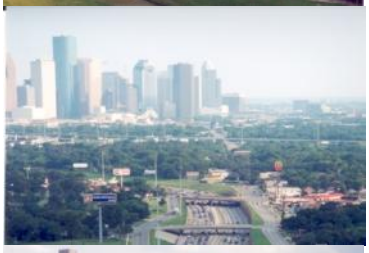
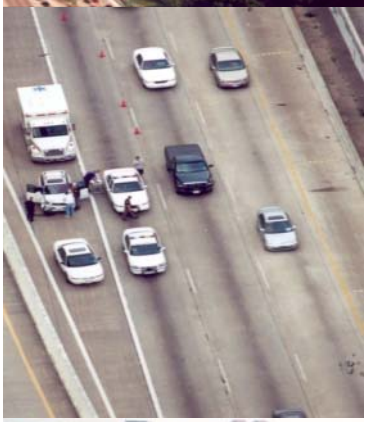






ENHANCING MOBILITY IN THE HOUSTON-GALVESTON REGION

RESEARCH AREA 4
IMPROVED TRANSPORTATION PLANNING TECHNIQUES

Mobility Analysis in
Long-Range Transportation Planning –
An Important Item on
the Mobility Checklist

Concepts and Procedures that Improve
Long-Range Transportation Plans

April 2009

Texas Transportation Institute

ABSTRACT

There have been several transportation planning efforts to improve the analytical and communication techniques used to convey the mobility problems and solutions. This paper is a summary of the lessons learned about developing effective mobility plans. The paper builds on several efforts in the Houston-Galveston region over the past several years to communicate the benefits of investment in transportation systems. The paper includes information on the methods that can be used in preparing a mobility plan, the integration of the plan with other planning efforts and the benefits from the activities.

The overall study produced information about more than 80 solution strategies in a format that is understandable to non-technical audiences. Research effort also identified improved planning analysis techniques that can be used to improve the processes and products from transportation planning activities. The study also investigated the factors that influenced the development and redevelopment activities in the area inside the I-610 Loop. More information is available on a website: http://mobility.tamu.edu

ACKNOWLEDGEMENTS

This research was conducted with funding provided by the U.S. Department of Transportation. Dr. Tim Lomax is the principal investigator for this study and a co-author of this paper. Mr. Ashby Johnson of the Houston-Galveston Area Council is the other co-author. The authors wish to thank Mr. Ed Weiner of US DOT for his guidance during this project. His ideas and thoughtful review comments greatly improved the usefulness of the final products.

In addition, staff of the Houston-Galveston Area Council (particularly Alan Clark and Chris Van Slyke) and the Greater Houston Partnership (particularly David Finklea and Theresa Rodriguez) contributed to the author's understanding of the challenges and role of possible improvements to current practice over the past several years. Ms. Michelle Young prepared and formatted the report and Mr. Kevin Hall developed the improved transportation planning model analysis technique described in this paper. Ms. Linda Cherrington was responsible for conducting an important and insightful analysis of the factors relating to development inside the I-610 Loop in Houston as part of Research Area 3 in the project.

