Appendix L: Strategies for Transportation System Management and Operations (TSMO)

Menu of Strategies for Transportation System Management and Operations (TSMO)

														DETAILED POLLS ON PRIORITY				
#	Grouping	Strategy	Related Strategies	Description	Benefits	Estimated Cost	Application	Effect on Reliability	Key Benefit(s)	Prior Experience?	Estimated Cost Ra	Priority (Hi/Low)	Viability	HI	MED	LOW	BLANK	Notes
A1	Arterial	Access Management		Access Management is the process that provides access to land development while simultaneously preserving the flow of traffic on the surrounding road system in terms of safety, capacity, and speed	- Reduction in accidents and accident rates by 40% on average - Increased LOS, capacity by about 40%, and speed by 50% to 90% - Other public benefits for pedestrians, bicyclists, public transit, taxpayers, and the environment	Cost spreads out across the board; cost is high when access rights are to be acquired	Political Factors = Access right acquisition, land use regulation and interest on different stakeholders should be taken into consideration Institutional Factors = Cooperation among and involvement of relevant government agencies, business owners, land developers and the public is necessary Technical Factors = Access management can be adopted easily in the pre-development stage, but extremely difficult in the post-development stage	Medium	Improved Mobility & Safety	60%	Low (unless access rights or property to be purchased)	MED	MED	4	2	1	3	- Cost should be medium
A2	Arterial	Advanced Signal Systems		Advanced signal systems include coordinated signal operations across neighboring jurisdictions, as well as centralized control of traffic signals which may include some necessary technologies for the later development of adaptive signal control.	- Reduced delay by 5% to 40%, travel time by 7% to 41% and stops up to 85% - Increased average vehicle speed - Reduced vehicle emissions by 2% to 13%, with fuel savings between 2% and 15%	$20 - $25 per foot for copper wire signal interconnect; $5000 per intersection for wireless interconnect (availability depends on agencies and signal locations); 1 - 2 million for signal system integration and firmware upgrade	Political Factors = New system needs to have significant advantage over the existing one to make the expenses reasonable Institutional Factors = Signal control across jurisdictions has to be coordinated, clear understanding of technology is necessary; system compatibility across jurisdictions may not be an issue in Oregon as they use the same signal system platform Technical Factors = Keep up with technology, consider risk/reward for "untested" technology	High	Reduced Congestion	60%	Medium-High	HI	MED	7	0	0	2	- Cost not that high - Project planned
A3	Arterial	Changeable Lane Assignments		The use of Changeable Lane Assignments Signs (CLAS) on frontage roads can mitigate the lane imbalances seen on a time-of-day recurring basis and during freeway incidents. As traffic signals have long been used as a time management technique for optimizing traffic operations, CLAS is used as a space management technique to add an additional dimension to optimization.	- Reduced delay by 1% to 26% and increased throughput by 50 to 1000vph during incidents		Political Factors = Institutional Factors = Requires interagency cooperation when part of a larger management strategy, such as incident management or integrated corridor management Technical Factors = Driver awareness and adjustment to their use. Require adequate approach and receiving lanes to facilitate their use.	Medium	Reduced Congestion		Low	LOW	MED	0	2	5	3	- Depends - Cost should be higher - Where appropriate
A4	Arterial	Signal Retiming / Optimization		Signal retiming / optimization includes updating signal timing plans for prevailing traffic conditions, interconnecting signals, and potentially upgrading signal technology to meet timing objectives.	- Reduced travel time by 10% to 20% - Decreased fuel consumption - High benefit-to-cost ratio which can range from 17:1 to 40:1	$20 - $25 per foot for copper wire signal interconnect; $5000 per intersection for wireless interconnect (availability depends on agencies and signal locations); $2,000 - $3,000 per intersection for signal retiming; $1,000 - $4,000 for controller + software replacement/upgrades; $10,000-$15,000 to replace signal control cabinets.	Political Factors = Prioritizing operational efficiency benefit over other projects Institutional Factors = Coordination and compatibility across agencies for new timing plans or signal system infrastructure Technical Factors = Understanding new technology, capabilities and limitations; Realize signal retiming and optimization should be revisited as needed, but every 3-5 years is recommended	High	Improved Mobility	70%	Low	HI	HI	7	1	0	2	
A5	Arterial	Red Light Cameras		Automated enforcement technologies can assist with the enforcement of traffic signal compliance. Still or video cameras, activated by detectors, can record vehicles traveling through a red signal.	- Decreased severity and number of turning/angle crashes (increased number of rear-end crashes) - 60-80% of drivers approve of their use based on survey data - 20-75% reduction in red light violations	$65,000 to $80,000 per intersection	Political Factors = Public perception of automated enforcement Institutional Factors = Who does the operations and maintenance? How are costs and profits distributed? Agencies should ensure clear laws or codes are in place to support automated enforcement (i.e. will citation go to registered vehicle owner or driver of vehicle at the time). Coordination with legal departments/lawyers maybe necessary upon start up due to law suits Technical Factors =		Improved Safety	10%	Medium	HI/LOW	MED	4	1	4	1	- No legislative approval for county use
A6	Arterial - On-Street	Parking Management		The management of on-street parking locations, durations, and vehicle types to allow more efficient use of existing roadway capacity and reduce potential conflicts which reduce traffic flow rates.	- Increased saturation/traffic flow - More efficient use of roadway capacity without adding new pavement	Minimal signing and striping costs	Political Factors = Prioritizing importance of moving vehicles vs. business access Institutional Factors = Easier to plan to manage parking on a new facility, than to remove or restrict on-street parking on an existing facility, Coordinate management strategy across jurisdictional boundaries when necessary Technical Factors =		Improved Mobility	20%	Low	HI/LOW	MED	3	0	4	3	- No issue yet
