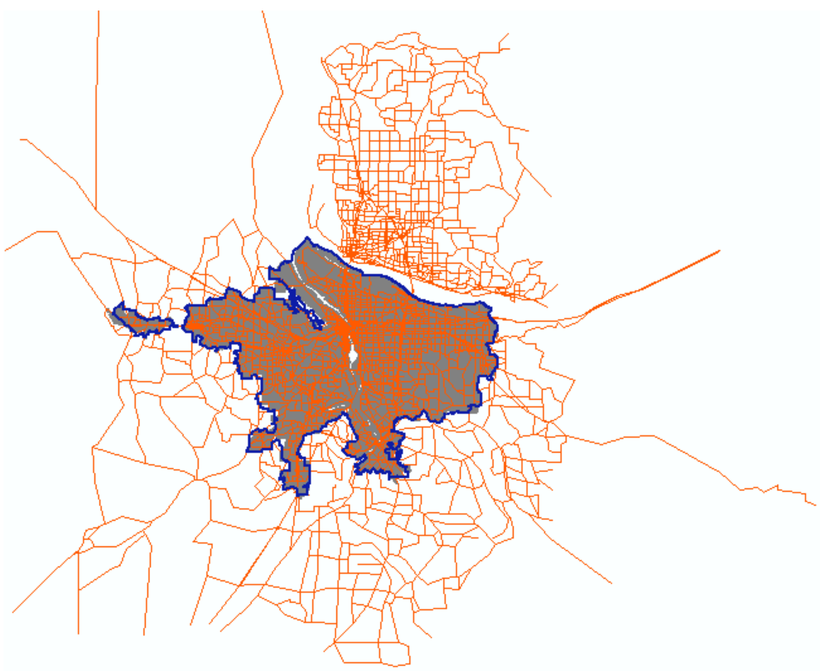
Historically, roadway congestion has been described in terms of volume-to-capacity ratio (V/C) and Level of Service (LOS). In recent years, FHWA and others have pushed to transition from these "engineering" measures to metrics that are more intuitive, especially for the general public. In this profile, preference is given to measures such as speed and travel time, concepts that resonate with users of the system and their day-to-day experience of congestion and delay. Attention is also paid to the concept of travel time reliability. Whereas most speed and time values are averages, experience is rarely "normal" and the reliability concept reflects how often average travel conditions are disrupted.

Part One: Where and When Does Congestion Occur?

Baseline Model Results

The traditional basis for diagnosing congestion is the regional travel demand model, which is used to simulate travel behavior based on where residents of the region live and work. For the development of this system profile, a scenario of the model is run that reflects current (i.e., baseline) conditions. In the exhibit below, the coverage of the road network in the model represents the road system as it existed in 2005, the baseline for the 2035 RTP.

Exhibit 1: Road Network in the Regional Travel Model (in and out of UGB)



Source: Metro

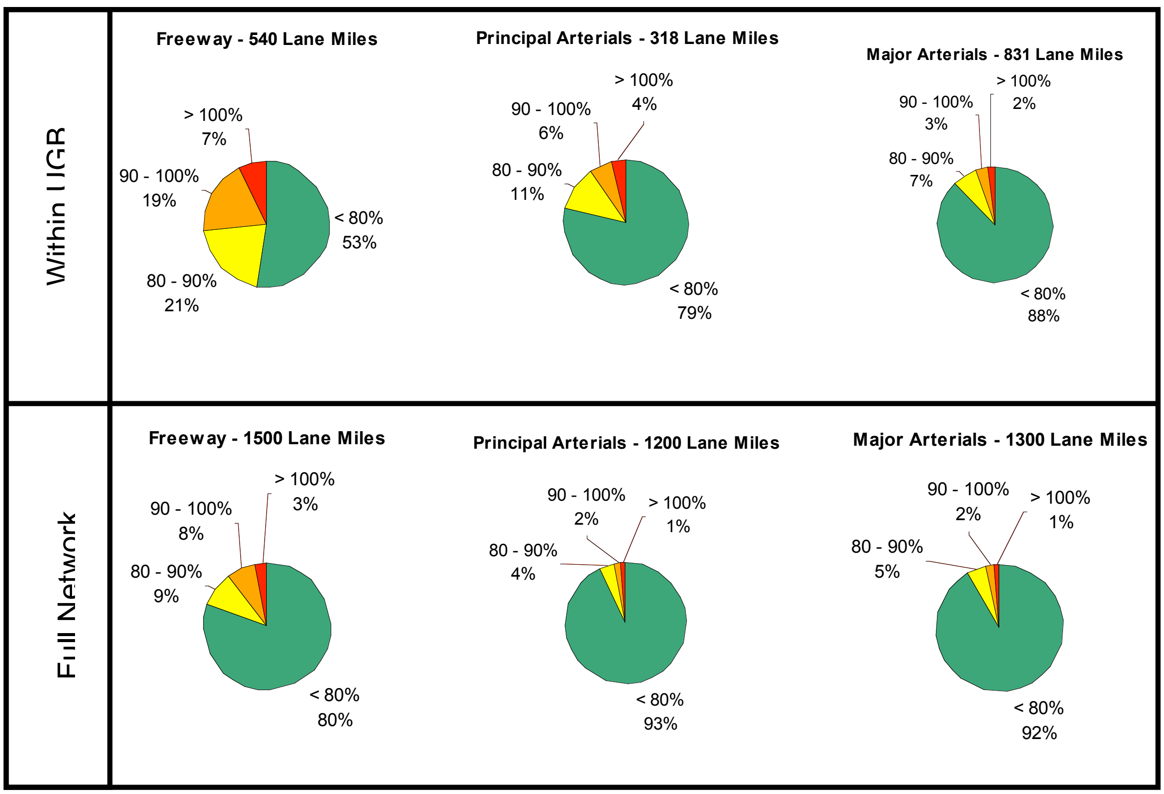
One of the model outputs is the volume of traffic assigned to each link of the network. In other words, how many vehicles use a certain road to get from one place to another. The ratio of that volume of traffic to the capacity of the facility is a standard indicator of congestion. When volume is below 80% of capacity, a road is considered uncongested. Between 80 and 90%, congestion is starting to form but is not yet a policy concern. However, when congestion exceeds 90% of capacity and especially when the volume of traffic seeking to use a facility exceeds its theoretical capacity (>100%), there are serious congestion problems.

