Managed Highway Lanes in Colorado:

Everyone Benefits from Including Carpools and Public Transit

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In its ongoing effort to relieve urban traffic congestion, Colorado's Department of Transportation has shifted its traditional focus. Instead of adding new general purpose highway lanes that quickly fill with ever more single-occupancy vehicles, the state now will focus on "managed lanes" which serve carpools, toll paying vehicles, and bus riders. This paper examines the rationale behind the new policy and proposes state legislative initiatives to further define and support it. In order to achieve the greatest public benefit, managed lanes should support carpooling and the expansion of public transit.

Introduction

The Colorado Department of Transportation (CDOT) adopted a "Managed Lanes Policy Directive" in January 2013 requiring that managed lanes be strongly considered during the planning process for new capacity projects on congested highways. Colorado is well served by this policy. Managed lanes provide a long-term solution to congestion, unlike new capacity that simply fills up in a few years. Tolling is a fair and economically efficient mechanism for generating revenue for transportation, as the people who get the most benefit pay tolls to help pay for the projects. However, there are questions of equity across income ranges when public rights of way and public funds are invested in managed lanes. Survey data shows that users of tolled express lanes are largely, although not exclusively, members of high income households. However, both carpools and bus service are used by a far broader range of income levels, so managed lanes can be made much more equitable by designing them to include carpools and express bus or Bus Rapid Transit (BRT) service.

Using managed lanes to serve high occupancy vehicles and to expand bus transit gives travelers more choices and offers greater transportation benefits. Managed lanes with effective bus services

can carry many more people than those that accommodate only single-occupant vehicles, so for the same capital expenditure the state is able to move significantly more people if transit is included.

There are also broad social changes underway that make it important to focus limited transportation dollars on truly multimodal approaches. After a 50-year period during which per capita driving increased every year, per capita driving has been flat or decreasing every year since 2004. Young people (aged 16-34) drive almost 25% fewer miles today than a decade ago.[1] A much greater share of housing growth is taking place in denser, multifamily housing in urban neighborhoods that leads to more trips by walking, biking and public transit.

In response to these trends, the Fitch bond rating agency recently issued a warning:

> Public transportation investment strategies will need to transform if trends toward increased multifamily housing, declines in driving, and increasing public transportation usage continue over the long run… This week's U.S. Census Bureau data showed a shift to more multifamily development in urban areas and that public transportation usage hit an all-time high. In our view, the transportation needs of the next 50 years will be markedly different from those of the past 50 years. U.S. policymakers must begin adapting their current decisions to these future needs. If these trends persist and meaningful policy changes are not made, the risk to the public transportation system would have negative implications for the entire economy.[2]

This paper provides analysis, based largely on locally available data on the demographics of transportation use in the Denver metro area, as well as information on the existing I-25 High Occupancy Toll (HOT) lanes and the US 36 HOT lanes/BRT project currently under construction.

Policy Recommendations

Numerous agencies are involved in making decisions about transportation programming in Colorado. The following recommendations are intended for consideration by the state legislature, the Colorado Department of Transportation (CDOT), the High Performance Transportation Enterprise (HPTE), metropolitan planning organizations such as the Denver Regional Council of Governments (DRCOG), transit agencies such as the Regional Transportation District (RTD), and local governments.

1. **Require that any significant addition of new roadway capacity by CDOT be in the form of managed lanes.**

This serves the state in three important ways: 1) it allows this new capacity to function over the long term, rather than becoming congested like new free lanes; 2) it provides a revenue source to help pay for the project; and 3) it properly allocates costs to those who most directly benefit. It also provides the greatest opportunity over the long term to affect travel behavior, which is the primary means CDOT has to manage a transportation system that serves a growing population base.

2. **Require that managed lane projects allow toll-free access for carpoolers and that this policy be applied consistently throughout the system.**

   This makes the projects more equitable, allowing residents of all income levels to benefit from the highway investments. It also increases the number of people who are moved by the managed lanes by increasing the average vehicle occupancy. However, CDOT must be able to set the required occupancy levels high enough to maintain free flow in the managed lanes. On corridors like the I-70 mountain corridor, where vehicle occupancy is already quite high, the required occupancy level will need to be higher than in traditional commuter corridors.