AF7	Arterial / Freeway	Active Traffic Management		Active traffic management consists of a combination of operational strategies that, when implemented in concert, fully optimize the existing infrastructure and provide measurable benefits to the transportation network and the motoring public. These strategies include but are not limited to speed harmonization, temporary shoulder use, junction control, dynamic signing and rerouting and managed lanes.	- Increase in average throughput in congested periods by 3% to 7% - Decrease in accident rate by 3 to 50%		Political Factors = Prioritizing operational efficiency benefit with existing system over expanded system capacity projects Institutional Factors = Key to have coordination and compatibility across agencies to maximize effectiveness Technical Factors = Understanding new technology, capabilities and limitations; Budget for training if new technology, and continued maintenance and support over life of technology; Consider risk/reward for "untested" technology		Improved Mobility	30%	Low-Medium	MED	MED	4	1	2	2	- "The high cost of free parking" is important to demand management - Project planned
AF8	Arterial / Freeway	Event Management		Event transportation management systems can help control the impact of congestion at stadiums or convention centers. In areas with frequent events, large changeable destination signs or other lane control equipment can be installed. In areas with occasional or one-time events, portable equipment can help smooth traffic flow.	- Reduced delay amidst heavy demand during special events - Reduced crash rates due to reduced conflicts - Increased attractiveness of event attendance, particularly repeat attendees	(System components are similar to Incident Management, which gives similar cost as that) $2,000 - $3,000 per intersection for specialized event timing plan; $20-$50 per hour per officer for manual traffic control; $2,000 - $3,000 per lane control display; $300K - $450K per lane control system including software, integration and other hardware costs	Political Factors = Frequent roadway detours and lane control measures may bring confusion and inconvenience to drivers and nearby residents Institutional Factors = Coordination with various event organizers and agencies is necessary Technical Factors = Events of various magnitude in different locations require different measures and scope of coordination	Medium	Reduced Congestion	30%	Low-Medium	MED	MED	4	2	1	3	
AF9	Arterial / Freeway	Integrated Corridor Management		With integrated corridor management, the various institutional partner agencies manage the transportation corridor as a system, rather than the more traditional approach of managing individual assets. Travelers could receive information that encompasses the entire transportation network. They could dynamically shift to alternative transportation options, even during a trip, in response to changing traffic conditions.	- Reduced travel time and delays - Increased reliability and predictability of travel	$2,000 - $3,000 per intersection for signal retiming; $50,000 - $100,000 per variable message signs depending on size; $1 - 3 million to design and implement; $100,000 - 2 million for annual O&M which varies among the scope of the system	Political Factors = Prioritizing management of the system over capacity expansion projects Institutional Factors = Interagency cooperation and implementation is key to project success Technical Factors = Understanding new technology, capabilities and limitations; Budget for training if new technology, and continued maintenance and support over life of technology.		Improved Mobility	30%	Medium	HI	MED-HI	5	1	2	2	- Project planned
AF10	Arterial / Freeway	Real-Time Traveler Information		Advanced communications have improved the dissemination of information to the traveling public. Motorists are now able to receive relevant information on location-specific traffic conditions in a number of ways, including dynamic message signs (DMS), highway advisory radio (HAR), and in-vehicle signing, or specialized information transmitted to individual vehicles. May include 511 systems.	- Reduced delay by 1% to 22% and number of stops by 5% to 6% - Reduced gas emissions by 3% to 5% - Decreased crash fatalities by 3%	$50,000 - $100,000 per variable message signs depending on size; $1 - 3 million to design and implement; $100,000 - 2 million for annual O&M which varies among the scope of the information system	Political Factors = Prioritizing information systems over regular infrastructure projects. Public perception can be high with this implementation. Institutional Factors = Agency partnership and data/resource sharing to create a robust system. Technical Factors = Rapidly changing field, user understanding is key	High	Improved Mobility	40%	Low (if little added infrastructure), High (if added infrastructure)	HI	HI	8	1	1	0	- Very important - Tripcheck survey indicates some people did choose different option or delayed trip because of information
AF11	Arterial/Freeway	Real-time Traffic Data Collection Using Probe Data		Automobiles are used to monitor the surrounding environment with an onboard computer. Data are sent to a Web server through pre-existing Wi-Fi networks, which help drivers track conditions specific to their cars and provides historical and real-time traffic conditions at different times of the day using combined data from all service subscriber participants.	- Reduce travel time and delay by alerting and informing drivers of congested areas - Reduce potential crashes due to congestion	$300 per GPS unit; $150 per year for operation (DASH)	Political Factors = Institutional Factors =Is the GPS vehicle data shared with the agency and at what cost? Technical Factors = Understanding new technology, capabilities and limitations; Integration with other ITS components	High	Improved Mobility		Low	MED	MED	3	2	3	2	- Data needs to be collected to make use of it - Implementation seems difficult
AF12	Arterial/Freeway	IntelliDrive (VII)		VII is a research program focused on enabling wireless communications among motor vehicles and between motor vehicles and roadside infrastructures. This involves various public and private sector entities. By enabling secure real-time communications with motor vehicles, new services will be enabled to enhance transportation safety, mobility, and commerce.	- Decrease traffic accidents and fatalities - Reduced delays - Increased effective roadway capacity	$10,000 to $15,000 per VII roadside equipment installation	Political Factors = Institutional Factors = Coordination between agencies is critical to provide uniform driver information Technical Factors = VII is under development and considerable amount of time is needed before large scale deployment is possible and communication infrastructure is mature		Improved Mobility & Safety		High	LOW	LOW	0	1	4	5	- Wait for vehicle technology - ?