The pie charts below (next page) illustrate how much of the network experiences these levels of congestion during the 2-hour PM peak period (3:30-5:30pm). A pie chart is shown for each of the three highest classifications of roads: freeways, primary arterials, and major arterials. For each of these categories, there is one pie chart that shows the level of congestion on the entire network and one that shows the relative amounts on just the roads within the UGB.

Finding: these results show that while there is considerable congestion in the region, especially when only the area within the UGB is accounted for, the burden is greatest on the freeways while the primary and major arterials are in better shape. However, as an aggregate measure, these pie charts only tell how much congestion there is but not whether it is concentrated in certain locations or distributed throughout. The next set of exhibits examines the spatial distribution of congestion in greater detail.

Exhibit 2: Extent of Congestion during the PM Peak (in and out of UGB)

Source: Metro

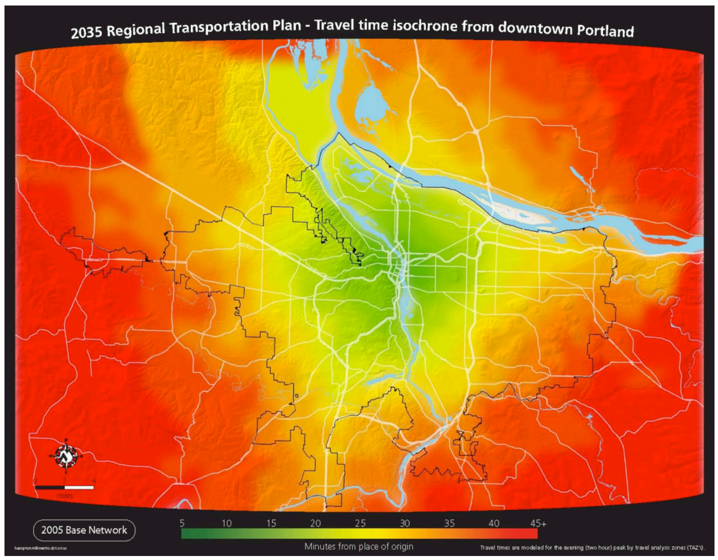


The map below is an example of an exhibit that is sometimes referred to as a commute-shed diagram or a travel-time contour plot. Either way, it is another output of the travel demand model and it helps to show not just the magnitude of congestion but where it is occurring. The map is based on a point of origin, in this case, the central business district of downtown Portland. Each color on the map indicates the amount of time it takes to drive from the point of origin to a given place on the map during the PM peak period. Green represents the shortest trips (5 or 10 minutes) while the dark red reprsents the longest trips, those 45 minutes or longer. In between are gradations of yellow and orange as the travel time grows.

In Appendix A, a total of 17 maps of this kind can be found. Eight of these have a regional center or the Portland City Center as the point of origin and is based on the PM peak period, as in the example above. The other nine are based on industrial areas and midday travel characteristics in order to illuminate the impact of congestion on freight moving during regular business hours.

Exhibit 3: Sample Travel Time Plot

Source: Metro



By linking data sets, it is possible to examine the effect that congestion is having on policy goals, such as providing access to jobs. For example, the table below indicates the number of households within 15, 30, and 45 minutes of each of the region centers. Given a total of 825,000 households in the metropolitan area (UGB and beyond), the top half of the table identifies how many are within individual contours (i.e., 0-15 and 15-30 minutes); the bottom half shows cumulative values (i.e., 0-30, and 0-45 minutes). This is an important baseline finding because it will enable analysis of how changes in the future increase or decrease the number of households within a convenient commute time of these employment centers.

Finding: The travel time contour plots and the household data that correspond to them demonstrate that even when there are elevated levels of congestion on the freeways or principal arterials, each of the regional centers has strong access to employees.

Exhibit 4: Households & Centers

Source: Metro

	CBD	Hillsboro	Beaverton	Wash. Sq	Gateway	Clackamas	OR City	Gresham	Vancouver
0-15 min	124,868	63,450	137,801	120,106	172,271	106,697	82,583	85,156	138,803
15-30	330,107	121,578	220,026	226,017	353,630	342,752	292,721	223,715	317,411
30-45	282,570	191,859	256,944	246,991	205,096	263,516	332,241	277,243	269,609
45+	87,440	448,098	210,214	231,871	93,988	112,020	117,440	238,871	99,162
0-30	454,975	185,028	357,827	346,123	525,901	449,449	375,304	308,871	456,214
0-45	737,545	376,887	614,771	593,114	730,997	712,965	707,545	586,114	725,823

