ATLANTA REGIONAL MANAGED LANE SYSTEM PLAN

ADVANTAGES AND DISADVANTAGES OF REVERSIBLE MANAGED LANES SYSTEMS

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ADVANTAGES AND DISADVANTAGES OF REVERSIBLE MANAGED LANES SYSTEMS WHITE PAPER

Introduction

Reversible lanes operate on the premise that there is a large directional split between flows during peak periods of the day, with rushes into activity centers in the morning and outward in the afternoon. Reversible lanes add additional capacity to the peak flow lanes, which helps to ease congestion and optimize passenger mobility. Moreover, reversible lanes help to reduce some of the negative externalities associated with potentially extensive widening of highway facilities required in bi-directional facilities. These benefits are enhanced further when combined with managed lane facilities, including HOV and congestion pricing techniques. The benefits, however, juxtapose with a series of drawbacks, including operational difficulties and safety concerns. A thorough analysis of existing and future conditions in addition to investment goals should be conducted when deciding between reversible or bi-directional managed lanes facilities.

The purpose of this white paper is to explore the advantages and disadvantages associated with utilization of reversible managed lanes systems. A number of factors contribute to the selection of a reversible flow system including operational issues, cost, safety, user transferability between systems and environmental and social considerations. Table 1 summarizes the results in a matrix.

Operational Issues

Reversible flow lanes pose a unique set of operational challenges and opportunities. These lanes work well at isolating managed facility users from the general purpose lanes, due to the use of barriers between the two systems. This separation allows for improved operational performance, discussed in a separate white paper entitled *Advantages and Disadvantages of Barrier Separated Managed Lanes*. Some of these advantages include enhanced safety, decreased turbidity in adjacent flows, greater efficiency in toll collection for priced facilities and improved public perception of the system's efficiency.

A 2006 analysis of the NCHRP's "Synthesis 340" found that reversible flow facilities are most suited for limited access pass-through travel, such as moving vehicles from further suburban areas into central business districts or activity centers. This type of flow reduces the access points, increasing the capacity for flow and decreasing the likelihood of any confusion. Consequently, reversible systems are not as well utilized for shorter distance highway trips within activity centers or from closer suburban areas to nearby business or shopping districts.

Reversible flow lanes require set hours of operation in each direction. In regions with multiple highway facilities, it can often be difficult to establish set hours of operation to maximize managed lane utilization by direction. Moreover, many regions have radial facilities that see inconsistent directional splits at all hours of the day. Establishing standardized operational hours by direction can potentially pose a problem for regions with this arrangement of transportation infrastructure.

A disadvantage of reversible flow lanes involves general lack of public awareness. There are less than one hundred reversible facilities in operation across the United States. Of these facilities, only a handful can be found on highways, with the vast majority functioning as reversible lanes on surface streets.

Operationally, reversible facilities require additional inputs of signage and safety features to ensure automobiles can easily and safely access the facility during off hours. Additional operational measures must be put in place to ensure traffic is routed into and out of the facility at set times to ensure maximized flow and standardized periods of operation. Raising public awareness to their operation and safety features should be a prime component of any reversible facility implementation plan.

Reversible flow lanes require additional study to determine the amount of time required to clear out the lanes prior to switching directions compared to bi-directional systems, which flow continuously in both directions. Clearance and resetting times vary by corridor length, speed limit and congestion. Efficient planning is necessary to determine system-wide clearance times in multi-facility and radial reversible managed lanes systems to ensure a safe transition for flow from one direction to the other.

Cost

By maximizing the utility of the managed lanes, reversible facilities are able to serve the peak demand while keeping costs at a minimum. While bi-directional facilities may serve off-peak demand in both directions, these facilities require an investment in both directions. Reversible facilities are less expensive than bi-directional facilities primarily due to the construction of one facility in the place of two separate unidirectional facilities.

In situations where the median is undeveloped, no additional right-of-way may be required to develop either a reversible or bi-directional lane facility. However, since reversible facilities more efficiently service peak demand with limited space, they require the construction of fewer lanes than bi-directional facilities. As a result, it is more likely that the existing median space will meet the requirements for the construction of the reversible facility. In situations where existing highway flow already utilizes the median, additional right of way must be purchased to build either system configuration. In this scenario, more land is still required to develop bi-directional facilities than reversible facilities increasing the overall cost of the project.

Safety

Reversible facilities require additional safety precautions when compared to their bi-directional counterparts. A signage system should be clearly established to inform travelers of the hours of operation for reversible facilities in their direction of travel. Highly visible gates should be developed and installed to prevent flow from the off-peak direction into the reversible managed facility during periods of opposite flow. Additionally, a public education campaign should be mounted to inform travelers well ahead of completion about the new facility, its operational hours, signage and protocols. The adopted measures should be simple enough, however, that non-local motorists can still efficiently and safely adapt to the system.

The safety and signage system should be developed in a manner that encourages its utilization while minimizing the probability of incidents relating to the facility's operation. Overall, a reversible facility requires more safety measures than separate bi-directional facilities. However, these additional measures do not make reversible facilities less safe than bi-directional lanes.

Furthermore, reversible facilities require additional safety measures and signage to direct flow through corridor interchanges. Multi-highway reversible flow managed lanes systems need to provide continuity between the highway segments to allow for maximized flow and safety between routes. Synchronization between the different corridor's hours of operation, safety protocols, facility sizes and features will ensure minimal traveler confusion and decrease the risk of accidents. Bi-directional facilities, on the other hand, generally do not require additional coordination due to continuous hours of operation and directed flow, which allows access from only one direction of the highway.

