TRANSPORTATION RESEARCH SYNTHESIS

Minnesota Department of Transportation
Office of Policy Analysis, Research & Innovation
Research Services Section
(651) 366-3780
www.research.dot.state.mn.us

TRS1205
Published August 2012

# Mitigating Highway Construction Impacts with Transit

## Introduction

This TRS is provides a summary of research done on how to mitigate the impacts of highway construction projects through the use of transit and what strategies can be used to retain riders it after a highway construction project is done.

Surprisingly, there has been little research done on the use of transit to mitigate construction impacts. For example, the Federal Highway Administration's "Work Zone Mobility and Safety Guidebook" (Federal Highway Administration 2011) does not include a section on the use of transit to improve mobility and safety in work zones. Likewise, the Federal Highway Administration does not include transit as an alternative in its "Congestion Reduction Toolbox" (Federal Highway Administration 2011) despite the fact that transit provides a clear alternative to driving. Even the T*raveler Response to Transportation System Changes Handbook* (Pratt, Texas Transportation Institute et al. 2000) does not identify or explore the impact of highway and roadway changes on transit. Not even MnDOT's "How to Thrive during Road Construction" mentions transit. (Minnesota Department of Transportation 2011)

This TRS reviews what literature is available on the question of the use of transit to mitigate highway construction impacts. It also looks at projects that have used transit as mitigation for highway construction impacts.

## Literature on How to Attract Travelers to Transit during Highway Construction Projects

How do we attract riders to transit during highway construction and then retain them after the project is done? One answer comes from understanding what drives transit ridership in general. The *TCRP Research Results Digest 4: Transit Ridership Initiative Report* (Jenks 1995) found five areas that planners and project managers need to consider when thinking about trying to increase or maintain transit usage:

- *Service:* Most fundamentally, ridership is driven by transit service that takes riders where they want to go when they want to go. People will only choose transit that provides a reasonable, convenient trip. If you want to attract more people to transit during construction, you need to provide transit that meets the travel needs of many individuals. This means making service adjustments. Service adjustments refer to any of a series of changes that tangibly alter the nature or character of services provided to the riding public. They include changes in route structure, service frequency, vehicle type or service type. It can also include actions to increase reliability, security, amenities, and improvements to station areas and parking facilities. For highway projects, project staff needs to consider additional trips (which reduce waiting time and increase travel reliability), additional routes (making transit attractive to more persons), bigger vehicles (which provide additional capacity), roadway transit advantages (dedicated lanes, queue jump lanes, in-line stations and other roadway enhancements that either reduce travel time or increase travel time reliability) and other enhancements or improvements to service itself. Also, planners need to think about the things surrounding the transit trip. Are there reasonable places for people to park their cars if they want to use transit? Are there safe and comfortable places for people to wait for transit? This can be especially important in Minnesota where winter can make waiting outside for a bus unpleasant.
- *Marketing and information*: Marketing and information increase the knowledge of the general public about the availability and benefits of transit. Making a behavioral change like changing travel modes takes effort and travelers need to be enticed out of their regular travel routines. Initiatives can range from broad public information programs to precisely targeted programs tailored to specific riders, specific services or specific employers. For highway projects, this often means general publicity about the highway project itself and alternatives to sitting in construction-related congestion. Transit alternatives should be integrated into project materials. But it also means highway project managers and transit planners should think strategically about targeted marketing. Are there special groups that should receive outreach? Employees of specific employers? Students? Elderly populations? Tourists? Hospitals or medical campuses? Others? Also, roadway information can be critical for travelers. If bus alternatives are available, it can be useful to post that information along travelers' routes.
- *Service coordination, collaboration, and market segmentation* Market segmentation means thinking specifically about the needs of certain groups as opposed to travelers in general. Service coordination and collaboration mean looking at other entities that work with or serve these specific groups to see how transit can coordinate or collaborate with these groups. Groups can include public school students, university communities, human service agencies, reverse commuters, off-peak travelers, special event attendees, tourists, sports attendees, welfare-to-work riders, or new residents. For highway construction projects, project managers need to think through the groups that make up their potential transit users and see how transit can integrate with other activities. Are organizations providing private transit that can be leveraged? Is it possible to partner with other organizations to induce ridership? Non-profit organizations, chambers of commerce, tourism bureaus, schools and universities and hospitals are just some of many alternatives.
- *Community planning:* One important activity in maintaining or growing transit is leveraging the knowledge of the community. In many ways, providing transit is about

understanding the personal decisions of thousands or tens of thousands of individuals. Oftentimes the community can have ideas about how to improve services. Highway and transit planners should work with the community to best understand these individual decisions. (Jenks 1995)