3. **Broaden the mission of HPTE to explicitly focus on moving people, not just moving vehicles.**

   This will help to focus managed lane projects in ways that best serve the public interest, both increasing the equity across income levels and increasing the transportation benefits provided by the projects. This is consistent with CDOT's evolution towards a true multimodal transportation agency.

4. **Require that CDOT analyze the inclusion of express bus service or Bus Rapid Transit (BRT) in all managed lane projects, and include transit in any corridor where it is feasible.**

   This will help to maximize the public benefit of these projects, by providing access to a broader range of income levels, and by enabling the lanes to move more people.

5. **Require that some portion of toll revenue is invested in transit service in these corridors.**

   This will help to both make the projects more equitable across income ranges, and to implement transit service that will increase the transportation benefits of the managed lane.

6. **Seriously consider optimizing current highways by converting some existing capacity to managed lanes**

   This could provide many of the benefits of adding managed lanes while significantly reducing the

amount of public expenditure required. In addition, it avoids the negative impacts (such as air pollution, noise, water pollution, and takings of private property) of roadway widening on adjacent communities and the environment, and makes it feasible to invest more toll revenue into public transit options.

Building more free lanes won't solve our traffic problems

Historically, attempts to solve traffic problems by expanding highways have not been very successful. The fundamental problem is that expanding roads actually generates more demand for driving. Many people intuitively describe this as "if you build it, they will come", and the data suggests that they are right. When additional free highway capacity is provided, people make multiple choices that increase traffic on these lanes. Some of these choices can include switching from other routes to the new lanes, switching from off-peak to peak travel times, and switching from public transit to driving. Over the longer term, land uses often respond by providing more auto oriented development that must be served by the added capacity.

In the last 20 years, numerous academic studies have analyzed the impact of roadway expansion on total traffic levels.[3] While the studies come to somewhat different quantitative conclusions, virtually all find that a significant percentage of new roadway capacity is taken up by new traffic generated by the existence of the new capacity, and that this effect increases over time. Typically, the studies conclude that over the long term, 70-100% of the new capacity is filled by new induced demand.

Photo by Andy Cross, Denver Post file photo

While roadway widening may reduce congestion temporarily, it rarely offers a long-term solution. We can already see this in the Denver metro area on I-25. Despite the large-scale "T-Rex" expansion completed in November of 2006, I-25 is again suffering from significant congestion. According to the DRCOG 2012 Report on Congestion, I-25 in the heart of the T-Rex expansion experienced four hours per day of severe weekday congestion in 2011. Clearly, the road expansion did not provide a long term solution to congestion in this corridor.[4]

Tolled managed lanes offer greater benefits than general purpose lanes

Tolled lanes are often presented as an unfortunate necessity that is imposed upon drivers because of a lack of state and federal transportation funds. But there are actually multiple public benefits that can come from charging a user fee for roads. User-fee systems can help roads perform better by:

- reducing congestion;
- reducing the need for infrastructure investments;
- increasing transit ridership; and
- reducing emissions.[5]

Consider a congested freeway. When the lanes are free flowing, some can carry up to two thousand vehicles an hour. When a lane gets overloaded, it switches to stop and go traffic, and the capacity drops dramatically, often dropping down to a thousand vehicles an hour. When drivers are charged a toll that increases when traffic gets heavy, people make different decisions. Some switch trips to less congested times or take different routes. Others carpool or use transit. The highway keeps flowing with much lower levels of congestion. State Route 91 in Orange County, California provides an instructive example. This is a 12-lane highway with 4 free lanes and 2 tolled express lanes in each direction. During rush hour, the free lanes crawl along at stop and go speeds, while the 2 express lanes carry nearly as many vehicles as the 4 free lanes.

