Combating Traffic Congestion in the Denver Metro Area: Examining Proposed Solutions and their Effects

A Policy Memorandum

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by

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Appendix B ......................................................................................................................... 50
Key Assumptions for Cost-Benefit Analysis ................................................................. 51
  Real Discount Rate .................................................................................................... 51
  Inflation Factor .......................................................................................................... 51
  Evaluation Period ....................................................................................................... 52
  Factors for Annualizing Traffic Data ........................................................................ 52
  Peak Periods ................................................................................................................ 52
Key Values for the Cost-Benefit Analysis .................................................................. 53
Cost and Benefit Calculations ..................................................................................... 55
  Status Quo (no build alternative) ............................................................................. 55
  FasTracks Northwest Rail Corridor .......................................................................... 56
  High Occupancy Toll Lanes ....................................................................................... 57
  BRT/Managed Lanes ................................................................................................. 58
INTRODUCTION

Residents of many urban, exurban, and rural areas are all too familiar with pulling onto a highway or turning on to a local road on their way home from work, only to notice the red glare of brake lights as far as the eye can see. Roads that normally allow citizens to travel from their point of origin to their destination at an acceptable pace are suddenly reduced to parking lots and slow-moving chains of commuters during peak periods of travel. This slowing occurs mostly during peak travel times in the morning and evening when the multitudes are traveling to and from their places of employment, but it also occurs during special events in the area and when accidents occur. The resulting congestion—commonly referred to as gridlock—often dominates the thinking of traffic engineers and urban planners. For growing metropolitan areas, the drawbacks of congestion can as simple as a bevy of angry residents, but can also be as serious as increased pollution-related ailments and decreased economic development. As the Denver region is poised for continued growth—and increased congestion—it is important for policy makers to allocate ever-scarcer funds to transportation projects that actually make a difference.

PROBLEM DEFINITION

According to the U.S. Census Bureau, the population of the West grew nearly 20 percent between 1990 and 2000. This rate of growth was nearly 10 percent higher than the growth rate for the country as a whole, and higher than the growth in both the Northeast and the Midwest. Recently released numbers from the 2010 Census reveal that the West continued its explosive growth in the last decade, with a population increase of 13.8 percent. Only the South had larger share of growth in the country, and only by half of a percentage point. More specifically, Colorado saw a tremendous increase in its population over the last two decades. From 1990 to 2010, the number of people living in the state increased from 3.2 to just over 5 million. Denver and the surrounding metropolitan area—including Denver, Arapahoe,

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1 "2010 Census Data"
as calculated by the Texas Transportation Institute – show that each commuter experienced an average of 47 extra hours of delay while commuting in the metro area. Fortunately, this average delay is lower than previous years, but still represents a marked increase from similar measurements in the early part of the decade. In addition to simply proving an inconvenience to commuters, travel delay has additional effects on individuals and communities.

Sitting in traffic, while a major annoyance to individuals on a daily basis, has additional, negative effects on metropolitan areas. In Denver, for example, the high level of annual delay hours also means that a large amount of fuel is wasted. The 2010 Urban Mobility Report found that nearly 61 million gallons of fuel were wasted by commuters sitting in traffic in 2009. On a mere individual level, the data shows that each commuter in the region consumes, on average, an additional 38 gallons of fuel every year due to congestion. Adding in the other costs that are associated with traffic congestion, the total costs add up quickly. The Texas Transportation Institute calculates that average cost of time is $16.01 per person hour in order to quantify the time that people spend in traffic. Extrapolating the value of annual delay and excess fuel consumption, it is calculated that the total cost of congestion in the Denver metropolitan area in 2009 was $1.7 billion. To put that cost in perspective, the annual cost of traffic congestion a decade earlier (1999) was almost $100 million less. When these numbers are broken down to a per person level, calculations show that each commuter paid an extra $1,057 in value of time and excess fuel consumed in 2009. Businesses are similarly impacted by the amount of congestion plaguing the metro areas’ roads. Using a rate of $105.67 per vehicle hour for commercial vehicles, the 2010 Urban Mobility Report calculates that the total cost of congestion for commercial vehicles in 2009 was $431 million.

While simply having the distinction of being one of the top twenty most congested metropolitan areas in the country may be enough to induce policy makers and urban planners to act, it is important for parties

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5 Numerous studies and transportation experts have pointed to high gas prices in 2007 and the 2007-2009 recession as reasons for the general drop and stagnation of congestion in metro areas. Patterns in commuting (i.e. shifting to public transportation) and the increase in unemployment is generally seen as the largest determinants in the temporary decrease in congestion and annual delay.

6 Urban Mobility Report, Data for Denver-Aurora

Originally opened for travel in 1951, the section of what is now U.S. Highway 36 between Boulder and Denver was operated as a toll road. Following successful repayment of the bonds that funded the road’s construction, toll collection was terminated in 1968. Since that time, population growth has spread outward from the city centers of both Denver and Boulder, and has increased the number of potential commuters along the route. For example, the population in the U.S. 36 corridor area was estimated to be 505,900 in 2005. Projected population growth along the corridor over the next 25 years is expected to be approximately 28 percent. If these projections hold, the marked increase would bring the population to nearly 650,000.⁸

While population growth on its own has the potential to increase traffic volume, it is employment growth in the corridor that assures more people will be commuting into, out of, and throughout the U.S. 36 study area. Current projections for employment along the corridor are 508,500 for the year 2035, which would represent a growth of 53 percent over 2005 levels.⁹ In addition to the overall growth of areas at either end of the corridor, planners worry about the growth along the middle portion of the corridor. In particular, fast-developing areas in Broomfield, Superior, Louisville, and Westminster have some of the highest growth projections for employment and population. This means that the employers in the area will be attracting more commuters from outside the corridor, and far greater numbers of residents will be commuting through the corridor to get to employment centers in central, southern, and northern parts of the metro area.