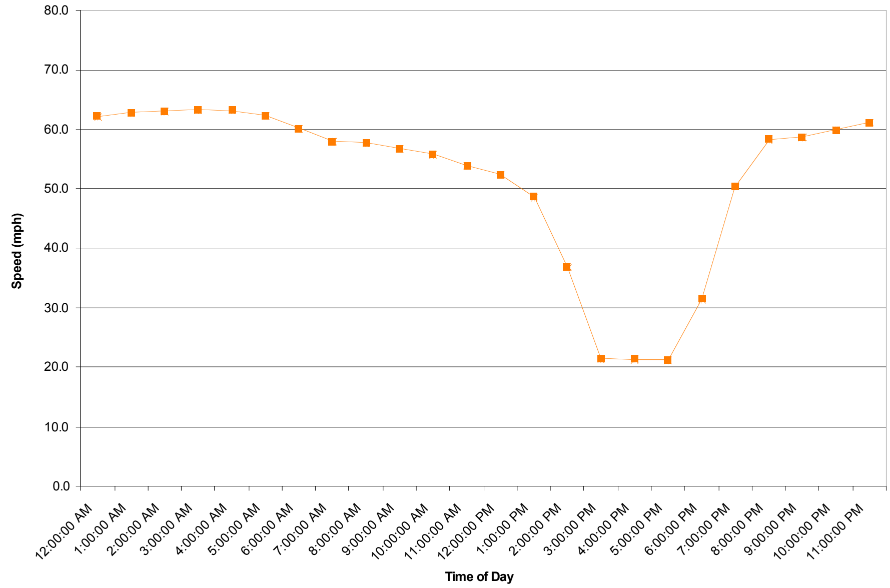
Empirical Data

Since the last RTP was adopted, a new analytical tool has emerged that enables enhanced examination of congestion and travel conditions on the region's freeways. This new tool is provided by researchers at Portland State University who collect and archive real-time data that is provided by the Oregon Department of Transportation. The data originate from sensors that ODOT has installed at various locations around the freeway system. These sensors are able to count the number and speed of cars passing over them.

For analyzing congestion, one of the useful outputs of this new tool is the ability to monitor the average speed at each one of these sensors. The graph below shows the average speed by time of day, based on weekdays in 2006 on I-5 northbound near the Interstate Bridge. The graph shows that average speed is lowest in the afternoon, when the rush hour creates a bottleneck, with large numbers of commuters returning to the Vancouver and Clark County in Washington. As a baseline observation, it is interesting to note the severity and duration of the PM peak period. The curve starts to decline in the early afternoon and nearly reaches 20 miles per hour before beginning its recovery, which is not complete until nearly 8pm.

Exhibit 5: Example of Annual Average Time-of-Day Speed Profile (Northbound I-5 at Marine Drive)

Source: Oregon DOT/Portland State University

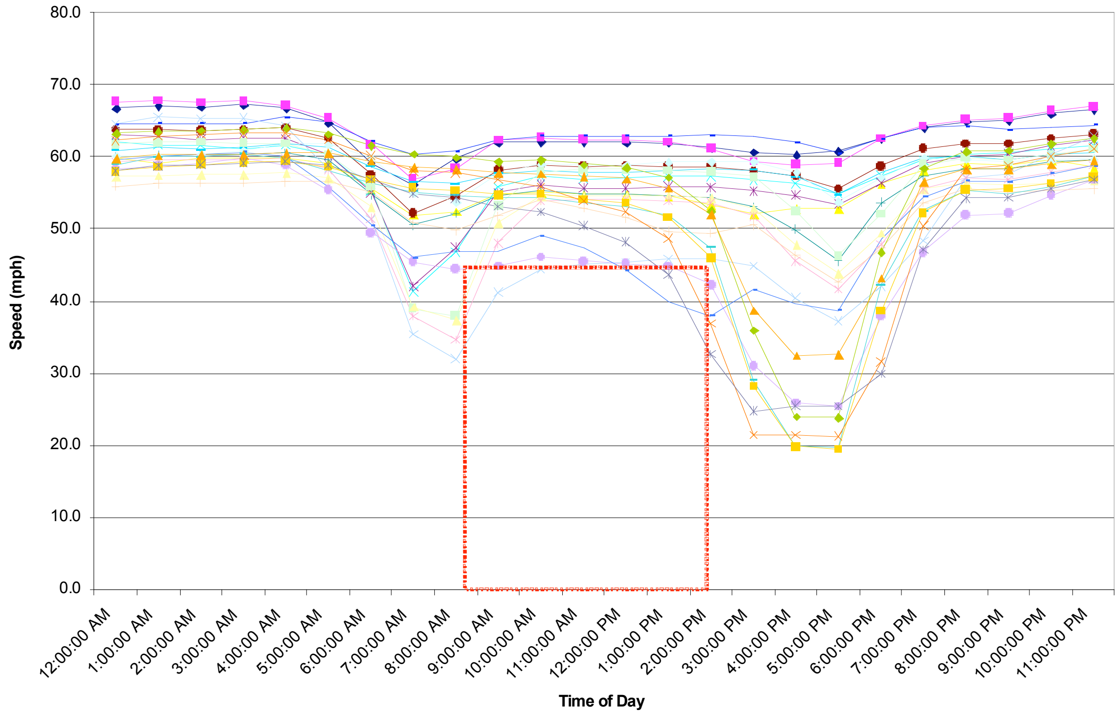


The number of sensors deployed by ODOT means that the congestion on I-5 can be very closely monitored. As shown in the exhibit below, there are more than 25 sensors on I-5 in the metro area, from Wilsonville to the Columbia River. By overlaying all of these different sensor results, it becomes easy to see that congestion in the morning south of the central city is not as severe as what occurs in the afternoon to the north.

In the exhibit, a box is drawn around the area from 9am to 3pm and up to 45 mph. This box represents the critical midday mobility period when a vast majority of trucks make their trips in, around, and through the Portland metropolitan area. By combining the many sensors on I-5 with this box, it is possible to observe the extent to which chronic congestion affects freight mobility.