Transferability

System-to-system interchange connectivity can affect the mobility of travelers along a reversible managed lane facility. Additionally, flow into radial systems may meet highway conditions with different predominate directional splits. In these situations, it may be necessary to divert travelers to the general purpose lanes, potentially enhancing bottleneck conditions as multiple managed facilities may converge onto existing general purpose lanes and negating some of the economic benefits of a priced system.

Because of connectivity issues, reversible managed lanes systems may lose some degree of utility when implemented across a network of facilities with directional splits that are not favorable for ease of transferability. In these situations, bi-directional managed lanes systems may be more beneficial to congestion mitigation, despite the associated enhanced costs and right-of-way required. Hybrid network systems that utilize a combination of reversible and bi-directional managed lanes, where appropriate, can help to alleviate some of the transferability concerns associated with system-to-system interchanges.

Environmental and Social Impacts

The implementation of reversible or bi-directional managed lanes systems can affect air quality, climate change, sensitive lands, and has ramifications for social equity throughout a region. Decreased congestion and improved peak hour travel speeds help to mitigate pollutants admitted by automobiles. As a result, reversible facilities maximize their benefit where directional splits remain quite high. In locations where the directional split is closer to 50 percent, a reversible system will not take full advantage of the potential air quality benefits of a managed lanes system. While improvements will occur, bi-directional facilities will maximize flow and therefore have the greatest impact on air quality and carbon dioxide emissions.

Reversible facilities can help preserve potentially environmentally sensitive lands compared to bi-directional facilities. By requiring less right-of-way, reversible facilities leave more undisturbed land on the shoulders of the roadway. This preserved land has the potential to continue serving important ecological functions, including stormwater runoff mitigation, drinking water infiltration, greenspace, wildlife habitat, *etc*.

In more highly urbanized areas, where the right-of-way is already urbanized, reversible managed lanes can benefit the social welfare of communities adjacent to the highway facility. The reduction of right-of-way requirements reduces the need to condemn and demolish structures and reduces the encroachment of the highway into residential land uses. As a result, the areas affected by unsafe or nuisance sound levels can be reduced when compared to bi-directional managed lanes facilities without compromising overall functionality of the corridor. Reducing the negative impacts on communities adjacent to proposed corridors can help to build support for the facility and the benefits it brings all members of society.

Table 1: Matrix of Advantages and Disadvantages of Reversible Managed Lanes Facilities

	Operational Issues		Cost		Safety	
	Advantages	Disadvantages	Advantages	Disadvantages	Advantages	Disadvantages
Reversible	▪ Efficient for moving vehicles longer distances ▪ Isolation from GP lanes improves flow ▪ Maximizes V/C ratio utility by putting lanes in the direction of greatest flow	▪ Not well known to drivers ▪ Complex operations ▪ Requires studies to determine optimal hours of operation ▪ Some proportion of demand will not be served ▪ Less suited to short trips	▪ Potentially Less expensive than bi-directional facility ▪ May require less right-of-way ▪ May require less overpass, bridge and interchange construction	▪ Trade-off between cost and total access	▪ Requires a barrier separated system which reduces risks due to traffic speed turbidity	▪ Requires additional signage and gates to prevent access to vehicles during off hours ▪ Requires more enforcement ▪ Requires extra development to ensure safety at system-to-system interchanges
Bi-Directional	▪ Can allow for buffer or alternative lane separation configurations ▪ Can be operational 24 hours per day ▪ Can be designed for short or long trips	▪ Provides more facility than demand requires in most off-peak hours	▪ Trade-off between cost and total access	▪ More expensive than reversible facility ▪ More overpass, bridge and interchange construction often required ▪ Requires more right-of-way	▪ Never utilizes the same corridor for flow in opposite directions	▪ Does not require barrier systems which can reduce the risk of collision due to traffic speed turbidity

	Transferability		**Environmental**		**Social**	
	Advantages	Disadvantages	Advantages	Disadvantages	Advantages	Disadvantages
Reversible	▪ During system-to-system transfers between facilities with similar hours of operation and flow directions, the disadvantages are negligible but the costs and operational improvements remain in place	▪ System-to-system interchanges may require additional engineering due to variations in peak hour directional flow ▪ Transference onto a radial corridor may not be possible ▪ Variations in hours of operation can complicate access	▪ May require less right-of-way ▪ May provide air quality improvements	▪ Does not maximize potential air quality benefits from both directions of traffic flow in locations with lower directional splits	▪ May require less right-of-way ▪ May have less impact on neighboring land uses ▪ Shorter construction period has less impacts on surroundings	▪ Provides access in only one direction at a time
Bi-Directional	▪ No hours of operations or one-way flows ▪ Normal routing and directional conditions ▪ Allows for continued access and transference along the managed lanes regardless of corridor shift	▪ Bi-directional system-to-system interchanges may require more system connections than reversible system interchanges	▪ Potentially maximizes air quality improvements	▪ May require more right-of-way	▪ Provides access in both directions at potentially all hours	▪ May require more right-of-way ▪ May have higher impact on neighboring land uses ▪ Longer construction period's adverse impacts on surroundings