All of these new — and existing — commuters will need transportation infrastructure that can handle the load. Analysts are currently forecasting that the number of people that will need to use the corridor will surpass the road’s capacity in 2035. When an analysis was conducted for the U.S. 36 Mobility Partnership in 2008, it was forecasted that population and employment growth would induce between 6,880 and 14,420 trips per day in the a.m. peak period that the highways capacity just simply

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⁸ U.S. 36 EIS, pg. 1.3-1.
⁹ ibid, pg. 1.3-1.
argued that, when commuters feel like they have alternative ways to reach their destination, they are more likely to use them. Part of this analysis will take into account the impact that each proposed solution has on the total travel options for the U.S. 36 corridor. In doing this, the following questions will be asked:

1. Does the proposed solution include improvements in transportation infrastructure for multiple modes of transport?
2. What is the likely impact, if any, of the proposed solution on alternative modes of transportation in the project area?

Projections and data about the possible impact to alternative sources of transportation have been compiled by both the Colorado Department of Transportation and the Regional Transportation District in their various project submittals to the state and national agencies.

Cost-Benefit Analysis

One important aspect of any major public works project is determining whether public funds are being spent efficiently. At issue is what costs are being incurred by local, state, and national agencies to deliver a certain set of benefits to those with standing. In conducting this analysis, various costs and benefits were quantified for each project and compared. The results of this analysis, and the underlying calculations, can be found under the “Cost-Benefit Analysis” section.

ISSUE ANALYSIS

A Brief History of Transportation Planning

By and large, transportation in the nation’s metropolitan areas is done by state and local government agencies. Since there has always been a need, be it for horse-drawn carriages or high-speed trains, to move people within populated areas, these agencies have had some role in the planning and execution of transportation policy. It has not, however, been until the middle part of the last century that large cities starting looking at transportation planning in a comprehensive way. Then, in 1956, the United
transit systems, and it increased the available funds that metropolitan planning organizations could look to when developing their long-range transportation policies.

The 1990s and 2000s saw federal legislation enacted that aimed to reduce the large emphasis on the federal highway system and better embrace multimodal forms of transportation. For example, the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) was passed with the intention of the development of a National Intermodal Transportation System that would move people and goods, in the most efficient manner, using all forms of transportation. It directed that metropolitan planning organizations and states should focus on reducing traffic congestion, improving air quality, practicing energy conservation. An updated version of the act was enacted in late 1998 (the Transportation Equity Act for the 21st Century) that further expanded on the goals that each state and MPO should focus on when doing their transportation planning. Legislation in 2005 — the Safe, Accountable, Flexible, Efficient Transportation Equity Act — further developed the notion of spending federal funds on multimodal transportation. The legislation created the New Starts program, which provides federal funds to those projects that “include any fixed guideway system which utilizes and occupies a separate right-of-way, or rail line, for the exclusive use of mass transportation and other high occupancy vehicles.”¹¹ This definition would include most forms of light rail, commuter rail, and bus rapid transit. The aforementioned pieces of legislation — and some that have not been mentioned — have been relevant in some of the Denver metro area’s previous attempts at transportation planning.

**Previous Projects in the Metro Area**

While traffic congestion may plague the metro area, that does not mean there have been no attempts in the past by transportation planners to do something about it. In fact, there have been a number of projects that have been undertaken over the last two decades to further enhance the transportation infrastructure and alleviate the traffic problem.

¹¹ "New Starts Project Planning & Development."
While the previous projects had focused mainly on traffic congestion in the central, northern, and southwestern parts of the metro area, the next project focused on the busy southeastern corridor. The Transportation Expansion Project (T-Rex) was intended to alleviate traffic congestion along the I-25 and I-225 corridors that handled much traffic traveling through Aurora and serving various job centers in the southeastern part of the metro area. The focus of the project was widening of highways throughout the corridor, including safety improvements and lane additions. The project also had a multimodal approach as the metro area’s light rail system was expanded along the corridor to further increase access to mass transit for commuters to downtown and southwestern suburbs. Its completion in 2006 was hailed as a major step forward in transportation planning for the region’s nearly three million inhabitants.

Results of Previous Transportation Projects

Coordinating the efficient flow of millions of people within the Denver metropolitan area on a daily basis is no small task. The task is even more difficult because the individual corridors all connect into the wider, regional transportation system. If one corridor has infrastructure improvements that drastically reduce traffic congestion, those benefits may be mitigated when commuters are transferring to an adjacent corridor that has worse congestion. This fact aside, the realities of the enormous amount of resources – in terms of capital investments capital investment, labor, and planning – required for an infrastructure project generally preclude full build-outs across the entire metro area. For this reason, it is important that policymakers and transportation planners analyze the effects that previous projects have had on particular corridors before deciding whether to expand a particular project or take an alternative course of action across the region. The following is a brief list of the aforementioned projects in the metro area and their results:

- **I-25 HOT Lanes** – the pilot program was intended to demonstrate that a successful conversion from HOV to HOT lanes would increase usage and improve congestion. As of July 2010, the combination of the Express toll lanes and the HOV lanes were attracting
traffic congestion because they directly experience the negative impacts on a frequent basis. The second group consists of companies that run freight operations. As much of their operations include the transit of goods and the delivery of services, traffic congestion can have a significant impact on their operating costs. The third group identified is the transit agency, which in this case is the Regional Transportation District. Since they are in the business of overseeing and operating much of the metro area’s transportation network, they have a strong interest in the conditions of that same network and in any changes to that network.