AF13	Arterial/Freeway	Automated Speed Enforcement		Automated speed detection (typically in work zones) can enable automated ticketing of vehicles exceeding posted speed limits when combined with automatically triggered vehicle identification technologies such as photographs, still or video digital imaging, or license plate recognition. Some systems transmit images of offending vehicles to police officers downstream of the work zone where enforcement can be carried out more safely.	- Increased perception of safety - Reduced travel speeds	$650,000 EUROS per vehicle mounted camera (~$850,000 US) $15,000 EUROS per fixed location installation (~$20,000 US)	Political Factors = Public perception of automated enforcement Institutional Factors = Who does the operations and maintenance? How are costs and profits distributed? Technical Factors =		Improved Safety		Medium-High	MED	LOW-MED	3	3	2	2	- Not allowed by ???? county
AF14	Arterial/Freeway	Traffic Surveillance		Many of the services possible through arterial and freeway management systems are enabled by traffic surveillance and detection technologies, such as sensors or cameras, monitoring traffic flow.	- Improved incident response times and accuracy - Real-time and historic system operations information - Improved visual information for decision-makers and the public	$15,000 - $30,000 per CCTV detection unit, $1 - 2 million for central system integration and firmware upgrade if run through a TMC	Political Factors = Public perception of "big brother" surveillance and invasion of privacy Institutional Factors = Sharing communication infrastructure and broadcasts across agencies. Technical Factors = Integrating with other TSMO or ITS components		Improved Mobility	50%	Low	HI	HI	6	1	1	2	- CCTV's
AF15	Arterial/Freeway	Emergency Management		ITS applications in emergency management include hazardous materials management, the deployment of emergency medical services, and large and small-scale emergency response and evacuation operations.	- Reduced incident response time - Improved HAZMAT and counterterrorism technology - Improved travel time and less congestion under evacuation scenarios (reversible lanes)	Cost varies depending on the scale and scope of the emergency mangement system; cost of an emergency operation center may range from $150K to $5 million; Hazmat transportation operation technology may range from $250 to $3,500 per vehicle. GPS AVL on emergency vehicles costs $4,000 per intersection and $2,000 per vehicle.	Political Factors = Viewed as proactive protection of public safety Institutional Factors = Coordination between agencies is critical to success Technical Factors = Integration of multiple ITS components may aid in project effectiveness		Improved Safety	40%	Varies depending on system complexity	HI	VARIES	7	0	0	3	- Very important
F16	Freeway	Incident Management		Incident management systems can reduce the effects of incident-related congestion by decreasing the time to detect incidents, the time for responding vehicles to arrive, and the time required for traffic to return to normal conditions. Incident management systems make use of a variety of surveillance technologies as well as enhanced communications and other technologies that facilitate coordinated response to incidents.	- Reduced average incident duration by 28% to 70% - Decreased secondary crashes by up to 28% to 70% - Reduced delay due to quicker incident response	$15,000 - $30,000 per CCTV detection unit, $400 per loop detector; $55 per vehicle hour for patroling vehicle; $8,000 - $13,000 per unit of mobile incident investigation equipment	Political Factors = Prioritizing incident response/system management over system expansion Institutional Factors = Various agencies and first responders need to be coordinated, inter-agency communication is the key; systems may provide flexibility for future installation and coordination by neighboring jurisdictions Technical Factors = A sound communication system with wide coverage is crucial; interoperability issue among different agencies	Medium	Improved Mobility & Safety	30%	Low	HI	HI	8	0	0	2	- Work with ODOT on detours
F17	Freeway	Work Zone Management		ITS applications in work zones include the temporary implementation of traffic management or incident management capabilities. These temporary systems can be stand-alone implementations or they may supplement existing systems in the area during construction. Other applications for managing work zones include measures to control vehicle speeds and notify travelers of changes in lane configurations or travel times and delays through the work zones. ITS may also be used to manage traffic along detour routes during full road closures to facilitate rapid and safe reconstruction projects.	- Reduced traveling speed across work zone by 9mph in a Minneapolis/St. Paul study - Improved safety with reduced travel speed - Reduced delay by 46% to 55% and travel time	$150 - 800k for a work zone management system, which commonly includes variable message signs ($50k-120k capital, $2.5k-6k operations and maintenance), CCTV-surveillence ($7k-19k capital, $1.0k-2.5k operations and maintenance), Highway Advisory Radio ($16-32k capital, $500-1,000 operations and maintenance), traffic detectors ($3-13k capital, $100-1,000 operations and maintenance) and variable speed limit display ($3-5k capital), etc. Costs are dependant on agency leasing or purchasing, and portable versus permanent components.	Political Factors = Prioritizing safety over system capacity expansion projects Institutional Factors = Technical Factors = Coordination with other ITS components	High	Improved Mobility & Safety	20%	Low (if little added infrastructure), High (if added infrastructure)	HI/LOW	MED	4	1	3	2	- Large projects need to integrate TDM for travelers before breaking ground