Managed lanes provide CDOT with the opportunity to significantly affect travel behavior. They are a key tool for managing a transportation system that serves a growing population.

One key innovation is the use of congestion pricing; i.e., tolls that vary with the level of congestion. Currently this is done through time of use pricing, where the tolls are set based upon the typical levels of congestion experienced at that time; essentially, higher tolls are charged during rush hour. However, in the future this may well transition to dynamic tolling, where the toll levels are set based upon real-time data on traffic levels and travel speeds.

Furthermore, because the tolls can be increased if traffic congestion gets worse, managed lanes will continue to function over the long term. This is a key advantage: unlike free lanes, which fill to capacity over time, managed lanes can offer a long-term uncongested alternative. This also reduces the budget pressures upon the state department of transportation. Not only do the tolls help to pay for building and maintaining the infrastructure, the fact that there is an uncongested alternative reduces the demand to spend public dollars for additional roadway widening.

There is an additional advantage to managed lanes from an environmental and energy perspective. The level of emissions of both greenhouse gases and criteria air pollutants varies significantly

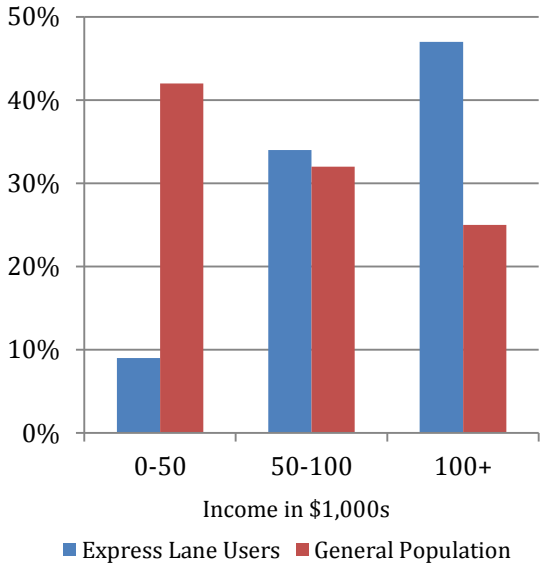
across traffic conditions. Stop and go traffic can generate more than double the emissions per mile compared to smooth flows, with the lowest emissions and lowest energy use occurring when vehicles travel 35-55 mph. Emissions then rise somewhat as speeds increase and air resistance requires additional energy input.[6] Managed lanes can be managed to maintain average vehicle speeds in this range. For example, the contract signed between the Colorado High Performance Transportation Enterprise (HPTE) and Plenary Roads Denver (the private contractor that will operate the US 36 HOT lanes) requires that tolls on the US 36 managed lanes must be set at a level that maintains traffic speeds of 50-55 mph during peak periods.

Tolled lanes can be problematic from an income equity standpoint

One of the big objections to managed lane projects is equity among income groups. Detractors deride them as "Lexus Lanes", and there is some truth to this label. Unsurprisingly, pricey tolls tend to shift usage towards higher income drivers. Studies of multiple managed lane projects all show similar demographic profiles of drivers who use the lanes, with very little use among drivers with household incomes under $50,000 and much higher use among drivers whose household income exceeds $100,000. This is a robust result, observed across multiple projects. In a review of managed lane projects across the nation, the Federal Highway Administration concluded that people with higher incomes use tolled roads more often than lower income travelers.[7] Figure 1 below shows the demographic breakdown by income level for the use of the I-25 Express Lanes.