Individual commuters, as referenced above, are one group of stakeholders that incur much of the cost from metro area traffic congestion. Whether it is excess fuel that must be consumed or the lost value of their time spent sitting in traffic, individual commuters have preferences for the transportation projects in their city. For example, according to the Federal Highway Administration’s publication, A Guide for HOT Lane Development, focus groups conducted during a feasibility study of the I-25 express lanes found that support was only marginal. Most people had not yet heard of the HOT concept, and they worried about issues of equity and public versus private operation. As knowledge of the program, and public dissatisfaction with the underutilization of HOV lanes, increase, commuters were generally more in favor. By 2008, a survey of users found that most that had used the express lanes at least once were generally satisfied, but obstacles still remain.

Individual commuters in the metro area seem much more support of the FasTracks rail expansion, however. During the 2004 general election, voters favored Referendum 4A by an overwhelming 65% to 35%, which approved a sales tax increase to help fund the program. Despite a large funding gap that now exists, due to falling sales tax revenue and increased commodity prices, recent polling still shows strong support for the project. The Denver Metro Chamber of Commerce conducted a poll in December of 2010 to gauge support for the project (and possible sales tax increases). Surprisingly, 75 percent of respondents believed that the passage of the referendum in 2004 was a good idea. Additionally, nearly half of the respondents ranked completion of the rail project as very important.

17 A Guide for HOT Lane Development, pg. 7.5.4.
promises to increase ridership along the entire system. Bus rapid transit, while relatively new in the metro area, may become a preference of RTD if it were to prove successful along the U.S. 36 corridor. Analyses may show that the LRT and BRT systems complement each other in efficiently moving commuters over long distances, and this would all benefit RTD. Since they have less direct control of highways and roadways in the metro, it is likely that an HOT project would be lower on their list of preferences. If, however, it is shown that managed lanes drive more commuters to rail and/or bus transit, their view may shift.

PROPOSED SOLUTIONS

In the world of urban planning, there is no shortage to the number of proposals that have been put forward to deal with the traffic that is generated in our cities. Many of the ideas have been tried in metropolitan areas throughout the world with varied levels of success. In order to limit the scope of this analysis, three different solutions will be examined. Each is aimed at, ultimately, reducing the congestion and improving the traffic flow on Denver’s streets.

FasTracks Rail Expansion

FasTracks is envisioned as a comprehensive expansion of the metropolitan area’s current transportation system over two decades. Voters in the metro area approved a sales tax increase to help fund part of the project in 2004. In addition to enhancing transit infrastructure that was previously completed in Denver’s central business district, Santa Fe corridor, and Southeast Interstate 25 corridor, the project would add 122 miles of new rail capacity to the transportation system. The rail expansion would create new lines along heavily-used commuter corridors throughout the metro area. Among these would be lines along the busy I-225, I-70, Northern I-25, and U.S. Highway 36 corridors. In addition, one rail line would connect the busy Denver International Airport with the transit hub in downtown Denver.

The FasTracks program was included in this analysis for a number of reasons. First, voters have already signaled their support for the program by voting for a sales tax increase in 2004 that would be
aims to use an interesting strategy. Along the distance between Denver Union Station in downtown Denver and the South Westminster/71st Avenue Station, the project would build and operate on tracks that are exclusively dedicated to commuter rail. For the rest of the segment, commuter rail would share tracks and right-of-way with freight traffic that currently operates on a line owned by the BNSF Railway Company.

Following the complete build-out of the rail project – projected to happen near 2035 – commuters along the U.S. 36 corridor would have an additional choice in transportation. RTD plans to operate commuter trains between Denver and Boulder in 15-minute intervals during the morning and evening peak travel periods. Service between Longmont and Boulder during these times is currently planned to happen every 30 minutes. During off-peak travel times – defined in the agency’s plan as 7:30 am-6:00 am and 9:30 am-2:30 pm – it is projected to operate trains at 30-minute intervals. Train frequency may be adjusted during the final design and construction period so that the project can simultaneously increase ridership and reduce operating costs.22 It is important to note that transit agencies frequently adjust their operating schedule and frequency to address demand issues, so projected operating intervals must be viewed as tentative.

**High Occupancy Toll Lanes**

The second alternative policy proposal to dealing with traffic congestion leaves rail out of the equation entirely. Instead, proponents of this option advocate that the best option to reduce congestion in the metro area is an expansion in the number of high-occupancy toll (HOT) lanes that exist in the region’s transportation portfolio. HOT lanes work mostly like the related high-occupancy vehicle (HOV), in that they are normally a separated set of lanes not available to everyone on the roadway. In the case of HOV lanes, use is generally restricted to those vehicles that carry multiple passengers or for a limited number of hybrid and fuel efficient vehicles without passenger restrictions. HOT lanes similarly allow vehicles to bypass general lanes of traffic, but offer single-occupancy vehicles the opportunity for use by paying a