*TCRP Research Results Digest 29: Continuing Examination of Successful Transit Ridership Initiatives* (Jenks 1998) identified additional factors that affect transit ridership. One new area identified was external factors, mostly related to the economy. The vast majority of transit users are going to and from work. If employment rises, transit ridership also rises. When employment falls, transit ridership falls. This is counterintuitive for some people who believe that transit ridership increases when the economy is poor. But typically, when people become poorer, they take fewer trips. Some may shift modes to more transit usage but this typically does not make up for the loss of someone riding to and from work daily. Another factor outside of the control of planners and project managers is fuel price. There is a strong link between fuel prices and transit ridership. When fuel prices increase, people shift to transit. When prices fall, people do not proportionately leave transit, however. It appears that travelers overreact to the impact of increased gasoline prices on their budgets and change travel modes but once new travel patterns are set, they tend to stay in their new patterns until a new disruption to their travel occurs. (Lane 2011) These factors can be completely out of the control of planners and project managers but can substantially affect transit ridership during a construction project.

Another set of impacts identified by Jenks was overall system changes. All public transit requires subsidies. Except for a few conspicuous examples, most transit systems need operating subsidies of two-thirds or more plus capital investments to operate. When the economy declines, tax revenues decline which often leads to reductions in transit service. When we talk about transit as a "system," it really functions like a system. Even though service may be enhanced in one area or on one route, if there are reductions in other parts of the system, ridership will fall on the enhanced routes as well as the rest of the system. So project managers may be fighting an uphill battle if the system is being reduced even if their own particular service is not.

*TCRP 27: Building Transit Ridership: An Exploration of Transit's Market Share and the Public Policies That Influence It* identified yet more factors influencing the choice to take transit:

- *Land use:* Development density is one of the most critical determinants of transit choice. This may seem simple, but it is often overlooked by persons who do not work with transit. For transit to work, you need enough individuals who can walk comfortably to a final destination. This is because an individual is without a car at the destination end of the trip and must walk to their journey's end. The higher density development, the more likely a successful transit route can be created. But it is critical to note that the importance of density is on the destination end of a transit trip rather than the origin. That is because it is possible to use park and rides to create density at the origin of trips.

  Density is not something that a project manager or planner can affect but it is something that must be considered when planning new or enhanced service. How many jobs can be accessed by walking at the trip end? Are there enough jobs available that there is a critical mass to make transit successful? Oftentimes, there are just not enough

walkable jobs to make a critical mass to support transit.

A subtlety of the question of land use is when jobs are available. For example, if an area has a casino that is its major employer, do the shift changes align for the various departments? If there are five departments and each changes shifts at different times and has differing peak employment times, transit may not work even though, on the face of it, it would appear that there is a large enough nexus of jobs to make transit feasible.

- *Travel time:* Overall travel times must be considered, from the door of the individual's house to the door of their final destination. The running time of the bus or transit vehicle is important but the total amount of time door to door is even more important. The bus trip may be quick but if a person has to walk a long distance to the bus or from the bus to their final destination, persons will not choose transit. The location of bus stops from parking and the location of bus stops at destinations can be important. One transit provider built a large park and ride as a surface lot. The lot never filled because the far off spaces were too far for people to walk in a timely manner. Often planners want to string together a number of transit stops at either the trip origin or destination but this can make travel times too long for riders. Also, how one walks from the bus stop to their final destination can be important. Having to cross landscaping or parking lots can add costly travel time and reduce transit attractiveness. Also, travel time has to be considered in terms of running time of the bus. If the bus can move faster, trips are more attractive. Buses can move faster through many enhancements. Dedicated lanes or queue jump lanes can make travel faster. These can also be critical during construction projects because travel time reliability may be an issue with construction activities. Also, the type of service is important. Service that stops frequently can make for a slow trip versus service that makes one stop and then goes directly to its destination.