Exhibit 6: Example of Facility-Based Annual Average Time-of-Day Speed Profile (Northbound I-5)

Source: ODOT/PSU



Appendix B includes 12 of these graphs:

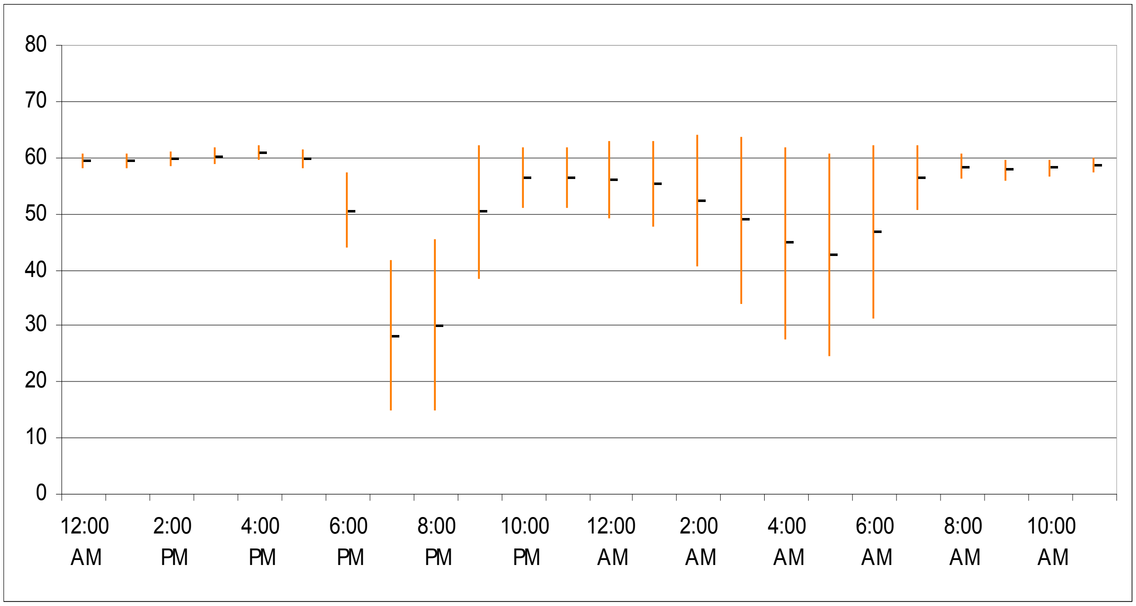
- I-5 Northbound and Southbound
- I-205 Northbound and Southbound
- I-405 Northbound and Southbound
- I-84 Eastbound and Westbound
- US-26 Eastbound and Westbound
- OR-217 Northbound and Southbound

Finding: As a new analytical tool, this PSU archive of ODOT data has verified the projections generated by the regional travel demand model. The data reaffirm what the model and the region's drivers know to be the case: there are several major bottlenecks in the region, from the Interstate Bridge to the I-84/I-5 interchange and more. As a first iteration, these data provide an important baseline regarding the severity and duration of peak periods in these chronic bottlenecks and in other locations. Such baseline findings will be a crucial point of reference when projections of the future are developed and alternatives are being considered.

Annual averages, however, are only one part of the picture. As national research has recently demonstrated, an important factor in congestion is the reliability of travel times, also visible in the variability of travel speeds. The exhibit below shows a single average speed curve (US-26 eastbound at Canyon Road) and it also includes the standard deviation[4].

Exhibit 7: Variability of Average Annual Speed

Source: ODOT/PSU



In this example, there is relatively little variation during the overnight hours, as illustrated by very short vertical bars. However, there is substantial variation throughout the day, even when the average speed is near free-flow conditions during the middle of the day. Appendix C includes one of these graphs for every location covered by ODOT's sensors.

Finding: while the analysis of annual average speeds found that congestion rarely reduces levels below 45 miles per hour between 9am and 3pm, these graphs of deviation from the average demonstrate that in many places, a driver must be prepared for speeds much slower than the average not only during the peaks but also during the midday.

Part Two: What Causes Congestion?

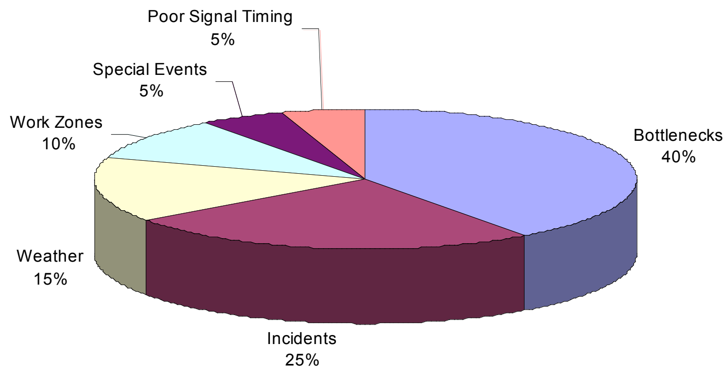
The impact of variability in speed and travel time is significant for many reasons, most related to the importance of on-time arrival. While this is important for any kind of travel, from commuting to socializing, it is especially important to the conduct of business and the delivery of goods. Therefore, investigating the causes of congestion requires looking not just at the chronic bottlenecks but also sources of delay such as incidents and construction.

[4] Two sets of data can have the same average but different standard deviations. For example, 6 is the average of 2 and 10 but it is also the average of 5 and 7 even though the variation between 2 and 10 is much greater than 5 and 7.

National data suggests that 55% of delay can be attributed to so-called "non-recurring" sources of congestion, including incidents (both collisions and breakdowns), construction, weather, and special events. This breakdown is shown exhibit 8, below.