This disparity in use might be acceptable if these were private roads being built with private investment, but that is not the case. In Colorado, the managed lane projects that exist (I-25 and US 36 HOT lanes), are under construction (US 36 HOT lanes, North I-25 between US 36 and 120th), or are in the planning or design stages (C-470, I-25 North past 120th, I-70 viaduct, I-70 mountain corridor Twin Tunnels and Peak Period Shoulder Lanes) are all on public rights of way, and involve substantial investment of state and federal transportation funds. Tolls pay

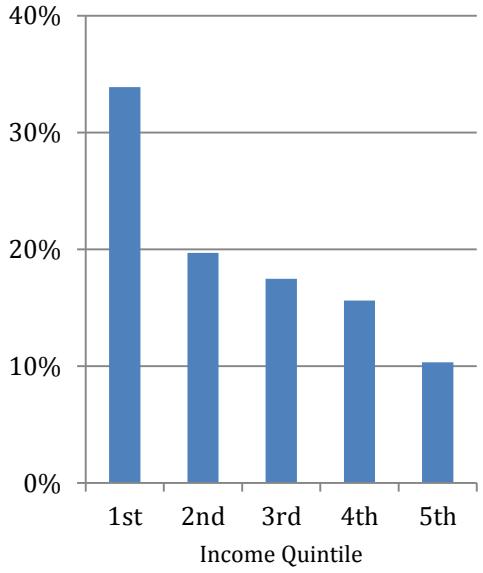
Figure 1 | Demographics of I-25 Express Lane Users Compared to General Population by Household Income[8]



only a portion of the cost to build these lanes. For the US 36 Express Lanes project, out of a total project cost of $497 million, $174 million is financed by tolls and the remaining $323 is public funds. Many people will have concerns about using these public resources to build infrastructure that largely serves upper income travelers.

Transportation is a significant expenditure for many households; on average, it is the second largest household expenditure after housing, ahead of both food and healthcare costs. Proportionally, it is a larger burden on lower and middle-income households than on higher income households, as illustrated in Figure 2. Given this, it is particularly important to ensure that transportation investments provide value to those households that are burdened by transportation costs.

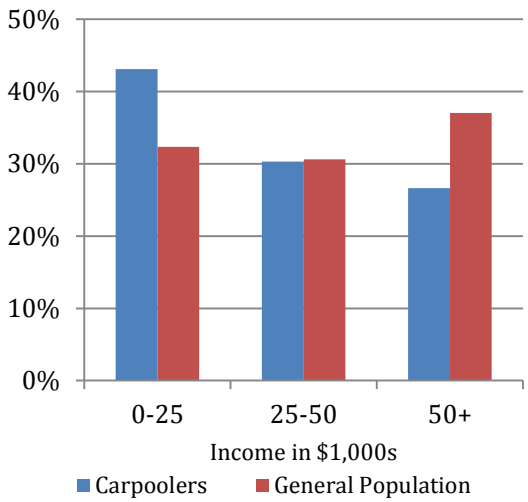
Figure 2 | Percentage of Household Income Spent on Transportation by Income Quintile in 2012[9]



Make managed lanes more equitable by including carpools

Managed lanes can be used to do more than move toll-paying, single-occupant vehicles. They can also offer congestion-free travel to carpoolers and buses. And it turns out that the demographics of carpoolers and bus riders are very different than that of toll-paying drivers. People of all income ranges carpool and lower income travelers are more likely to ride buses. Figure 3 shows carpooling behavior by income range for the Denver metropolitan area. One strategy to make managed lanes equitable is to ensure that they serve carpoolers and transit riders as well as toll-paying drivers.

Figure 3 | Demographics of Denver Metro Carpoolers Compared to General Population by Individual Income[10]



To serve carpoolers, the key is to make sure that all new managed lane projects are High Occupancy Toll (HOT) lanes, which allow carpoolers to use the lanes in addition to toll-paying, single-occupant vehicles. While the existing managed lanes project in Colorado (the I-25 HOT lanes) and the project under construction (US 36) do include high occupancy vehicle (HOV) access, current law allows the HPTE to build toll lanes with no HOV access. CDOT is considering adding managed lanes with no toll-free HOV access on C-470.