F18	Freeway	High Occupancy Vehicle (HOV) and High Occupancy Toll (HOT) Managed Lanes		HOV lanes carry vehicles with a higher number of occupants, which serve to increase the total number of people moved through a congested corridor. In general, carpoolers, vanpoolers, and bus patrons are the primary beneficiaries of HOV lanes by allowing them to move through congestion. HOT lanes allow single occupancy vehicles use the HOV lanes for a toll.	- Improved people throughput by allowing a higher flow for HOV - Incentive for carpooling/vanpooling/transit - Can remove vehicles from roadway, reducing emissions	$100,000 to $3 million per mile capital costs, depending on need to reconstruct lanes or not. Low operations and maintenance costs, generally.	Political Factors = High public perception, involves public policy decision for prioritizing people movement over individual vehicle movement. Institutional Factors = If congestion spans agencies, they should work together to implement consistent TSMO strategies to realize full benefits. Technical Factors = May increase congestion for general purpose lane	Medium/High	Improved Mobility	20%	Low (if restriping/signing), High (if new construction)	MED	MED	3	2	4	1	- Need policy for when will be the tipping point for this
F19	Freeway	Reversible Lanes		Traffic sensors and lane control signs can be used to implement reversible flow lanes allowing travel in the peak direction during rush hours or for special events/emergencies.	- Reduced crash rates due to decreased congestion - Improve travel time and delay in peak directions - More efficient use of existing roadway pavement/capacity	$2,000 - $3,000 per lane control display; $300K - $450K per lane control system including software, integration and other hardware costs	Political Factors = May create confusion for infrequent drivers Institutional Factors = Education for the public on what they are expected to do during contra-flow situations is necessary Technical Factors = New technology in US		Reduced Congestion		Medium-High	LOW	LOW	1	1	5	3	
F20	Freeway	Lane Controls / Temporary Shoulder Use		Lane control signs, supported by surveillance and detection technologies, allow the temporary closure of lanes to avoid incidents on freeways, or use of shoulders as a travel lane to increase capacity.	- Reduced crash rates - Improve travel time and delay in peak directions - More efficient use of existing roadway pavement/capacity	$2,000 - $3,000 per lane control display; $300K - $450K per lane control system including software, integration and other hardware costs	Political Factors = May create confusion for infrequent drivers Institutional Factors = Education for the public on managed lane signage and operations Technical Factors = New technology in US		Reduced Congestion		Medium-High	LOW	LOW	1	1	4	4	- Needs more research
F21	Freeway	New Toll Roads / Congestion Pricing		Congestion pricing is a way of harnessing the power of the market to reduce the waste associated with traffic congestion. Congestion pricing works by shifting purely discretionary rush hour highway travel to other transportation modes or to off-peak periods, taking advantage of the fact that the majority of rush hour drivers on a typical urban highway are not commuters.	- Provided high level of service to users, with 20% decrease in traffic for the London case - Divert traffic to another mode or to travel at different times of the day	~$250,000 per mile for conversion of HOV to HOT lanes; $2 - 4 million per lane per mile for new construction of HOT lanes $2 million for conversion of HOV to HOT lanes; $85 to $177 million for new construction of HOT lanes	Political Factors = Can be publicly controversial, tough to establish toll facilities if the concept is new to a region or not widely practiced Institutional Factors = Technical Factors = Effects of different tolling methods vary, benefits versus costs need to be carefully considered	Medium	Improved Mobility	10%	High	MED	LOW	3	3	2	2	- Great TSMO/TDM strategy
F22	Freeway	Electronic Toll Collection		Electronic toll collection (ETC) supports the collection of payment at toll plazas using automated systems to increase the operational efficiency and convenience of toll collection. Systems typically consist of vehicle-mounted transponders identified by readers located in dedicated and/or mixed-use lanes at toll plazas	- Reduced traffic volume by up to 17% - Reduced delay by 50% to 85% - Reduced vehicle emissions by 16% to 63% - Cost saving for electronic toll lane over staffed lane (ETC only requires one maintenance person and account support)	~$1 million hardware cost for a 7-lane toll plaza; $16,000 per year to operate an electronic toll collection lane; $0.05-0.10 cost per ETC transaction; $15-$50 cost for each transponder	Political Factors = Privacy concern on vehicle and personal information with the use of tolling technologies Institutional Factors = Interoperability issues at the transponder level with neighboring toll facilities Technical Factors = Plan for changes in tolling technologies so that interoperability can be attained easily in the future	High	Reduced Congestion		High	MED	LOW	2	2	2	4	- Along with new project
F23	Freeway	Road Weather Information Systems		Surveillance, monitoring, and prediction of weather and roadway conditions enable the appropriate management actions to mitigate the impacts of any adverse conditions.	- Improved safety by reducing 3 to 17% of crashes - Reduced vehicle speed by 2 to 5mph during adverse weather - Improved information for agency decision-makers and travelers	Cost varies which can range from $20,000 for a sensor unit to over $3 million for a weather management system. Weather station ($20-50k capital, $1.5-4k operations and maintenance), CCTV-surveillance ($7k-19k capital, $1.0k-2.5k operations and maintenance), Highway Advisory Radio ($16-32k capital, $500-1,000 operations and maintenance), variable message signs ($50k-120k capital, $2.5k-6k operations and maintenance), and variable speed limit display ($3-5k capital).	Political Factors = Prioritizing safety over expanded system capacity Institutional Factors = Interagency cooperation provides greatest benefit to traveling public Technical Factors = Integration of various ITS components	High	Improved Safety	20%	Low-Medium	HI/LOW	MED	3	0	5	2	- Network & weather stations - good for maintenance too - Seems mainly abide urban area
F24	Freeway	Bottleneck Removal		Bottleneck removal in freeway can be achieved by various geometric or operational strategies after identifying the bottleneck locations and detecting the causes.	- Decreased injury crash rate by 35% on average - Reduced delay	Cost varies, can range from a few thousand dollars to tens of millions	Political Factors = Institutional Factors = Technical Factors = Sufficient and accurate data collection is important for bottleneck analysis and the subsequent mitigation	High	Reduced Congestion	10%	Medium-High	HI	MED	8	1	0	1	