Exhibit 8: Sources of Congestion

Source: FHWA

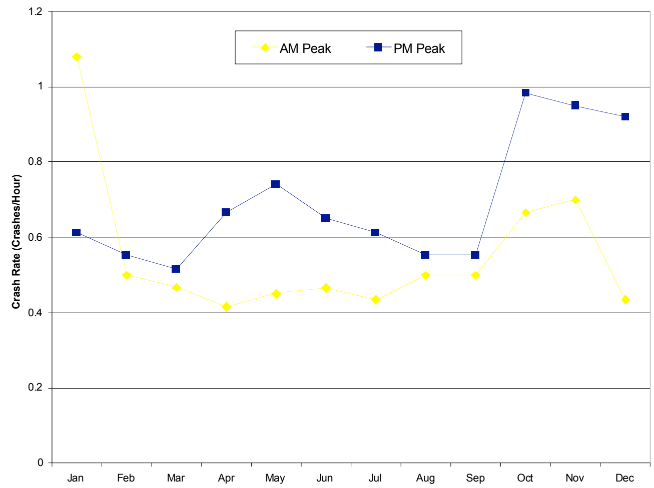


On Portland's regional freeways in 2005, there was an average of approximately 1000 incidents per month (808 breakdowns, 249 crashes). According to the Highway Capacity Manual, even a stalled vehicle in the shoulder can reduce capacity of a 3-lane highway by 17%. That loss grows to 51% when a single traffic lane is blocked and to 83% if the incident interferes with 2 of the three lanes.

Exhibit 9, below, shows that crashes are more likely to happen at certain times of day and certain months of the year. Comparing the morning peak (7-9am) with the evening peak (4-6pm), it is interesting to note that except for January, crashes occur more frequently in the evening than in the morning. This may be attributable to end-of-day fatigue or darkness and the spike in morning crashes in January may be attributable to icy conditions. It is also interesting to note how the crash rate increases in the October and November, typically when the heavy rain returns to the region and daylight savings time ends.

Exhibit 9: Traffic Crash Rates by Month and Time of Day

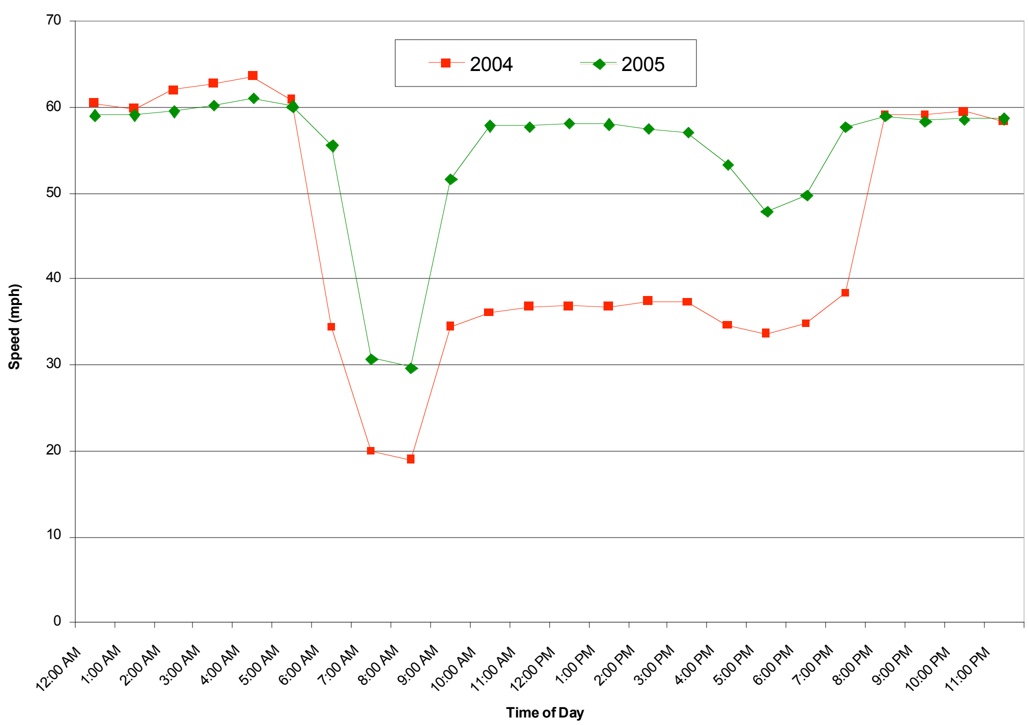
Source: ODOT/PSU



Work zones are another culprit in the realm of non-recurring congestion. Exhibit 10, below, illustrates how travel speed on the eastbound Sunset Highway changed between 2004, when construction was active and 2005, when it was complete. Note that each speed curve follows the same basic pattern – very slow during the morning peak and slightly slow during the evening peak – but that the speeds are lower in ’04 than they are in ’05 or ’06.

Exhibit 10: Traffic Speed on US26 Eastbound at Canyon Road, 2004 vs. 2005

Source: ODOT/PSU



The data also suggest that the wet months witness more congestion than other times of the year. As noted above, the frequency of crashes increases significantly in October and November. There is a well documented phenomenon that the first major rain in a long time leads to frequent crashes, mainly because oils build up on the road and make the road slick when it rains. But bad weather also reduces visibility and creates other hazardous conditions, explaining why the level of congestion seems to peak in November. As shown in Exhibit 11, on the next page, the months with the highest rainfall (in 2006, January and November were notable extremes), also witness the most congestion. In the graph below, the cumulative monthly rainfall is shown in columns while the occurrence of congestion (average amount of time per day when congestion is present) is illustrated by the line.

Finally, special events can disrupt traffic, even though they are often anticipated and efforts are made to mitigate their impacts. Some events, such as a Trailblazers game or concert at the Rose Garden simply overwhelm parts of the system for a short period of time. Other events, such as holiday parades and road races, require the closing of some roads and bridges. Exhibit 12, below, shows the volume of traffic on I-405 northbound on three consecutive Sundays. On the third (shown in red), the volume spikes for several hours because I-5 northbound was closed for a charity bike ride. Because the event was held on a Sunday morning, the impact on traffic was probably limited but that is not always the case.