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22 NWR Final Environmental Evaluation, 2.4.2.4, pg. 78.
This plan calls for the constructions of two managed lanes in each direction along the 18.2 miles of U.S. 36 between Denver and Boulder. On the Denver end, the lanes would connect with the HOT lanes already in place along I-25, which is intended to create a seamless system of managed lanes along two busy corridors. The four additional lanes would be constructed in the area of the highway that is currently occupied by the median that separates the two directions of traffic. In order to improve the safety of the new system – since traffic in the general and managed lanes will most likely have differing volumes and speeds – the four lanes will be separated from the rest of the highway by concrete barriers. As is normal with most similar projects, there will be a number of exit and entrance points in the system. Unlike the current HOT lanes along I-25 (which reverse accessible lanes depending on the AM or PM rush hour), the lanes along U.S. 36 will operate in both directions continuously. Access to the managed lanes will differ depending on the vehicle in question. The initial plan is to let all high-occupancy vehicles use the lanes for free, provided that they contain two or more passengers (commonly cited as 2+ in transportation circles). The definition of high occupancy is subject to review in the future, however, and may result in 3+ or 4+ thresholds being required to qualify. This measure would likely only take place if the managed lanes were so successful that higher than expected numbers of HOVs were using them. Transit vehicles, motorcycles, and a limited number of hybrid vehicles will also be permitted to use the lanes without paying a fee. Commercial vehicles will be allowed to use the lanes by paying a normal toll, plus an additional fee per axle. The High Performance Transportation Enterprise (formerly the Colorado Tolling Enterprise), the body that is granted the power to establish user fees on roadways, projects that the system will use a fully dynamic pricing model when completed. This will allow toll prices to be adjusted along the corridor to account for current speed and congestion levels most weekdays, and will allow for dynamic pricing to occur during special events on the weekends.

25 Managed lanes in this project refer to the HOT and HOV lanes separated from the general lanes of traffic.
The scalability of the project makes it attractive to municipalities within the metro area that lie along the proposed FasTracks rail lines, because the bus rapid transit system could be in place along those same lines years before the rail is completed. Other proponents argue that placing these bus lines along highly traveled and congested routes would provide an incentive for some to switch from a single-occupancy vehicle to a bus, thereby increasing the carrying capacity of the road and decreasing overall congestion.

Along the U.S. 36 corridor specifically, bus rapid transit is a solution that was originally proposed as part of the FasTracks rail expansion approved by voters in 2004. The project would take existing express bus stops along the highway and make infrastructure upgrades. These stations are: Table Mesa, U.S. 36 & McCaslin, Flatiron/96th St., Broomfield, U.S. 36 & Church Ranch, Westminster Center, and a terminus at Denver Union Station’s multimodal transit hub. Among the improvements that would be made at the existing bus facilities would be upgrades to the ticket vending machines, improvements in safety measures (video surveillance, emergency phones, etc.), variable signage for visual notification of bus schedules, fiber optic upgrades to the stations, redesigned marketing and branding, and general enhancements to the property. As part of the BRT aspect of the project, the frequency of service would see a general increase over the project area. This means that length of time between buses will decrease in both peak and off-peak hours. In addition, a number of new routes will be created to serve what are considered to be “activity centers” — or simply areas that already see, or are

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27 "U.S. 36 Managed Lanes/Bus Rapid Transit", pg. 5.
28 O’Toole, pg. 13
Table 1: Comparison of Proposed Transportation Projects

<table>
<thead>
<tr>
<th>Impact on VMT</th>
<th>FasTracks Rail (Northwest Corridor)</th>
<th>HOT Lanes</th>
<th>BRT/Managed Lanes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact on VHT</td>
<td>No/minimal impact</td>
<td>Increase of 121,920,000/yr</td>
<td>Increase of 170,180,000/yr</td>
</tr>
<tr>
<td>Impact on Average Speed</td>
<td>No/minimal impact</td>
<td>Increase of 406,400/yr</td>
<td>Increase of 1,041,400/yr</td>
</tr>
<tr>
<td>Does project include multimodal improvement?</td>
<td>Yes, bus system rerouting to serve new rail stations.</td>
<td>No, improvements to highway only</td>
<td>Yes, improvements to highway, bus system, and bike system</td>
</tr>
<tr>
<td>Impact on other modes of transport?</td>
<td>Yes, increase in transit-linked trips across the corridor(^{30})</td>
<td>Yes, more reliable travel time for buses traveling in the corridor</td>
<td>Yes, 8 minute travel time savings for drivers in general lanes along US 36</td>
</tr>
</tbody>
</table>

Source: Project impact projections for the Northwest Corridor taken from both Northwest Rail Corridor Final Environmental Assessment and US 36 FEIS; projections for the HOT and BRT options from US 36 Corridor Final Environmental Impact Statement.

As noted in the table above, each project has a number of impacts on the congestion along the U.S. 36 corridor and also affects other modes of transport in the area. The Northwest Corridor rail expansion through the FasTracks project is not projected to have much of an impact on either vehicle miles traveled, vehicle hours traveled, or average speed along U.S. 36. In contrast, both of the other projects have significant impacts on these three measures. The HOT managed lane project increases VMT by over 120 million per year. Project proponents argue that this mainly stems from an increase in efficiency in the system which allows the corridor to serve an increasing number of commuters with less congestion. Coupled with more people traveling along the route, VHT is also expected to increase. All these extra travelers, however, will be doing so at more reliable speeds as the project will increase the average speed along the system by 7 mph (up from 41.5 mph under the no build scenario). Similarly, the BRT project increases both VMT and VHT, with an addition of approximately 170 million and 1 million respectively over the no build scenario. Additionally, the BRT project is expected to increase speeds along the corridor by 7.3 mph.