F25	Freeway	Ramp Closures		Surveillance and control technologies can allow for the temporary closure of freeway ramps to accommodate peak traffic conditions or inclement weather conditions.	- Reduced crash rates - Increased mobility on mainline		Political Factors = Limits access to roadways, which can lead to public frustration. Institutional Factors = Can move congestion onto surface street system Technical Factors = Should be integrated with other ITS components (traffic management center, weather management system, etc)	Medium	Improved Mobility & Safety		Low	MED	MED	1	2	3	4	- Impact to arterial streets and tradeoff with freeway operations
F26	Freeway	Ramp Metering		Traffic signals on freeway ramp meters alternate between red and green signals to control the flow of vehicles entering the freeway. Metering rates can be altered based on freeway traffic conditions.	- Reduced mainline peak period delay - Increased freeway speed by 8% to 26% - Improved freeway capacity by 10% (Minneapolis study) - Reduced duration of congestion - Reduced vehicle conflicts by 24% to 50%	$25,000 - $66,000 per site; $6,500 for detection components per site; $1,000-$3,000 per site for annual operation and maintenance	Political Factors = Public perception and potential resistance Institutional Factors = Agency coordination on operations to ensure ramp queues don't impact surface street operations. Technical Factors = Ensure infrastructure and timing plans allow green time to meet demand. Avoid queue spillback to adjacent intersections.	High	Reduced Congestion	20%	Low-Medium	HI	HI	5	1	1	3	
F27	Freeway	HOV Ramp Bypass		Priority access to highway is given to HOVs. Access options include allowing HOVs to bypass ramp meters, providing a dedicated flyover ramp for HOVs, etc.	- Reduced passenger travel time by 2% to 15% - Incentive for carpooling/vanpooling/transit - Can remove vehicles from roadway, reducing emissions by 2% to 13%	$100,000 to $3 million per mile capital costs, depending on need to reconstruct lanes or not. Low operations and maintenance costs, generally.	Political Factors = High public perception, involves public policy decision for prioritizing people movement over individual vehicle movement. Institutional Factors = Agencies should work together to develop a ramp metering system and timing plan to avoid queue spillback to upstream intersections. Technical Factors =	Medium	Improved Mobility	10%	Low (if restriping/signing), High (if new construction)	LOW	LOW	1	1	4	4	- Not without highway system
F28	Freeway	Transportation Management Center		The purpose of a Transportation Management Center is to integrate various departments and offices of transportation and emergency agencies into a unified communications center. The integration provides the communications and computer infrastructure necessary for coordinated transportation management on roadways during normal commuting periods, as well as during special events and major incidents.	- More efficient coordination and operation of various transportation systems - Better data collection for decision-making and future planning purposes - Co-locate and collaborate with traffic, transit, fire, emergency, police, etc.	$1.8 million - 10 million for TMC capital cost; $400K - $2 million for annual O&M	Political Factors = Expenses may be huge depending on the scope of the TMC Institutional Factors = Communication and interoperability issues may exist among agencies. Changing agency culture to operate differently. Potential collaboration with transportation, emergency, police, fire, etc. Technical Factors = TMC's can be very simple or complex. Understanding technology is key to maximizing benefits.	High	Improved Mobility & Safety	20%	High	HI	MED	6	1	0	3	- Under construction
F29	Freeway	Variable Speed Limits		Variable speed limit systems use sensors to monitor prevailing traffic and/or weather conditions, posting appropriate enforceable speed limits on dynamic message signs. Also known as "speed harmonization."	- Decreased mean travel speeds by up to 3mph - Reduced crash rates - Reduction of congestion	$3000 - $5000 per variable speed display sign	Political Factors = Potential need to increase law enforcement of variable speeds Institutional Factors = Cooperative or identical systems should be used across jurisdictional boundaries Technical Factors = Integration into detection/surveillence and communication systems	High	Reduced Congestion & Safety		Low-Medium	HI	HI	5	2	1	2	- Need good enforcement & new laws - Project planned
FR30	Freight	Real-Time Freight Information		Real-time information on cargo status can be provided to ocean carriers, exporters, importers, foreign freight forwarders, customs brokers, terminal operators, and rail and trucking services. It enables port users to post and receive information on the location and status of freight shipments.	- Ability to track the freight location and estimate the traffic condition for real-time freight route planning - Increased freight movement efficiency	Ranges from $500 to $2,500 per in-vehicle tracking equipment depending on the functionality	Political Factors = Prioritizing freight movement over people Institutional Factors = Technical Factors = Integration with other ITS components (i.e signal system for truck priority)		Improved Mobility		Low	MED	MED	2	1	4	3	- Depends on area - Not sure which is provided ???? within the freight industry
FR 31	Freight	Roadside Electronic Screening / Clearance Programs		Electronic screening applications promote safety and efficiency for commercial vehicle operators. Carriers that equip their fleets with low-cost in-vehicle transponders can communicate with check stations and automatically transfer regulatory data to authorities as trucks approach check stations. These and other technologies such as weight-in-motion (WIM) scales improve efficiency and reduce congestion at check stations by allowing safe and legal carriers to bypass inspections and return to the mainline without stopping.	- Reduced inspection time by 14% to 66% - Reduced freight travel time and delay - Reduced vehicle emissions	$150k to $780k per electronic screening weigh station	Political Factors = Institutional Factors = Technical Factors = Integration with other ITS components (i.e freight AVL)		Improved Mobility & Safety		Medium-High	MED	MED	2	1	1	6	- Existing?