Exhibit 11: Relationship between Rainfall and Congestion

Source: ODOT/PSU

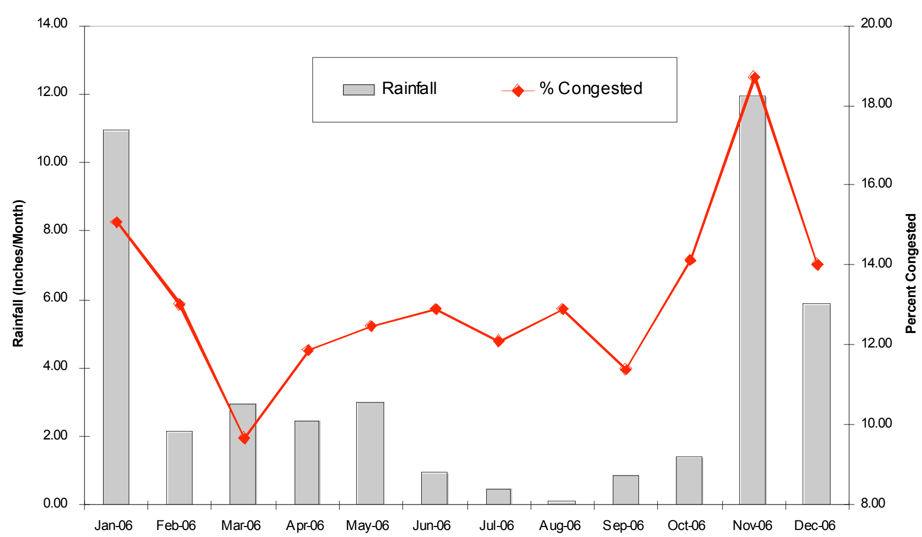
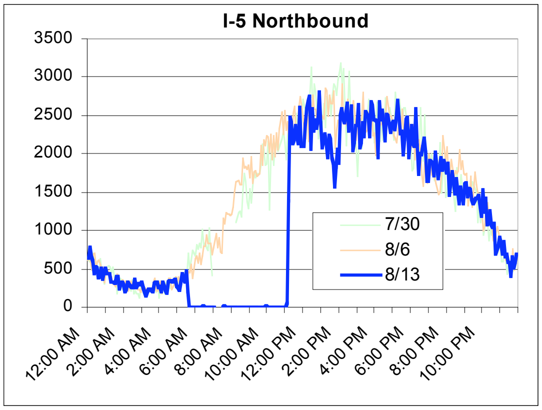
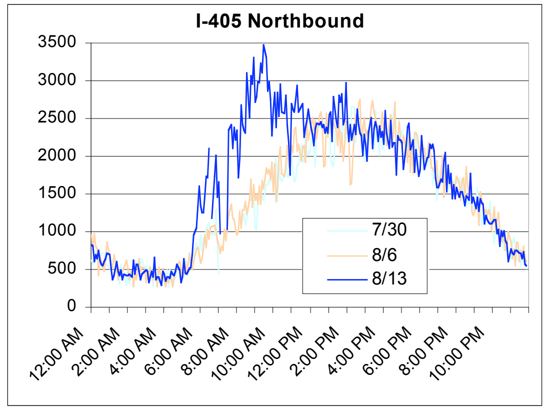


Exhibit 12: Traffic Volumes and Special Events

Source: ODOT/PSU





Part Three: How is Congestion Managed?

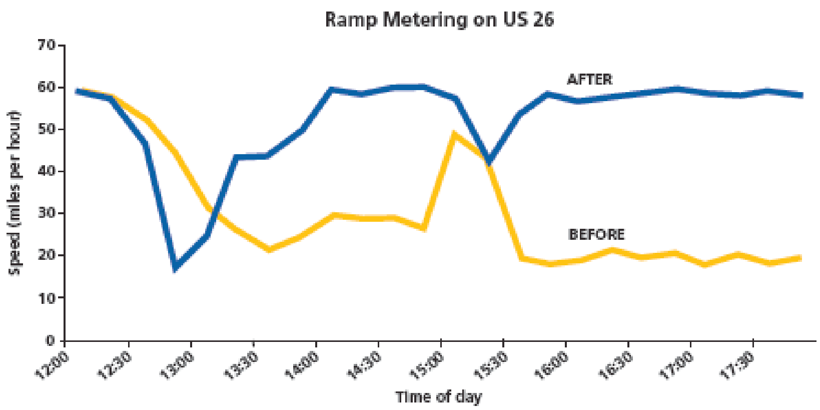
Consistent with federal planning regulations, Metro maintains a Congestion Management Process (CMP) for the Portland metropolitan area. The CMP includes capital investments, such as new or enhanced road capacity, as well as demand and system management strategies that are designed to increase the performance of the existing infrastructure. Demand management strategies are covered in a separate profile report on Metro's Regional Travel Options program.

System management encompasses a wide array of measures. Several system management strategies are already in place on the region's highways and the benefits of most can be seen in the data. One of the most visible examples of this is ODOT's use of ramp metering at almost all entrances to the freeways. By creating space between vehicles that are entering a congested freeway, ramp meters reduce congestion and also the frequency of collisions in the interchange area.

Exhibit 13, below, shows one example where the introduction of ramp metering increased travel speed. The data for this graph came from an ODOT study that demonstrated ramp metering saved nearly 15 minutes on the commute from Hillsboro into Portland.