\(^{30}\) RTD does not model how many additional transit trips will occur for each mode of transit along the corridor. Their estimates, however, project that 30% of rail users will take a bus to reach the nearest station.
The Northwest Corridor rail expansion project is already planned to additional rail corridors built through the Denver metro area. In addition to the West Corridor line that is currently under construction, RTD plans to build out the rail system to include lines throughout each sector of the metro area. This includes a commuter rail line that will connect Denver International Airport to the Union Station transit hub along I-70, a line to the Northern suburbs along I-25, a line running along the I-225 corridor, a line running to the Western suburbs along I-70, and extensions to the existing lines running to the Southwestern and Southeastern suburbs. Regional transportation planners have high hopes that the major investment in rail infrastructure will not only expand travel options throughout the metro area, but will have positive impacts on easing congestion and shaping development patterns. One benefit of extending the rail lines into multiple transportation corridors is that they are considered to be “grade separated” from the surrounding road network. This means that rail service can operate at relatively consistent speeds, no matter how much congestion takes place along roads in the corridor.

The High-Occupancy Toll lane concept, on the other hand, has no immediate plans for expansion in the metro area. The express toll lanes along I-25 have proved quite successful and further success along the U.S. 36 corridor could give a big boost to proponents that would like to implement HOT lanes throughout the region. Colorado’s High Performance Transportation Enterprise (HPTE) has begun moving forward on a number of environmental studies – some being updates to earlier studies – and funding analyses to establish HOT lanes along other corridors in the area. One of these would build upon the systems already in place and expand those lanes along North I-25 to Fort Collins. Another would study HOT lanes along I-70 that would help ease traffic on the Eastern edges of the metro area. The final study will examine the possibility of adding toll lanes to the length of C-470 between I-70 and I-25 in the South metro area. While each corridor is distinct in the exact configuration and traffic type distribution, comparative success to the I-25 express lanes could offer a substantial improvement to region-wide traffic congestion. One potentially large roadblock to greater implementation is resistance by the public to support such a project. Allowing drivers of single-occupancy vehicles to pay a fee to skirt the traffic in
means, however, that many of the benefits of transportation projects are not realized until the full project is complete. While some projects are built in stages – for logistical or funding considerations – most projects still take a decade or more to complete. All in all, this means that net present value can a misleading measure when examining projects over the short to mid-term.

In the same vein, simply relying on vehicle miles traveled and vehicle hours traveled can be a misleading measure. While it can certainly be argued that a reduction in VMT and VHT would be a strong indicator for congestion relief, all it really does is indicate that there are less vehicles traveling along the corridor. For example, both the HOT and BRT/managed lane alternatives increase the VMT and VHT along the U.S. 36 corridor. This is simply because improvements in traffic flow along the corridor and increased demand by commuters means that there is more traffic volume. With increased volume, it naturally follows that there would be more miles traveled and more hours traveled. Even transportation planners are not sure how useful a measure VMT really can be in accurately depicting the congestion of a roadway. Some argue that VMT should actually be seen as a positive measure when compared to congestion. That is, a higher VMT value for a metro area shows that that area is doing better economically, since people are traveling to and from employment centers, residences, and leisure locations. Others argue that both quality of life measurements and economic vitality can still remain strong while VMT is reduced. Either way, it is too base to simply look at the reduction or increase in VMT and VHT to assess a policy proposal.

To this end, the evaluation of policies, then, requires a more nuanced approach. This approach looks at the entirety of the projected impacts on VMT, VHT, total project costs, possible impact on additional modes of transport, and potential applicability to the rest of the Denver metro area. As noted earlier, simply looking at VMT and VHT in isolation can skew the results of an evaluation. Project costs, while tilted towards a negative net present value when examining proposals over the short and mid-term is still important because it can guide determine support from policymakers and the public. Given the increasing popularity “green” transportation options the decreasing construction space available in many metro areas, it is also important to look at how a project will complement other forms of transportation.
about the equity issues involved with creating the pay lanes. These issues focused mainly on the fear that those better off drivers would have their own quasi-personal road, paid for with public funds. Lower income drivers would be relegated to the more congested “free” lanes, with vital transportation dollars being siphoned off from projects that could potentially benefit everyone. This fear, however, was put aside when residents saw that the existed HOV lanes along I-25 were being drastically underutilized. The dynamic helped create the public support needed for the original HOT lanes in the metro area, and that projects success has largely tempered any opposition to current proposals. In fact, the biggest complaint in recent study areas for HOT expansion was that the traffic engineers had designed the project badly, leading to a potential for more congestion at key interchanges. So far, it appears that little opposition has emerged in either the public or policymaking circles that would make this recommendation difficult to implement in the real world.

WEAKNESSES AND LIMITATIONS

The major weakness that I see with this analysis is the inclusion of only quantitative measures. These - like operating costs, lower automobile operating costs, etc. - make conducting a cost-benefit analysis much easier than it would otherwise be, but they do not represent the entire issue. There is currently a heated debate going on in the transportation planning world about whether qualitative measures are as, or more, important to municipalities in the long term than many quantitative measures. In addition, many measures - such as livability, walkability, accessibility, and sustainability - which were once mostly qualitative have now seen attempts at quantification. Given that many are ill-defined and lack a consistent analytical framework, it is easy to see why they are criticized. As Randal O’Toole points out in a recent policy brief, “when planners rely on vague terms like sustainability and walkability, they run the risk of writing plans that are judged on basis of their intentions, not their results.” 31 Quantifying some

31 "Roadmap to Gridlock: The Failure of Long-Range Metropolitan Transportation Planning," pg. 7.
additional congestion throughout the area under evaluation. The added travel time experienced by those in 
the construction zones – and beyond, given the nature of the metro area’s roadways – would, undoubtedly 
increase the costs incurred during the project build-out. Given the complexity of forecasting this impact 
on travel time, however, the variable was not incorporated into the analysis.