FR32	Freight	Truck Only Lanes		Truck-only lanes are lanes designated for the use of trucks. The purpose of truck-only lanes is to separate trucks from other mixed-flow traffic to enhance safety and/or stabilize traffic flow.	- Increased highway safety - More stable traffic flow	$100,000 to $3 million per mile capital costs, depending on need to recon	Political Factors = Prioritizing freight movement over people Institutional Factors = Technical Factors = Truck only lanes are not common in the US	Medium	Improved Mobility & Safety	10%	Low (if restriping/signing), High (if new construction)	MED	MED	2	0	3	5	
FR 33	Freight	Truck Signal Priority		Truck signal priority is used to improve the operation of heavy trucks passing through traffic signal controlled intersections on rural high-speed highways, by adding vehicle detectors that would respond only to trucks.	- Reduced number of truck stops, which is estimated to cost $3 per truck per stop	$30,000 per inductive loop truck detector; $5,000 per intersection for data collection and retiming effort	Political Factors = Institutional Factors = Technical Factors = Adjusts the traffic actuated signal systems which can decrease the presence of vehicles in the dilemma zone, potentially resulting in a safety issue		Improved Mobility	10%	Low	HI/LOW	MED-HI	4	1	3	2	- Good for safety - With demonstrated benefit
FR 34	Freight	Vehicle Tracking (AVL)		Automated vehicle location, together with computer aided dispatch systems, can assist carriers with scheduling and tracking of vehicle loads.	- Increased fleet productivity by 5% to 25% - Improved HAZMAT safety and security by reducing potential terrorist consequences by approximately 36%	Ranges from $500 to $2,500 per in-vehicle tracking equipment depending on the functionality	Political Factors = Institutional Factors = Technical Factors = Integration with other ITS components (i.e signal system for truck priority)		Improved Mobility	10%	Low	MED	MED	2	0	3	5	
T35	Transit	Park and Ride Lots		Park and ride facilities are public transport stations that allow commuters and other people wishing to travel into city centers to leave their personal vehicles in a car park and transfer to a bus, rail system or carpool for the rest of their trip.	- Eased congestion and parking demand in city center	Grade-Level Surface Parking - $5,000 per stall Freestanding Parking Garage Above-Grade - $18,000 per stall Below-Grade - $40,000 per stall	Political Factors = Institutional Factors = Technical Factors =		Reduced Congestion	50%	Medium-High	MED	LOW-MED	3	3	2	2	- So we may need bike facilities
T36	Transit	Real-Time Transit Information		Transit agencies can disseminate both schedule and system performance information to travelers through a variety of applications, in-vehicle, wayside, or in-terminal dynamic messages signs, as well as the internet or wireless devices. Coordination with regional or multimodal traveler information efforts can also increase the availability of this transit schedule and system performance information.	- Enhanced passenger convenience - Increased attractiveness of transit	$1 - 4 million for a real-time transit information system $7,000 per "next stop" annunciator	Political Factors = Objection from union on adopting ITS due to the increased probability of layoff Institutional Factors = Cooperation and integration between agencies and their ITS systems is beneficial Technical Factors = GPS location refreshing rate is critical for real-time transit information but limited by communication bandwidth; lack of IT expertise in transit agency to implement ITS due to the lack of understanding of IT in transit; system will get outdated quickly as new technologies come out fast (i.e. putting up message board at transit stop may not be worthwhile if everyone can use their cell phone to check the transit arrival time)		Improved Mobility	20%	Medium-High	HI	MED	5	0	2	3	- Need smaller transit systems to join info platform with TriMet
T37	Transit	Transit Signal Priority		Transit signal priority systems use sensors to detect approaching transit vehicles and alter signal timings to improve transit performance. For example, some systems extend the duration of green signals for public transportation vehicles when necessary.	- Improved Overall Travel Time by 2% to 42%/Reduced Delay up to 48% - Improved Travel Time Reliability/Less Variability - Fleet reduction - Reduced system operational costs (number of buses and fuel costs)	$5k to $35k per intersection; $2k to $14k per bus	Political Factors = Willingness to prioritize transit over other modes Institutional Factors = Signal system capabilities across agencies Technical Factors = Infrastructure to support TSP (i.e. controllers); lack of IT expertise in transit agency to implement ITS due to the lack of understanding of IT in transit; system will get outdated quickly as new technologies come out fast; Transit preferential treatments in place always, or by time of day, number of riders, and schedule adherence.		Improved Mobility	30%	Low	HI	MED	5	2	2	1	- ???? ITS use - Make surface transit more competitive with private vehicle travel time
T38	Transit	Transit Only Lanes/Queue Jumps		Transit-only lanes are lanes designated for the use of transit vehicles only. The purpose of transit-only lanes and transit queue jumps are to provide preferential treatments to give transit an advantage over other roadway modes.	- Reduced transit delay - Improved transit travel times - Increased transit ridership	$75,000 to $125,000 per approach for queue jump/bus bypass (not including right-of-way costs) $100,000 to $3 million per mile capital costs, depending on need to reconstruct lanes or not. Low operations and maintenance costs, generally.	Political Factors = Willingness to prioritize transit over other modes Institutional Factors = Signal system capabilities Technical Factors = Infrastructure to support transit preferential treatments (controllers, interconnect, etc); Transit preferential treatments in place always, or by time of day, number of riders, and schedule adherence.		Improved Mobility	20%	Low (if restriping/signing), High (if new construction)	MED	LOW-MED	2	1	3	3	- Make surface transit more competitive with private vehicle travel time