Exhibit 13: The Travel Speed Benefits of Ramp-Metering

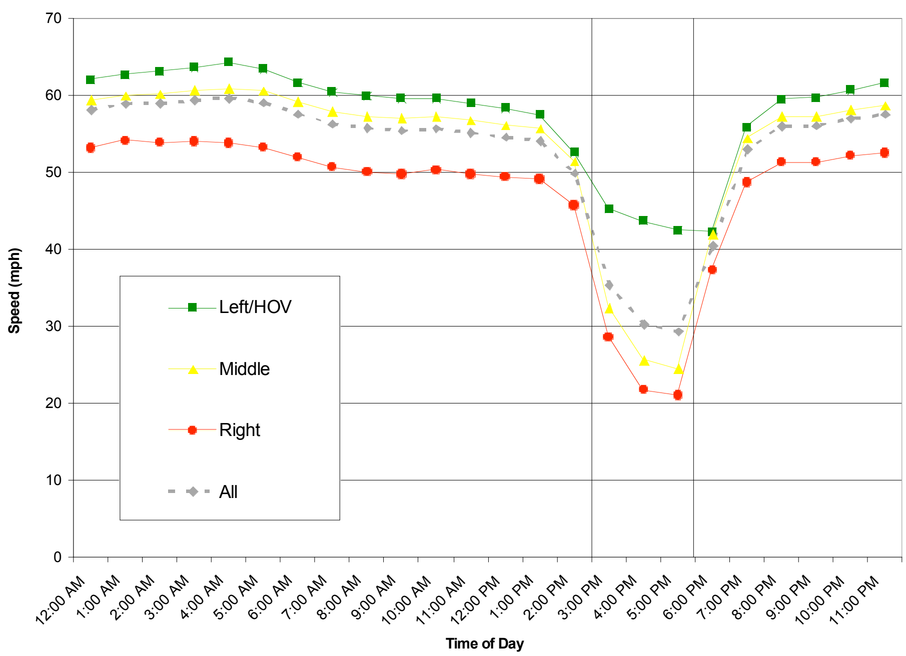
Source: ODOT



On one section of I-5 northbound, the region has its only High-Occupancy Vehicle (HOV) lane, also known commonly as a carpool lane because, when the restriction is in effect from 3-6pm on weekdays, only vehicles carrying 2 or more people (and motorcycles) can use it. As shown in Exhibit 14, below, during the evening rush hour, when the HOV rule is in effect, the people who are able to use that lane travel significantly faster (45 miles per hour) than the people traveling in the "general purpose" lanes (20-25 miles per hour).

Exhibit 14: Speed by Lane and Time of Day on I-5 Northbound at Portland Blvd

Source: ODOT/PSU



There are other strategies for managing the freeways as well, such as incident management and traveler information. The same data that ODOT uses to run the ramp meters (and that it shares with PSU) can also be used to provide the kind of congestion data featured in this report to drivers in real-time. Using the internet, telephone, or broadcast media, ODOT can disseminate information about where there is congestion, especially when it exceeds normal conditions, such as construction activity or a crash scene. By providing this information, travelers have the option to choose an alternate route, mode or time to travel, thereby avoiding additional congestion.

VI. CONCLUSION

Through a combination of modeled and empirical data, this system profile report has documented where, when and why congestion occurs in the Portland metropolitan area, the affect it has on the job access and midday mobility, and some of the system management strategies that are being employed to deal with it.

One overarching finding is that the data reaffirm what most residents and drivers of the region already know: congestion is worst at some of the physical bottlenecks that exist in the region, including the Vista Ridge tunnels, the Interstate Bridge, and the interchange of I-5 and I-84.

The report has illustrated the value of archived data from ODOT for the purpose of monitoring and tracking the duration of congestion and the variability of travel speeds based on individual locations or entire facilities.

Referencing research done by the Federal Highway Administration, the report has also noted the importance of non-recurring congestion and major sources thereof, including incidents, work zones, and weather.

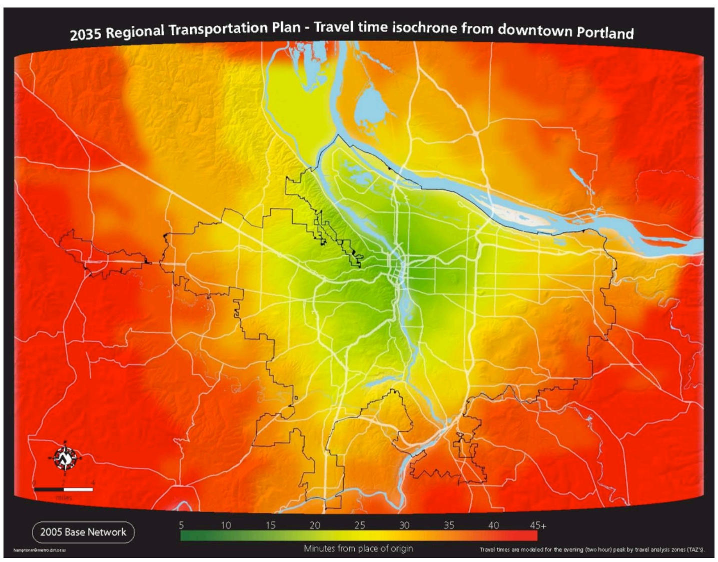
As a baseline, these data provide a foundation for using the model to forecast changes and to use the empirical data to track these changes in real time.

Finally, the report noted efforts already underway in the region to employ system management strategies to address the congestion. These operational strategies, including ramp metering, high occupancy vehicle lanes, and incident response, are essential complements to capital investments in the road system.

Appendix A: Travel Time Contour Maps

The map below is an example of an exhibit that is sometimes referred to as a commute-shed diagram or a travel-time contour plot. Either way, it is another output of the travel demand model and it helps to show not just the magnitude of congestion but where it is occurring. The map is based on a point of origin, in this case, the central business district of downtown Portland. Each color on the map indicates the amount of time it takes to drive from the point of origin to a given place on the map during the PM peak period. Green represents the shortest trips (5 or 10 minutes) while the dark red reprsents the longest trips, those 45 minutes or longer. In between are gradations of yellow and orange as the travel time grows.