  Also, all travel times are not equal. Riders are much more time conscious in the morning, as most are going to work. In the evening, riders may be more tolerant of longer trip times, more travel time variability or more stops as they are typically not as concerned about arriving within a specific time frame.
- *Comfort:* Although hard to define, "comfort" and "convenience" are very important. In studies that have made serious attempts to measure the effects of "comfort" and "convenience," they often prove to have a significant impact on consumer choices. Because using transit means interacting with other people, the environment that transit is provided in is important. Also, women ride more than men. Spaces must feel safe. Buses must be clean and drivers must be courteous. Waiting areas must be clean and well lit, especially when transit service begins during hours that it is dark. Security cameras can heighten a sense of security. Snow removal must be prompt. Waiting areas must feel safe and secure.

A number of other studies echoed these results. Some of these studies include: *TCRP 111: Elements Needed to Create High Ridership Transit Systems* (TranSystems 2007), *TCRP H-32 Determining the Elements Needed to Create High-Ridership Transit Systems* (Fleishman 2004) *TCRP Web Document 32 (Project H-32): Contractor's Interim Guidebook: Elements Needed to Create High Ridership Transit Systems* (TranSystems Corporation, Planners Collaborative et al. 2005) *TCRP Report 55: Guidelines for Enhancing Suburban Mobility Using Public Transportation* (Urbitran Associates, Multisystems et al. 1999) TCRP Research Results Digest 69: Evaluation of Recent Ridership Increases (Chisholm-Smith 2005) and many more studies.

So, if these are factors that affect transit ridership overall, what things impact highway construction transit-mitigation activities?

One issue is the question of free fares. Many construction mitigation activities will use free fares to attract travelers to transit. But how does that affect on-going ridership? *TCRP 27: Building Transit Ridership: An Exploration of Transit's Market Share and the Public Policies That Influence It* (Charles River Associates 1997) and *H-6: Transit Fare-Pricing Strategy in Regional Transportation Systems* and *TCRP Report 95: Chapter 12, Transit Pricing and Fares(Mccollom and Pratt 2004)* all found that fares do matter but not in the way it would seem on its face. All three studies founds that fares are important determinants in attracting travelers to transit. The lower the fares, the more people choose to use transit. But once people make the decision to change their travel behavior and they ride for a while, they are fairly insensitive to changes in fares. Habits form and they tend to stay with that habit even if it becomes more expensive. For highway mitigation projects, a free ride may be a good way to attract riders to make an initial change in their behavior. But once that change has occurred, it appears that when fares go up to regular rates that the vast majority of travelers will stay with transit despite having to pay more. In fact, research on short-term fare changes shows that travelers factor those upcoming changes into their decision to try transit if they know that reduced fares are temporary. (Mayworm, Lago et al. 1980)

Another question is how often transit mitigation activities are being undertaken. MnDOT is not the only state to use transit during construction projects. A recent survey of the transportation agencies of 21 states and the cities of Chicago and San Francisco found that 86% reported taking measures to address other modes prior to highway construction. But the number of projects that agencies did this for varied substantially. States were asked how frequently they took measures to address other modes prior to construction. Responses were:

9% - Always
0% - Very often
23% - Often
54% - Sometimes
14% - Never (Tom Warne and Associates 2011)

Respondents reported varying levels of activities also. Specifically:

- 87% reported coordinating with other modes during the engineering design process
- 83% reported coordinating with other modes during the planning process
- 83% reported having specific meetings or committees with transit agencies
- 39% reported having permanent, on-going meetings/committees with transit agencies (Tom Warne and Associates 2011)