T39	Transit	Vehicle Tracking (AVL)		Automatic vehicle location (AVL), together with computer aided dispatch (CAD) systems, facilitates the management of transit operations, providing up-to-date information on vehicle locations to assist transit dispatchers as well as inform travelers of bus status.	- Enhanced passenger convenience - Better on-time performance, early and late arrivals were decreased by 12 and 21% respectively in a Denver study, performance increased from 80% to 90% in Kansas City - Lower operation and maintenance cost due to smaller fleet size needed, without degradation in customer service	$3,000 - $6,000 per GPS equipment installation; $60,000 - $70 million depending on the size of fleets	Political Factors = Objection from union on adopting ITS due to the increased probability of layoff Institutional Factors = Multiple AVL systems may have to be installed for various transit ITS strategies due to limitations from system vendors Technical Factors = System compatibility and future upgrade potential; lack of IT expertise in transit agency to implement ITS due to the lack of understanding of IT in transit; system will get outdated quickly as new technologies come out fast		Improved Mobility	10%	Low	MED	MED	2	2	2	4	- Provides more reliable schedules which benefits riders

Travel Options Strategies

TO40	Travel Options	Mass Communication		Mass Communication uses media, advertising and marketing campaigns to increase public awareness of the benefits and availability of transportation options, and to connect people with transportation services.	• Decrease in drive-alone trips in favor of transportation options • Increase in awareness of regional transportation options and the need to use efficient options • Increase in brand identity that connects the public with the transportation system and services • Ability to introduced new transportation infrastructure to a broad audience of potential users	• $500,000 per year builds awareness to approximately one-third of residents and is necessary to maintain and increase that awareness several percentage points per year	Political Factors • Different stakeholder interests should be considered Institutional Factors • Multi-agency partnerships are required to advance and reinforce campaign messages and strategies		Improved Mobility									
TO41	Travel Options	Individualized Marketing		Reaching individuals with personalized information and assistance by neighborhood or target audience.	• Projects in inner Portland yield an 8 percent to 12 percent reduction in drive-alone trips • Ability to introduced new transportation infrastructure to a targeted audience of potential users	• Costs are scalable at $15 to $20 per household; however, projects are typically $500,000 to reach 25,000 or more households	Political Factors • Positive results: the City of Portland and TravelSmart in Victoria Australia have noted public support for transportation in neighborhoods that receive individualized marketing Institutional Factors • Partnerships should be formed in order to deliver the best assistance to individuals Technical Factors • Staff resources must be allocated in a planned fashion so that orders are filled soon after individuals request assistance		Improved Mobility & Safety									
TO42	Travel Options	Traveler Information Marketing Campaigns		Not only marketing the information services available but also building familiarity for checking information sources before embarking on a trip.	• Improve travel times by giving drivers tools for timing their trips	• Cost will depend on how this information is delivered (one-on-one communication or advertisements)	Political Factors • Brand identity is often associated with specific agencies which may not see the value of consolidating into one brand, such as 511 Institutional Factors • Marketing of traveler information tools should link to other travel options marketing efforts Technical Factors • Tools currently available are likely programmed in different web programming languages		Reduced Congestion & Improved Mobility									
TO43	Travel Options	Route Planning Tools (software)		Develop a regional multi-modal trip-planning tool.	• Introduce more people to travel options for all trips • Compare time and cost between modes to encourage efficient travel choices	• TriMet's project will total around $130,000. This includes development of the tool but takes advantage of existing data and web server capacity to operate	Political Factors • Different stakeholder interests should be considered Institutional Factors • Marketing can help build familiarity with route planning tools Technical Factors • Regularly updating data • Maintaining server capable of meeting usage rates of the tools, especially during peak demand (for example, during a weather event)		Improved Mobility & Safety									
TO44	Travel Options	Employer Program		Support employers and commuters to increase the use of travel options for commute trips.	• Employers are assisted in implementing an auto-trip reduction plan tailored to their work site location and employees. Benefits are directly related to commute incentives implemented by employer (see below)	• TriMet Employer Outreach has resulted in cost-per-vehicle-mile-reduced annually of $0.01. • The RTO program uses a reference point of $0.05/VMR annually in order to make investments that will reach Strategic Plan goals	Political Factors • None, many employers appreciate receiving help from the Employer Program Institutional Factors • Large employers (more than 100 employees) are affected by the DEQ Employee Commute Options (ECO) Rules and are therefore compelled to seek support to reduce auto trips • Many partnerships are already in place Technical Factors • RTO staff is implementing a coordination plan which will improve efficiency of delivering employer outreach services. The coordination plan has prioritized a customer relationship management (CRM) online database application		Improved Mobility & Safety									