Sample Travel Time Plot
Source: Metro

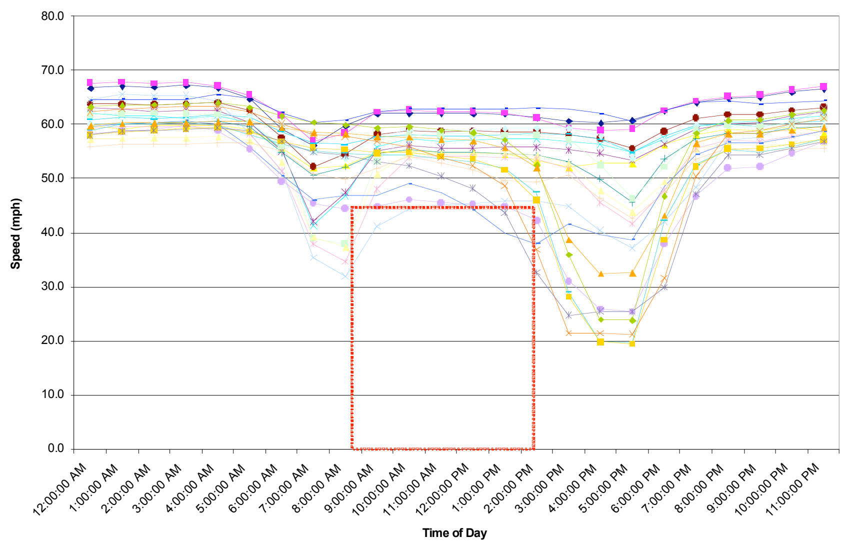


This appendix includes 17 of these diagrams. Eight of these have a regional center or the Portland City Center as the point of origin and is based on the PM peak period, as in the example above. The other nine are based on industrial areas and midday travel characteristics in order to illuminate the impact of congestion on freight moving during regular business hours.

Appendix B: Facility-Based Annual Average Time-of-Day Speed

Since the last RTP was adopted, a new analytical tool has emerged that enables enhanced examination of congestion and travel conditions on the region's freeways. This new tool is provided by researchers at Portland State University who collect and archive real-time data that is provided by the Oregon Department of Transportation. The data originate from sensors that ODOT has installed at various locations around the freeway system. These sensors are able to count the number and speed of cars passing over them. For analyzing congestion, one of the useful outputs of this new tool is the ability to monitor the average speed at each one of these sensors. The graph below illustrates the average speed, by time of day, for all of the sensors located along I-5 northbound in the metro area (from Wilsonville to the Interstate Bridge).

Facility-Based Annual Average Time-of-Day Speed Profile (Northbound I-5)
Source: ODOT/PSU



In the graph, a box is drawn around the area from 9am to 3pm and up to 45 mph. This box represents the critical midday mobility period when a vast majority of trucks make their trips in, around, and through the Portland metropolitan area. By combining the many sensors on I-5 with this box, it is possible to observe the extent to which chronic congestion affects freight mobility.

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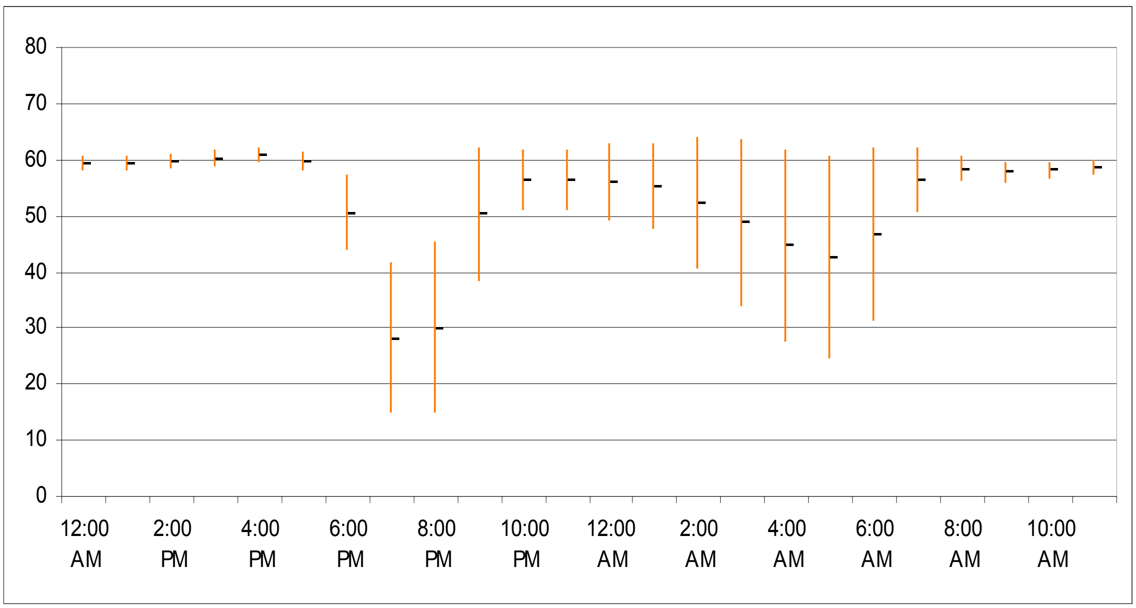
- I-5 Northbound and Southbound
- I-205 Northbound and Southbound
- I-405 Northbound and Southbound
- I-84 Eastbound and Westbound
- US-26 Eastbound and Westbound
- OR-217 Northbound and Southbound

Appendix C: Variability of Average Annual Speed

National research has recently demonstrated that an important factor in congestion is the reliability of travel times, also visible in the variability of travel speeds. The exhibit below shows the average speed by time of day (at an individual location) as well as the standard deviation. Longer vertical bars indicate greater variability in speeds observed at that location.

Variability of Average Annual Speed
Source: ODOT/PSU



Appendix C includes one of these graphs for almost every location monitored by ODOT and archived by PSU (approximately 140 graphs). As the index at the end of the appendix describes, a handful of the monitoring stations were excluded because of data quality problems. An additional subset were included but with a notation that the data quality for the year was less than 85%. The results are still considered informative but the caveat is important to keep in mind.