Despite reporting that agencies considered other modes during project planning, most reported minimal reliance on other modes of transportation to mitigate the vehicle throughput restrictions on a given corridor during construction. Only 9% of the responding agencies reported that diverting volume to other modes was effective, whereas the majority only found some effectiveness in doing so. The "Never" and "Sometimes" responses were provided 69% of the time, reflecting a low level of reliance on other modes to accommodate mobility needs during construction. Instead, most agencies report including other modes in their planning but with a focus on accommodating their movements instead of as a strategy for reducing

vehicles in work zones. (Tom Warne and Associates 2011) This may be because of the perception that transit carries a small number of travelers overall. Despite transit providing 2-5% of all trips in a region, the number of persons being carried on transit versus automobiles during peak travel can be much higher. Likewise, the percentage of persons who are choosing transit versus auto travel in congested highway corridors (which provides a travel time incentive to use transit) can be much higher. In some corridors in the Twin Cities, transit carries the equivalent of one or even two lanes of auto traffic at peak. Because of this, transit can have a much larger impact on travel than may be the common perception. Also, automobile movement is very dependent on small changes in traffic volumes. It takes a relatively small number of automobiles to turn free-flow traffic into stop-and-go traffic. Transit's ability to remove even a small number of vehicles from a corridor may have a disproportionately positive impact on travel. This can be especially critical during construction periods.

A change has been occurring in our understanding of transit's impact on highways and on highway construction. As highway expansion becomes more difficult due to a lack of funds and push-back from affected neighborhoods, there has been a growing recognition that transit provides an alternative to be able to move more people on the same roadways. MnDOT itself has been going through this recognition, moving away from Level of Service (LOS) measures to mobility measures in its long-range highway planning. The 2010 edition of the "Highway Capacity Manual," the bible on highway management has taken a multimodal approach in its most recent update, a substantial shift from previous versions. (Ryus, Vandehey et al. 2010)

Prior to 2005, from a national perspective, the integration of transit into highway construction projects was haphazard. Some highway departments did extensive work to integrate multiple modes into highway construction planning and management while others did little. In 2005, Federal Code of Regulations Rule 23 CFR 630 was revised and the Work Zone Safety and Mobility Rule was published. This rule updated and broadened the former regulation at 23 CFR 630 Subpart J Among other things, this rule requires robust travel management plans (TMP) for every transportation project. Transit must be included where it exists. The major requirements of this rule are:

- Development and implementation of an overall, agency-level work zone safety and mobility policy to institutionalize work zone processes and procedures.
- Development of agency-level processes and procedures to support policy implementation, including procedures for work zone impacts assessment, analyzing work zone data, training, and process reviews.
- Development of procedures to assess and manage work zone impacts of individual projects. (Federal Highway Administration 2005)

This plan requires construction planners and managers to consider demand management strategies in their work zone planning. This includes:

- Transit service improvements
- Transit incentives
- Shuttle services
- Parking supply management
- Variable work hours
- Telecommuting
- Ridesharing/carpooling incentives

- Park-and-Ride promotion

It also requires extensive public awareness strategies which can be used to promote alternative modes of transportation, including:

- Branding
- Press kits
- Brochures and mailers
- Press releases/media alerts
- Mass media (earned and/or paid)
- Paid advertisements
- Project Information
- Telephone hotline
- Planned lane closure website
- Project website
- Public meetings/hearings, workshops
- Community task forces
- Coordination with media/schools/business/emergency services
- Work zone education and safety campaigns
- Work zone safety highway signs
- Rideshare promotions
- Visual information

As a result, there has been increased attention paid to transit and its issues in highway construction. One would expect that there will be more research on the use of transit to mitigate construction impacts as data becomes available from more highway projects.

**Major Construction Projects using Transit as a Mitigation Tool**

The FHWA's Work Zone Safety rules require every major project consider transit in its project development. It hasn't been that way in the past however. Despite this, some projects that have integrated transit into their projects. Examples include:

- *Carmageddon: Los Angeles I-405 (2011)*: The ten mile stretch of Interstate 405 in West L.A. between LAX and the San Fernando Valley is one of the most congested freeways in the United States. In July 2011, the freeway had a planned shutdown for 53 hours over a weekend. The media predicted "Carmageddon," a complete shutdown of transportation in Los Angeles. In response, Metro added 100 buses and 32 rail cars on the bus and rail lines serving the area. Metrolink stepped up its regularly-scheduled weekend service with seven round-trips on the Ventura County Line and nine additional trips on the Antelope Valley Line. Also a fare discount of a $10 Weekend Pass on July 1, good for unlimited rides on Metrolink trains from Friday night at 7p.m. through Sunday night at 11:59 p.m. was implemented. Additionally, Amtrak offered a 50 percent discount on fares for all its Pacific Surfliner trains to those traveling in the affected area. (Los Angeles Metro 2011) As a result of this work and other mitigation efforts, there was no grand gridlock in Los Angeles. In fact, with almost 20,000 boardings over the weekend, Metrolink experienced the highest weekend ridership it had seen in its 19 year history,

with ridership 50% higher than the same weekend the previous year. (Los Angeles Metro 2011)

- *Milwaukee – Marquette Interchange (2004-2006):* The Marquette Interchange is a five level interchange where Interstates 43, 94 and 794 intersect. This three year, $810 million, 5.5-mile reconstruction project rebuilt this interchange as well as related ramps and roadways. Project engineers determined long-term ramp closures and project-related congestion on freeway and local road transit routes would create longer travel times for downtown commuters. Additional buses were added on key transit routes into downtown for the duration of the project. Removal of free parking downtown created additional demand for transit. As a result, additional express and mid-day park and ride services were added. Summertime freeway festival flyer service was enhanced during the construction project. (Hustad, Nac et al. 2006)
- *Springfield Interchange Project, Virginia (1998-2004):* The Springfield Interchange, also known as "The Mixing Bowl," is one of the busiest intersections in America. Three major highways (I-95, I-395 and I-495) converge at this point, creating a three-mile stretch of on- and off-ramps, bridges and HOV carpool lanes. In 1998, the Virginia Department of Transportation began an eight-year construction project to improve this intersection. To ease congestion during construction and help commuters avoid delays, VDOT and the Virginia Department of Rail and Public Transportation developed a comprehensive congestion management plan. Over eight years, the Virginia Department of Transportation (VDOT) made investments in transit including a 10 percent increase in park and ride spaces, increased commuter rail service, enhanced bus services, discounted transit fare and promotion of vanpools, carpools and bus-pools. (Virginia Department of Transportation 2005)
- *The Transportation Expansion Project (T-REX), Denver, Colorado (2004-2007):* The Transportation Expansion Project or T-REX was a $1.67 billion venture within the areas of Interstates 25 and 225. The T-REX widened major interstates to as much as seven lanes in each direction and added 19 miles of double-track light rail throughout the metropolitan area. Most of the transit activities remain intact after the completion of the project. 50% of commuters in Denver affected by construction used some TDM strategies, which improved congestion during T-REX. Transit promotion activities included:
    - 14 employers purchased Eco Pass which resulted in over 1,200 employee Eco Pass holders,
    - 318 commuters purchased subsidized transit pass products
    - 80 commuters utilized Commuter Checks to purchase vanpool services
    - 179 Vanpool riders received T-REX TransOptions subsidies
    - 9 Vanpools were formed (Colorado Department of Transportation 2008)
- *I-15 CORE, Salt Lake City, Utah (current):* I-15 CORE will renovate I-15 in Utah County to meet transportation demands through the year 2030. The project will add new lanes, extend express lanes, reconfigure interchanges and replace 63 aging bridges. Transit enhancements include expanded TRAX light rail service, expanded express bus service, enhanced local bus service, expansion of vanpools.
- *I-405, King and Snohomish Counties, Washington (current):* The I-405 Corridor Program includes a number of projects focused on improving congestion chokepoints along this heavily traveled corridor (approximately 800,000 people daily). As part of its construction mitigation plan, the Washington Department of Transportation (WSDOT) implemented targeted bus route expansion, temporary phased bus lines along

construction routes, new bike lockers to support bike-bus integration and additional park and ride facilities in affected areas. Additionally, as part of the state's Commute Trip Reduction (CTR) Program, employers with more than 100 employees were provided with support for promoting and facilitating alternative transportation options for their employees. In support of the goal to add 2,000 new vanpools in the next 20 years, WSDOT provides financial incentives to both users and providers of vanpools. (Washington Department of Transportation 2012)

- *I-95 Integrated Transportation Management Effort, State of Delaware Philadelphia/Wilmington area (2000 - 2003):* I-95 serves as the principal connection between Philadelphia, Wilmington, and Baltimore. The project included reconstruction, highway widening, and capacity improvements. Improvements included enhanced bus service, fare discounts and a new fare collection system (DARTCard) that allowed tailoring of free rides to specific riders. (UrbanTrans Consultants 2003)

**Summary**

So from this research, what key strategies emerge for taking advantage of this opportunity to change people's habits and get them to use and continue to use transit?