*Transportation Choice*

Many proponents of transportation projects – excluding those that simply expand highway 
capacity – argue that the goal of such projects should be to increase the number of choices people have 
for transportation. Indeed, there is certainly something to be said for the possible benefit that comes with 
having an expanded list of options, whether those options are used or not. Some argue that the benefit of 
more options is extremely important for those that fall on the lower end of the economic scale, and for whom owning an automobile is simply not an option. In this analysis, there was no attempt to monetize 
transportation choice benefits.

*Livability*

Livability is certainly one of the buzzwords that have become associated with any non-highway 
transportation project. While the term is used quite loosely in transportation literature, Federal Highway 
Administration and Federal Transit Authority (along with the Department of Housing and Urban 
Development and the Environmental Protection Agency) are trying to standardize the term. In their 
recently published, *Livability in Transportation Guidebook*, they see livability as providing more 
transportation choices, promoting affordable housing, enhancing economic competitiveness, supporting 
existing communities, and enhancing the unique characteristics of all communities.\(^{34}\) Even when the 
specific characteristics have been defined, it is often difficult to quantify. A recent report published by the 
City of Portland Bureau of Environment Services examined aesthetics, community cohesion, 
environmental equity, and access to nature.\(^ {35}\) This analysis, however, simply did not produce a set of 
comparable values that could be used in a quantitative analysis. The complexity of the issue, and general

\(^{34}\) *Livability in Transportation Guidebook*, pg. 5.

\(^{35}\) *Portland’s Green Infrastructure: Quantifying the Health, Energy, and Community Livability Benefits*, pg. 5-2.
## Cost-Benefit Analysis (3 Year Time-Horizon)

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Alternatives</th>
<th>Status Quo (in millions)</th>
<th>FasTracks Rail (NW Corridor) (in millions)</th>
<th>HOT Lanes (in millions)</th>
<th>BRT/Managed Lanes (in millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benefits</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individuals (commuters)</td>
<td>.35</td>
<td>0</td>
<td>0</td>
<td>762</td>
<td>759</td>
</tr>
<tr>
<td>Companies (freight)</td>
<td>.30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Transit Agency</td>
<td>.35</td>
<td>1,063</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total Benefits</strong></td>
<td></td>
<td>1,063</td>
<td>10</td>
<td>772</td>
<td>769</td>
</tr>
<tr>
<td><strong>Costs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individuals (commuters)</td>
<td>.35</td>
<td>10,664</td>
<td>0</td>
<td>107</td>
<td>138</td>
</tr>
<tr>
<td>Companies (freight)</td>
<td>.30</td>
<td>1,647</td>
<td>0</td>
<td>697</td>
<td>949</td>
</tr>
<tr>
<td>Transit Agency</td>
<td>.35</td>
<td>1,727</td>
<td>385</td>
<td>1,639</td>
<td>1,394</td>
</tr>
<tr>
<td><strong>Total Costs</strong></td>
<td></td>
<td>14,038</td>
<td>385</td>
<td>2,443</td>
<td>2,481</td>
</tr>
<tr>
<td><strong>Total (NPV)</strong></td>
<td></td>
<td>(12,975)</td>
<td>(375)</td>
<td>(1,671)</td>
<td>(1,712)</td>
</tr>
<tr>
<td></td>
<td>ALTERNATIVES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------------------------------------</td>
<td>---------------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td></td>
<td>Status Quo (in millions)</td>
<td>FasTracks Rail (NW Corridor) (in millions)</td>
<td>HOT Lanes (in millions)</td>
<td>BRT/Managed Lanes (in millions)</td>
<td></td>
</tr>
<tr>
<td>Stakeholders</td>
<td>Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BENEFITS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individuals (commuters)</td>
<td>.35</td>
<td>0</td>
<td>0</td>
<td>2,365</td>
<td>2,361</td>
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<td>Companies (freight)</td>
<td>.30</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Transit Agency</td>
<td>.35</td>
<td>1,085</td>
<td>45</td>
<td>77</td>
<td>187</td>
</tr>
<tr>
<td>Total Benefits</td>
<td></td>
<td>1,085</td>
<td>45</td>
<td>2,442</td>
<td>2,548</td>
</tr>
<tr>
<td>COSTS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individuals (commuters)</td>
<td>.35</td>
<td>33,568</td>
<td>0</td>
<td>329</td>
<td>425</td>
</tr>
<tr>
<td>Companies (freight)</td>
<td>.30</td>
<td>5,112</td>
<td>0</td>
<td>2,007</td>
<td>2,745</td>
</tr>
<tr>
<td>Transit Agency</td>
<td>.35</td>
<td>7,559</td>
<td>807</td>
<td>1,664</td>
<td>1,426</td>
</tr>
<tr>
<td>Total Costs</td>
<td></td>
<td>46,239</td>
<td>807</td>
<td>4,000</td>
<td>4,596</td>
</tr>
<tr>
<td>Total (NPV)</td>
<td>(45,154)</td>
<td>(762)</td>
<td>(1,558)</td>
<td>(2,048)</td>
<td></td>
</tr>
</tbody>
</table>

Each cost-benefit analysis shows that the net present value stays consistently in the negative for all policy proposals over this time period. The most reasonable explanation for this is that transportation projects tend to have costs stacked at the front— or distributed over time— while benefits tend to accrue at the back end of a project. The status quo alternative, FasTracks rail expansion, and the BRT/Managed Lane projects all show a decrease in the net present value from short-term to mid-term analyses. Only the HOT project shows an increase net present value over the study periods. Given enough time, it is likely that benefits would surpass the costs of the project, assuming continued growth in the area.