TO45	Travel Options	Commuter Incentives		Incentives to reduce single-person vehicle trips made by commuters by offering them time or cost savings; and, rewards.	• Transit subsidies are currently offered by 881 employment sites. Transit ridership goes up and drive-alone commutes go down at these sites • In addition to financial incentives, a 2006 Portland State University (PSU) study found that non-financial incentives (for example, flex-time, emergency ride home, etc.) resulted in significantly higher use of non-drive alone travel options	• Costs are generally paid for by private entities (employers and prize donations to commute challenges)	Institutional Factors • Large employers (more than 100 employees) offer incentives to demonstrate their effort to reduce auto trips in order to comply with the DEQ ECO Rules • TriMet has over 10 years of an established program with a variety of options for employers to subsidize transit Technical Factors • Administrative time is needed to process contracts and fulfill incentives		Improved Mobility									
TO46	Travel Options	Rideshare Services		Rideshare services involve online carpool matching, assistance to employers to match their employees and vanpools. Vanpools that meet program criteria, such as travelling at least 20 miles round-trip, are given a partial subsidy as an incentive.	• Carpools and vanpools reduce miles traveled for people who would otherwise choose to drive • Carpools and vanpools create a mobility option for people who do not drive and cannot take transit • Vanpools take cars off the region's freeway system during peak hours	• Costs for the maintenance of an online carpool matching system are approximately $30,000 per year • Metro VanPool's cost per van is approximately $500 monthly	Political Factors • Not all of Oregon is using the same online-ridematching tool • Questions are addressed in a coordinated way about who pays for vanpools originating in Washington State and Salem • Employers are not strictly exempted in Oregon from liability if a vanpool crashed Institutional Factors • There are only 3.4 miles of carpool lane in Oregon which means the incentive to save time is low • Metro currently leases vans; however, Washington State's model of owning a vanpool fleet shows lower operational costs once the capital investment has been made Technical Factors • The current online carpool matching software was quickly outdated. Metro will transition to using new software purchased by Washington State		Improved Mobility									
TO47	Travel Options	Telecommuting		An employee works from home or a satellite office space on a regular basis. Of course, this type of strategy does not work for all types of employment such as manufacturing.	• Likely to remove auto trips directly from peak commute times • Infrastructure is critical during catastrophic events to restore commerce	• Less than 1 FTE typically provides employer outreach specializing in telecommuting	Political Factors • Benefit to having infrastructure in place to rebound from catastrophic events. Can be linked to emergency management plans Institutional Factors • Some employers will not allow telecommuting for a variety of reasons Technical Factors • While high-speed internet is useful, telecommuting can be arranged simply by correspondence over the phone		Reduced Congestion									
TO48	Travel Options	Urban Centers, Corridor and Industrial Area Investments		Reduce barriers to non-auto travel by coordinating development of end-of-trip facilities, parking, carsharing locations and other strategies that complete urban centers, corridors and industrial areas. This strategy often involves public-private partnerships such as Transportation Management Associations. These organizations address needs relevant to their location.	• Local presence in centers, corridors and industrial areas • Leveraged local investment	• $15,000 to $50,500 per TMA annually, depending on meeting performance measures	Political Factors • City jurisdictions must be a partner of public-private partnerships like TMAs • TMA policy is set by Metro Council resolutions Institutional Factors • For-profit carsharing companies will not risk locating beyond their market without a revenue guarantee Technical Factors • Employer Program coordination is required to assure performance measures are met and to avoid overlapping efforts		Improved Mobility & Safety									
TO49	Travel Options	Bicycle Signal Heads		Bicycle signal heads are traffic signal displays devoted to improving flow of cyclists at intersections. They may offer movements for cyclists that wouldn't otherwise be possible at the intersection. Also referred to as scramble phases.	- Reduced travel time by 10% to 20% - Increased use of cycling for all trips - Further propel the Portland-metropolitan region as the most Bicycle Friendly Community	• Approximately $25,000 per bicycle signal head and mounting; $1,500 per loop detector to detect bicycles	Political Factors • Bicycle signal heads have not been approved by the Federal Highway Administration • Auto traffic congestion caused by exclusive phase, resulting in complaints Institutional Factors • Concern about implementation due to lack of FHWA approval Technical Factors • Potential for unfamiliar drivers to be confused by bicycle signal • Increased cycle length will increase average delay for all other modes		Improved Safety									
TO50	Travel Options	Bicycle Enhancements		A wide range of engineering techniques to improve bicycle conditions; this may include concepts like the green wave (signal timing for cyclist speeds), bicycle count locations where feedback to the users encouraged additional activity, and wayfinding systems.	- Reduced stops for cyclists - Provide positive reinforcement for cyclists - Innovative technique not used in the U.S.	• For implementation of green wave: o $20 to $25 per foot for copper wire signal interconnect; $5,000 per intersection for wireless interconnect (availability depends on agencies and signal locations) o $3,000 to $5,000 per intersection for signal retiming o $1,000 to $4,000 for controller plus software replacement/upgrades (if necessary)	Political Factors • Potential to increase complaints from drivers about traffic signal timing and maintenance • Reduced air quality due to increased idling at traffic signals (not in all cases) • Auto traffic congestion resulting in complaints Institutional Factors • Cycle lengths may need to be revised, which requires comprehensive evaluation of a corridor Technical Factors • Increased maintenance costs due to braking caused by heavy vehicles		Improved Bicycle Mobility & Safety									