- *Transit must go where people want to go when they want to*. Many riders identified "Convenience" or "Quicker Trip" or the "Availability of a Parking Lot" as major factors in making the choice to select transit. Fundamentally, people will not use transit if it does not provide a real viable alternative to driving. For a construction project, this means that transit must be as optimized as possible to provide the best trip possible when travelers experiment with changing their habits.
- *There must be a concentration of walkable destinations:* There need to be walkable environments with high enough concentrations of jobs to make transit viable. Oftentimes, a lack of concentrated walkable destinations is the major reason why transit service fails to be economical.
- *Frequency of Service must be high enough to provide travel alternatives for riders:* No one wants to ride the last bus because if they miss it, they are stranded. Likewise, if something comes up during the day and riders need to go home, if there are not alternatives, transit users can be stuck. In the morning, if riders are running late, they want to have another bus coming to provide their trip. Because of this, there must be transit service with a high enough frequency that if you miss one bus, another bus will be coming along soon. At minimum, routes should have at least four trips in the morning and four in the evening, preferably more because typically very few people will ride the last bus. Mid-day service can also help increase the desirability of transit even though ridership may be low.
- *Minimizing Travel Time makes transit more attractive:* Reducing travel times, especially during a construction period, increases convenience. Queue jump lanes, dedicated bus lanes, priority for transit vehicles or other improvements to run times can help increase the convenience of transit. But construction managers and transit planners need to be aware of not only the actual convenience but whether riders perceive this as a convenience that they want to change their habits for. Seeing buses zip by them day after day may be as much an inducement to change habits as the actual travel time itself. Because of this, signage along a route which points out the benefits of changing travel modes can be important. Also, the total amount of time from door to door is important. The time that people have to walk from their car or house to the bus

and the time they have to walk from the bus to their destination is as critical as how quickly the bus moves.

- *The Span of Service must be broad enough to encompass work shifts:* Service needs to run during times when people want to get to work and back. For typical office workers, 8 a.m. is the peak time when travelers want to arrive at work, although many workers are often spread out an hour either side of that and some percentage may want to ride even earlier. Departure times are often even more broadly arrayed with many people wanting to depart as early as four or as late as six-thirty. There are many industries that have shift work (such as factories) or operate 24 hours a day (medical facilities, casinos, etc.) that can vary from this. Transit service must meet these schedules.
- *Free fares can be a powerful incentive for people to try transit, although they do not appear to impact people stopping using transit*. Free transit fares can be an inducement for riders to make a mode change. Although this may be an inducement for starting to use transit, subsequent surveys and other research found that fare costs were not a significant influence in stopping the use of transit. It may be that either habits are strong enough once they are set to not be influenced by fare changes or it may be that because riders know that free trips are temporary and they factor this into their decision about choosing transit. Research supports the latter.
- *Intensive promotion of alternatives is critical to users making the choice to change modes*. Research shows the importance of promoting transit as an alternative to driving. Travelers must be enticed out of their regular travel routines. For project managers, transit information should be featured prominently with other general project information. But marketing tailored to specific riders, specific services or specific employers can be very effective. Project managers must think strategically about targeted marketing. Are there special groups that should receive outreach? Employees of specific employers? Students? Elderly populations? Special event attendees? Tourists? Others? DTA both did general outreach and promotions targeted to specific employers as part of its mitigation efforts and this proved to be effective.
- *Comfort and safety are important for retaining riders*. If travelers, especially women, do not feel safe and comfortable, they will not continue to use transit.

**Bibliography**


Charles River Associates, I. (1997). TCRP Report 27: Building Transit Ridership: An Exploration of Transit's Market Share and the Public Policies That Influence It. T. C. R. Program. Washington DC, Transportation Research Board.