**Sensitivity Analysis**

While a cost-benefit analysis is essential to help guide the decisions of policy makers, it is also important to take into account the high level of variability in these projects. Specifically, each of the
Political Feasibility

An ever-present concern when dealing with public policy is the probability that a strategic recommendation can actually be implemented. In the case of the aforementioned transportation policy proposals, most generally have a reasonable chance at being enacted. Fittingly, it appears that it is only the status quo that is unacceptable to the millions of people who experience the negative effects of traffic congestion on an annual basis. The FasTracks rail expansion, on the other hand, was widely supported when legislation to raise sales taxes for funding was put to voters in a general election. Recent polling suggests that increasing numbers of voters support the idea of the rail expansion, although transit officials are wary about asking voters for an additional sales tax increase to cover cost overruns. HOT lanes, similarly, have a good possibility for being implemented in the Denver metro area. Previous experience with the lanes along I-25 has produced better-than-expected results, and opposition to subsequent proposals has been relatively muted from the public and public officials. With the BRT/Managed Lanes proposal, support has also been strong. Local policymakers, while always concerned for the financial feasibility of a project, have been quick to embrace projects that focus on improving flow along the U.S. 36 highway corridor. The multimodal aspect of the proposal is likely to capture a larger share of support from both alternative transit proponents and those that favor improvements to existing roads.

Economic Concepts in Transportation Policy

The following economic concepts are particularly relevant to the issue of traffic congestion and transportation policy. While many policymakers may be more concerned with the immediate political impact of a decision, these concepts can help guide projections of the non-political outcomes of enacting going forward with policy proposal.

1. Loss from inefficiency – one of the major arguments about why traffic congestion can be such a problem is that each individual commuter does not bear the full cost to society of their actually being on the road and using the transit infrastructure. That is, the only costs that individual incurs directly are those private costs such as fuel, vehicle repairs, car
when the price for that travel fluctuates. Price changes can be caused by any number of factors including fuel costs, general vehicle operating costs, and even the value of their time due to traffic congestion. In addition, there are travel demand price elasticity values with respect to both bus and rail transit. With these two modes of travel, most changes in price are a direct result of increase or decreases in fare. Much research has been done on how changes in price – via individual elements – shifts travel demand and patterns. The Victoria Transport Policy Institute has synthesized much of the data and uses the following elasticity values in their travel research:

**Table 2: Transportation Elasticities**

<table>
<thead>
<tr>
<th></th>
<th>Short-Run</th>
<th>Long-Run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic levels with respect to gas price</td>
<td>-0.16</td>
<td>-0.71</td>
</tr>
<tr>
<td>Bus demand with respect to fare</td>
<td>-0.28</td>
<td>-0.55</td>
</tr>
<tr>
<td>Rail demand with respect to fare</td>
<td>-0.65</td>
<td>-1.08</td>
</tr>
<tr>
<td>Public transit use with respect to gas prices</td>
<td></td>
<td>0.34</td>
</tr>
</tbody>
</table>

**Source: Victoria Transport Policy Institute**

Short-term elasticities are normally seen as two years, while long-term elasticities are 10 years or more. It is important to note that some literature suggests that impacts generally increase over time because consumers (commuters, in this case) have more options in the long term to deal with price changes. For example, a spike in the price of gasoline will cause commuters to alter their driving behavior, but not by much. In the long-term however, their elasticity is much greater because they more options to change their driving habits. Perhaps they are able to purchase a new home that is close to a rail station or bus line, which dramatically alters their commuting patterns. This option may not have been there in the short-term, so their ability to alter patterns was less elastic. The

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38 VTPI, Transport Elasticities: How Prices and Other Factors Affect Travel Behavior, pg. 12. X
References


*Comprehensive LRT Station Activity Weekday Data.* Regional Transportation District, 2010. Print.

“Denver by the Numbers.” 2009.


“June 2010 — CDOT.” 6 Apr 2011.
Appendix A

Charts, Graphs, and Maps
Figure 2 - Complete Map of All Existing and Planned Rail Transit

Source: Image taken from www.rtd-fastracks.com
Key Assumptions for Cost-Benefit Analysis

The following assumptions have been made for the cost-benefit analysis evaluating the projects to reduce traffic congestion in the Denver Metropolitan Area.

Real Discount Rate

As is customary with many public infrastructure projects, benefits and costs in this analysis are expressed in constant dollars to avoid having to project future inflation values and to adjust the future costs and benefits accordingly. In order to properly express future values in constant dollars, it is necessary to discount those values. Choosing a suitable discount rate is vitally important because the value can significantly alter the net present value of a project. For many transportation projects, which include long project timeframes, the discount rate is even more important. The U.S. Office of Management and Budget has suggested the following real discount rates:

Table 3 - Real Discount Rates

<table>
<thead>
<tr>
<th></th>
<th>3-Year</th>
<th>5-Year</th>
<th>7-Year</th>
<th>10-Year</th>
<th>20-Year</th>
<th>30-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.4</td>
<td>0.8</td>
<td>1.3</td>
<td>2.1</td>
<td>2.3</td>
<td></td>
</tr>
</tbody>
</table>

Source: OMB Circular A-94, Appendix; published in December 2010, to be used in calendar year 2011.

For this reason, the rates of 0.0, 0.4, and 1.3 have been used for the 3-year, 5-year, and 10-year analyses respectively.

Inflation Factor

Where original dollar values were based in past years, the average Consumer Price Index value was used for the original calendar year to convert to 2011 dollars.

\[39\] OMB Circular A-94.
weekday (A.M. and P.M.). The A.M. peak period lasts from 7-10am and the P.M. period lasts from 3:30-6:30pm.