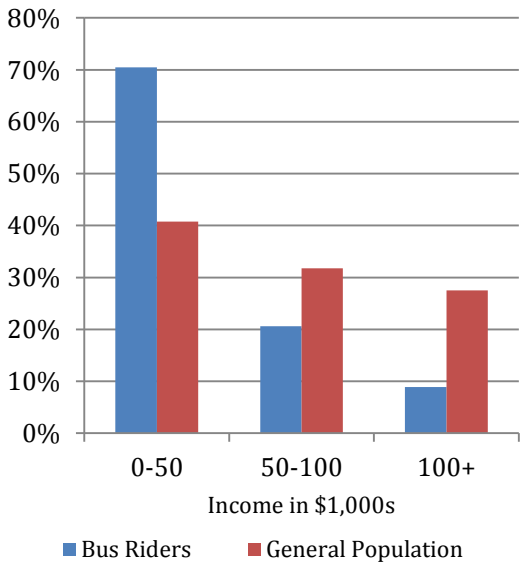
HOT lanes can set differing levels of occupancy required for free access. The I-25 HOT lanes are currently HOV 2+, meaning that access is free for vehicles with two or more occupants. The HPTE has made the decision to transition to HOV 3+ by 2017, or earlier if certain traffic triggers are met before that date. It is important to have the ability to set the minimum occupancy level high enough to ensure that the HOT lanes flow freely.

Make managed lanes more equitable by including transit

Transit ridership tends to serve a broader demographic mix than toll lanes. Figure 4 shows the demographic breakdown by income level of RTD bus riders compared to the general population.

Managed lane projects can serve transit riders in several ways. The first is to use the HOT lanes as a platform for better bus service. Because managed lanes offer a travel time advantage, buses running in the HOT lanes can offer higher quality transit service than those running in traditional regional bus routes. This service could be simply regional service running in a HOT lane, or it could be upgraded to true Bus Rapid Transit (BRT) with amenities such as slip lanes to stops, enhanced stations, pre-paid boarding, and other improvements to offer rail-like service. This higher quality BRT service, which offers much faster and more reliable travel compared to travel in the general purpose lanes, is likely to attract more riders, thereby removing vehicles from the already strained highway system.

Figure 4 | Demographics of RTD Bus Ridership Compared to General Population by Household Income[11]



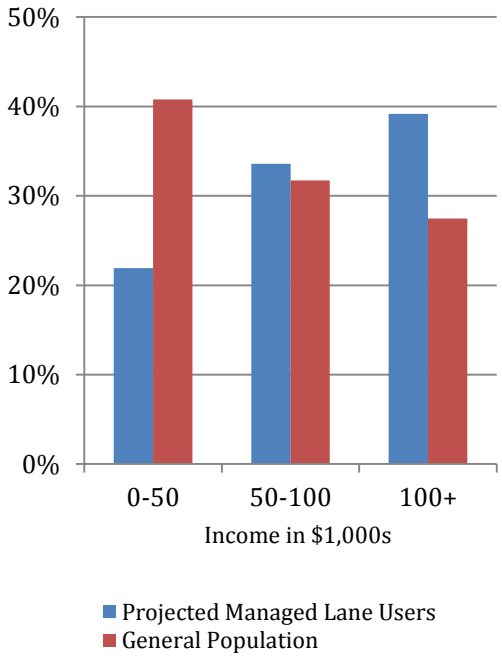
Note that there are many broader benefits that may come from BRT, including the ability to concentrate development in transit-oriented development near BRT stations, very similar to the development and place-making benefits that come from rail service.

In addition, toll revenues can be used to support the transit service. While in many cases toll revenues will be needed to pay for construction in the early years of a project, over time there will be excess toll revenues available. Investing a portion of these toll revenues in transit service in the corridor helps to improve the overall equity of the project. In some cases, such as conversion of a shoulder to a toll lane, which requires only modest upfront investment, toll revenues could be available to support transit from the beginning of the project.