Chisholm-Smith, G. (2005). TCRP Research Results Digest 69: Evaluation of Recent Ridership Increases T. R. Board. Washington DC, Transit Cooperative Research Program: Research Results Digest.

Colorado Department of Transportation (2008). Transportation Demand Management: TECHNICAL REPORT. C. D. o. Transportation. Denver Colorado, Colorado Department of Transportation.

Federal Highway Administration (2005). FHWA-HOP-05-066: Developing and Implementing Transportation Management Plans for Work Zones. F. H. Administration. Washington DC, U.S. Department of Administration.

Federal Highway Administration (2011). Congestion Toolbox. FHWA. Washington DC.

Federal Highway Administration (2011). Work Zone Mobility and Safety Guidebook. FHWA. Washington DC.

Fleishman, D. (2004). TCRP H-32: Determining the Elements Needed to Create High-Ridership Transit Systems T. C. R. Program. Washington DC, Transportation Research board.

Hustad, M. W., M. Nac, et al. (2006). "Mitigating Traffic Impacts During the Marquette Interchange Reconstruction Project." ITE Journal **76**(4): 38-43.

Jenks, C. (1995). TCRP Research Results Digest 4: Transit Ridership Initiative. T. R. Board. Washington DC, Transit Cooperative Research Program.

Jenks, C. (1998). TCRP Research Results Digest 29: Continuing Examination of Successful Transit Ridership Initiatives. T. R. Board. Washington DC, Transit Cooperative Research Program: Research Results Digest.

Lane, B. (2011). "A time-series analysis of gasoline prices and public transportation in US metropolitan areas." Journal of Trasport Geograpy **November 2011**.

Los Angeles Metro (2011) Metro, Metrolink Trains, Amtrak, Beach Bus offer special transit service to help mitigate congestion during the I-405 closure weekend. Metro Press Releases

Los Angeles Metro (2011) Metrolink Experiences Record Ridership during I-405 Closure. Metro Press Releases **July 19, 2011**,

Mayworm, P., A. M. Lago, et al. (1980). Patronage impacts of changes in transit fares and services. . Washington, D.C: , The Office of Service and Demonstration Methods.

Mccollom, B. E. and R. Pratt (2004). TCRP Report 95: Chapter 12, Transit Pricing and Fares. T. R. Board. Washington DC.

Minnesota Department of Transportation (2011). How to Thrive During Congestion. M. D. o. Transportation. St Paul MN.

Pratt, R., Texas Transportation Institute, et al. (2000). Traveler Response to Transportation System Changes Handbook. T. C. R. Program. Washington DC, Transportation Research Board.

Ryus, P., M. Vandehey, et al. (2010). Highway Capacity Manual 2010. T. R. Board. Washington DC, National Academy of Sciences.

Tom Warne and Associates (2011). NCHRP SYNTHESIS 413: Techniques for Effective Highway Construction Projects in Congested Urban Areas. A Synthesis of Highway Practice. T. R. Board. Washington DC, National Cooperative Highway Research Program.

TranSystems (2007). TCRP Report 111: Elements Needed to Create High Ridership Transit Systems. T. R. Board. Washington DC, Transit Cooperative Research Program.

TranSystems Corporation, I. Planners Collaborative, et al. (2005). TCRP Web Document 32: Contractor's Interim Guidebook: Elements Needed to Create High Ridership Transit Systems. T. C. R. Program. Washington DC, Transportation Research Board.

UrbanTrans Consultants (2003). Transportation Demand Management and Corridor Planning. H.-G. A. Council. Houston, Houston-Galvaston Area Council.

Urbitran Associates, I., I. Multisystems, et al. (1999). TCRP Report 55: Guidelines for Enhancing Suburban Mobility Using Public Transportation. T. C. R. Board. Washington DC, Transportation Research Board.

Virginia Department of Transportation (2005). Overview of Congestion Management Programs: The Plan Development and Critical Success Factors. R. Department. Richmond Virginia, Virginia Department of Transportation.

Washington Department of Transportation (2012). I-405 Corridor Program. W. D. o. Transportatoin. Seattle, Washington Department of Transportation.