Key Values for the Cost-Benefit Analysis

Average cost of time – this value signifies the value of each person hour, as calculated by the Texas Transportation Institute for their annual Urban Mobility Report. Their last updated value was put at $16.01 per person hour in 2009 dollars. This measure was updated using CPI-U for this analysis, and represented a value of $16.52 in 2011 dollars.

Cost of operating a commercial vehicle – valued by the Texas Transportation Institute as $105.67 per vehicle hour in 2009 dollars. The value was updated for this analysis, and inflation brings the total value of operating a commercial vehicle to $109.01 in 2011 dollars.

Fuel Cost – represents to the cost of fuel to either the passenger or commercial vehicle. The value is calculated using the following formula: \( \frac{\text{Annual VMT}}{\text{MPG}} \times \text{Price of Gas} \)

Fuel efficiency – projected average fuel efficiency for both passenger and commercial vehicles were taken from the U.S. Energy Information Administration’s Annual Energy Outlook 2011. Their analysis projects average miles per gallon through the year 2035.

Table 4 - Average Fuel Efficiency for Passenger and Commercial Vehicles

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Vehicles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.2 mpg</td>
<td>21.4</td>
<td>21.7</td>
<td>21.9</td>
<td>22.3</td>
<td>22.6</td>
<td>23.0</td>
<td>23.5</td>
<td>23.9</td>
<td>24.3</td>
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</tr>
<tr>
<td>Commercial Vehicles</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.1 mpg</td>
<td>12.2</td>
<td>12.3</td>
<td>12.4</td>
<td>12.6</td>
<td>12.8</td>
<td>13.0</td>
<td>13.2</td>
<td>13.4</td>
<td>13.5</td>
<td></td>
</tr>
</tbody>
</table>

Source: U.S. Energy Information Administration, Annual Energy Outlook 2011
chosen. For off-peak travel, a weighted average of $1.80 was chosen. Total revenue is calculated using the following formula: \[ \text{Revenue} = \text{cars} \times \text{annual peak or non-peak hours} \times \text{toll} \]

**Travel time cost** – a measure of the total cost for an individual with respect to time. This value is calculated in the following way: \[ \text{Travel Time Cost} = \text{Avg. cost of time} \times \text{annual VHT} \]

**Vehicle miles traveled (VMT)** – these figures are calculated by multiplying the traffic volume by the length of the road segment. \[ \text{VMT} = \text{Traffic Volume} \times \text{Segment Length} \]

**Vehicle hours traveled (VHT)** – these figures are calculated by dividing the vehicle miles traveled by the average speed of the segment. \[ \text{VHT} = \frac{\text{VMT}}{\text{Speed}} \]

**Cost and Benefit Calculations**

All monetary values in 2011 dollars, unless otherwise noted.

**Status Quo (no build alternative)**

1. Benefits to the transit agency – in this case, RTD gains the entire benefit of not expanding the money for capital costs on a transportation project. Values for both capital and operating & maintenance costs were taken from Northwest Corridor Final Environmental Evaluation (EE).

Since the transit agency would be responsible for varying amounts, depending on the project in question, the larger sum for the rail project is used, since RTD would also have a higher stake in that project.

   a. Total capital costs = $1,030,876,468

   b. Total Operation and Maintenance Costs (only realized in year 10, after completion of project)

      i. \[ PV = \frac{21,277,409}{(1.013)^{10}} = 18,664,394 \]
b. Operating cost – $0.0 (3 year), $0.0 (5 year), $0.0 (10 year)

c. Travel time – $0.0 (3 year), $0.0 (5 year), $0.0 (10 year)

3. Cost to companies (freight)

   a. Operation cost – $0.0 (3 year), $0.0 (5 year), $0.0 (10 year)

   b. Fuel cost - $0.0 (3 year), $0.0 (5 year), $0.0 (10 year)

4. Cost to transit agency

   a. Capital cost - $385,460,838 (3 year), $629,837,971 (5 year), $901,662,781 (10 year)

   b. Operating & Maintenance cost - $0.00 (3 year), $0.00 (5 year), $18,664,419 (10 year)

**High Occupancy Toll Lanes**

1. Benefit to transit agency

   a. Toll revenue during peak hours – $0.00 (3 year), $6,454,588 (5 year), $20,213,053 (10 year)

   b. Toll revenue during off-peak hours – $0.00 (3 year), $2,162,288 (5 year), $6,771,373 (10 year)

   c. Increased bus ridership$^{44}$ - $10,096,500 (3 year), $21,727,794 (5 year), $60,376,434 (10 year)

2. Benefit to individuals (commuters)

   a. Travel time - $762,304,538 (3 year), $1,267,375,901 (5 year), $2,365,371,560 (10 year)

3. Cost to individuals (commuters)

   a. Fuel cost - $52,205,199 (3 year), $88,550,510 (5 year), $168,978,568 (10 year)

   b. Operating cost - $54,864,000 (3 year), $89,647,058 (5 year), $160,421,053 (10 year)

4. Cost to companies (freight)

   a. Operation cost - $605,149,394 (3 year), $982,258,639 (5 year), $1,731,976,941 (10 year)

   b. Fuel cost – $92,048,685 (3 year), $150,677,157 (5 year), $275,639,957 (10 year)

5. Cost to transit agency

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$^{44}$ Assumes ticket prices of $5.00 for current express service, plus 10% increase every 5 years, starting in 2010. This is simply an estimate, and the projected cost of a ticket has not come from RTD.