The US 36 corridor provides an interesting example of a comprehensive partnership among multiple agencies and jurisdictions to integrate bus rapid transit into a HOT lane project. This project will extend from the existing US 36 HOT lanes at Pecos to Table Mesa Drive in Boulder. There will be one HOT lane in each direction, open to HOV 3+ cars, BRT vehicles, and toll-paying, single-occupant vehicles. In addition, the project will include a continuous bikeway from Boulder all the way to Westminster, facilitating shorter distance trips, and will include significant station and bus access improvements. High frequency BRT service will begin after the construction is completed.

We have combined projections for transit ridership, toll customers and HOV 3+ carpoolers on US 36, as described in the next section, with the demographic data on users by mode to estimate the use of the US 36 managed lanes by household income, shown in Figure 5. Comparing to the toll lane demographics shown in figure 1, we see that this is a far more equitable distribution than toll lanes without a significant HOV and transit presence.

Figure 5 | Projected Use of US 36 Managed Lanes by Household Income, Compared to Metropolitan Area Population by Household Income



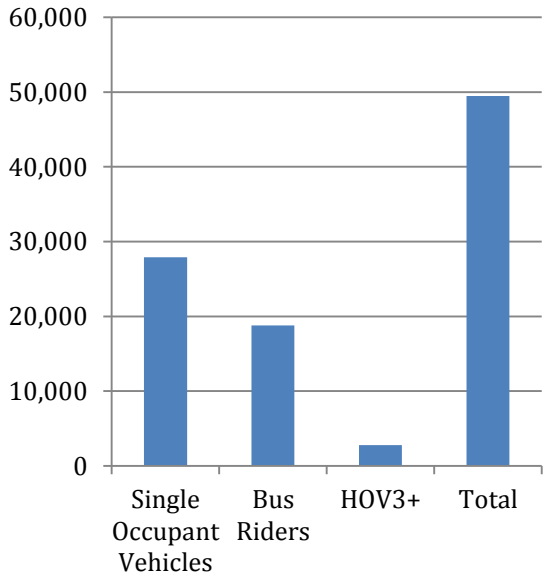
Including HOV and transit makes managed lanes more cost effective

The real goal of these projects is not to move cars; rather, it is to help people get where they need to go. Every time a carpool moves two or three people, or a bus moves 40 people, the same investment is moving more people than if the lane were just full of toll-paying, single-occupant vehicles.

According to analysis conducted by HPTE, the maximum volume of vehicles expected in any segment of the US 36 managed lanes is 27,900 by 2035.[12] The Northwest Mobility Study predicts that there will be 18,800 passengers riding bus rapid transit in the managed lanes.[13] That is, the presence of transit allows the lanes to carry 46,700 people per day – 67% more than if the lanes were only carrying single occupant cars! If we assume that 5% of the vehicle trips are HOV 3 (based on observed levels in the general purpose lane of 2-3%)[14], there would be an additional 2,790 HOV passengers. Note that if additional arterial BRT routes are developed feeding into US 36, the transit mode share would be expected to increase. For example, RTD estimates a ridership increase of 6,800-7,800 trips per day if BRT is added to US 287 between Longmont and Broomfield, feeding onto US 36 for the portion from US 287 to Denver.

In addition, CDOT and the HPTE have signed a Memorandum of Understanding with the local governments along the US 36 corridor governing how future toll revenues will be used.[15] In the near term, toll revenues will go to paying off the bonding and private equity that is helping to pay for construction. However, at some point revenues will begin to flow back to the state. Under existing law, these revenues must be spent in the US 36 corridor. The MOU specifies that revenues may be used for public transit, first and final mile improvements near transit stations, and transportation demand management programs (such as supporting transit pass purchases) in addition to roadway expenditures. The distribution of these revenues will be a joint decision by CDOT, HPTE and the local governments.

Figure 6 | Projected Daily Trips on US 36 Managed Lanes in 2035



Optimize existing roads by converting some capacity to managed lanes

Many of the benefits from managed lanes come from the management strategy, not from the addition of more lanes. It is possible to capture these benefits by converting existing lanes from free general purpose to managed HOT lanes, without incurring the cost or other impacts of adding additional lanes.

As discussed as above, managed lanes are able to offer free flow conditions during periods when adjacent general purpose lanes are congested. Converting some of these existing lanes to managed lanes would give travelers in these corridors a congestion free alternative. In addition, because the cost of lane conversion is much lower than the cost of adding new capacity, this strategy gives a much greater ability to invest toll revenues into transit and transportation demand management services in the corridor. A managed lane conversion that incentivizes carpooling and carries a significant number of transit riders may well carry many more people than adjacent general purpose lanes, helping to reduce demand on these lanes while providing direct benefits to those using the managed lanes.

Converting existing lanes to managed lanes avoids the negative impacts—air pollution, noise and water pollution—that the widening of highways has on adjacent communities and the environment.

From a fiscal perspective, lane conversion offers great benefits. In general, tolling is only able to pay a fraction of the costs of adding new capacity, so every addition of new lanes requires large investments of public funds. For example, as discussed above, nearly two thirds of the cost of the US 36 HOT lanes project is paid by public funds, with tolls covering about one third. The numbers are large; for example, the public investment for US 36 is $320 million. Conversion of existing lanes offers many of the same benefits, while avoiding such large expenditures. Current law does allow the conversion of free lanes, but sets a very high procedural bar by requiring that every jurisdiction that might be impacted must approve the conversion. To date, no project involving conversion of existing general purpose lanes has moved forward, although there has been discussion of the potential on a short section of North I-25.

Another approach, which is being implemented on a portion of I-25 and considered for a portion of the I-70 mountain corridor, is conversion of existing shoulders into peak period managed lanes. This allows the creation of managed lanes at a much lower cost than adding new lanes. It also results in fewer impacts to the natural environment and to communities, compared to traditional road widening. Shoulder conversion projects also open up the possibility of spending a larger share of toll revenues on enhancing transit in the

corridors. For example, on the I-70 mountain corridor, toll revenues could be invested in bus service running in the toll lanes, linking the metro area to ski areas. While CDOT is currently planning to offer limited bus service on I-70 using other revenues, it will not effectively serve these high volume destinations during peak periods. Managed lanes would offer this opportunity.

Conclusion

CDOT has taken a step in the right direction with the policy directive to focus new capacity in manage lane projects rather than new general purpose lanes. The US 36 HOT lane/BRT project provides an excellent example of how a managed lane project can incorporate all modes, and would be a good model for CDOT in the future. In order to maximize the transportation benefits of future managed lane investments, make them equitable for all income ranges, and respond to the increased need for multimodal transportation, the state and other planning partners should require a focus on both carpooling and public transit in future projects. In addition, serious consideration should be given to lower cost approaches such as managing existing capacity or using existing shoulders for managed lanes.

The Southwest Energy Efficiency Project is a public interest organization dedicated to advancing energy efficiency in Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming. For more information, visit www.swenergy.org.

SWEEP's Transportation Program seeks to identify and promote the implementation of policies designed to achieve significant energy savings and reductions in greenhouse gas emissions from the transportation sector. SWEEP's work focuses on two general strategies: reducing vehicle miles traveled and improving vehicle fuel efficiency.

Questions or comments about this report should be directed to Will Toor, Transportation Program Director, wtoor@swenergy.org.

Endnotes

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[9] Source: US Department of Labor, 2012 Consumer Expenditures Survey, retrieved from http://www.bls.gov/cex/2012/combined/quintile.pdf.
[10] Source: US Census. Table B08119: Means of Transportation to Work by Workers' Earnings in the Past 12 Months, 2007-2011 American Community Survey 5-Year Estimates for the Denver-Aurora-Boulder Combined Statistical Area. Note that this data was reported as individual rather than household income, so will appear slightly different than the other figures showing demographic data.
[11] Source: RTD 2011 Customer Satisfaction Survey, Demographic Comparisons, Annual Household Income; US Census. Table B19011: Household Income in the Past 12 Months, 2007-2011 American Community Survey 5-Year Estimates for the Denver-Aurora-Boulder Combined Statistical Area.
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