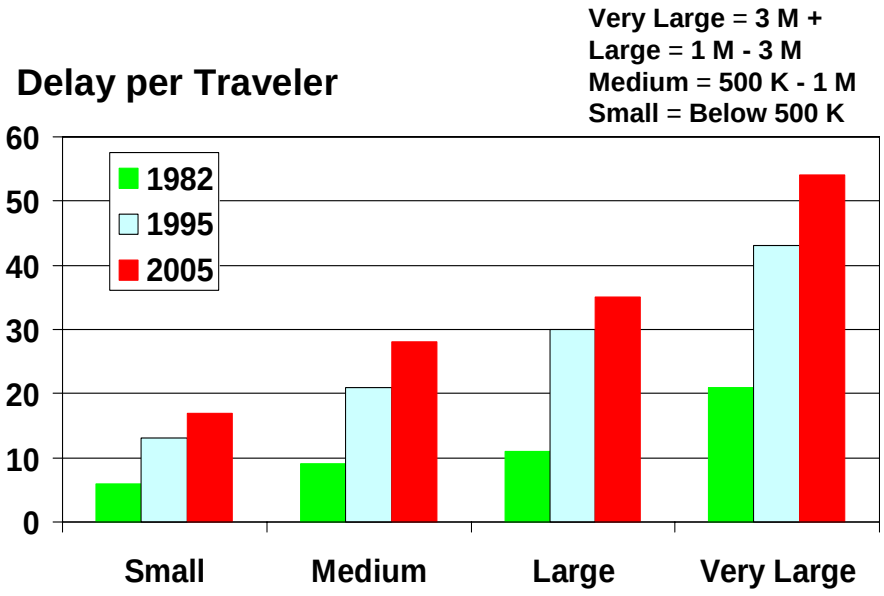
TABLE OF CONTENTS

OVERVIEW

With congestion increasing in cities of all sizes (Exhibit 1) and a greater focus on identifying the best mobility improvements, methods to finance the projects, programs and policies and strategies to discuss the benefits with the public and the business community, there is a need for analysis techniques and data to provide some perspective on possible solutions. Major metropolitan regions will be challenged to address congestion concerns while their economy grows.

Decisions by transportation planners, appointed and elected officials and opinion leaders to craft vision-oriented plans can provide information for this range of purposes. Identifying the set of solutions required to achieve desired mobility levels can help focus the public discussions on alternative investment levels in a much more informed way than those efforts that only develop the federally mandated plans for financially constrained long range plans. The process and products should continue to evolve as lessons are learned and the uses are identified, but the first steps outlined in this paper can show the way to a significant enhancement in regional planning efforts. "Mobility" in this paper includes a broad set of attributes that professionals and academics use to describe the ability of travelers and shippers to reach their destinations in an acceptable time.

Exhibit 1. Congestion Trends in U.S. Urban Areas by Population Group



Source: Reference (1)

(1) – Indicates number in Reference list.

INTRODUCTION TO MOBILITY PLANNING

Experience in the Houston and Atlanta metropolitan regions, as well as a statewide program in Texas was used to identify the key steps in mobility planning. The purpose of this paper is to demonstrate the value of moving beyond the required planning steps to learn more about the transportation needs of a region and the benefits to addressing those needs.

What is a Mobility Plan?

A mobility plan is one element of a process. The mobility plan examines the location, timing and scope of the transportation system improvements needed to achieve a vision. The "plan," in this case, is not a map of projects or a list of programs that are included. It is the step *before* a map is developed; the step that engages the public and decision-makers in a discussion about the need for improvements and the benefits from addressing mobility challenges.

A mobility plan focuses on "what could be." The benefits of mobility improvements are discussed in a framework of "what could be our future if we invested more, and/or more wisely for improvements in transportation performance and system condition?"

A mobility plan is an extension of the long-range transportation plan. Current procedures answer "what is happening?" and "what will happen?" Those issues have a reporting framework that includes performance reports, financially constrained long-range plans, and near-term transportation improvement programs. The question that describes mobility planning and causes different actions is "what could happen?"

A mobility plan is mode, project and program-neutral. Many types of strategies have positive transportation effects. These might include traditional construction of added capacity, operation and demand management projects, programs and policies. They increasingly include some element of pricing and exploration of land use changes and development options. The improvements might also be in a number of topic areas outside of transportation programs including law enforcement, school location and quality, job training, etc. Selection of specific strategies is the step after a vision and goal has been identified.

A mobility plan estimates the benefit from additional transportation investment. The goal of a mobility plan is to illustrate the beneficial effects from a variety of policies and programs that affect transportation and then identify the amount of additional investment that is needed to reach the vision and goals. The mobility plan might also indicate the location of needed investments given the land use, population and employment assumptions included in alternative scenarios.

A mobility plan should be connected to other reporting elements. Descriptive statistics and information can be used to assess the adequacy of plans, policies and project development efforts. They can also be used as a key element of proposals to increase funding or enhance financing options. The planning effort is focused on understanding the mobility problems and the general magnitude of the solutions required to achieve a target mobility level, while the periodic reporting cycle illustrates the effect of near-term actions.

A mobility plan should include a performance target. The derivation of a congestion level goal can be made in several ways; the important element is that there should be a standard that the community accepts and uses to gauge progress. The target can be an overall average congestion level, a link-based standard, a reliability measure or some other combination of measures. The target should recognize that there may be many types of improvement strategies. A mode-neutral set of measures or a set of measures that include all modes usually work well in this environment.

A mobility plan should build on existing success. If the agency(s) involved are perceived as doing a good job with the funds they have, there is more likelihood that the information will be well received. This is equal parts of "doing a good job" operating the system and delivering promised projects and being transparent, accountable and communicating with the public about the performance and condition of the transportation network and services.

Organization of Paper

This paper describes the key elements of a mobility plan, the analysis methods, performance measures and commendable practices. The paper is one element of a larger research effort to improve congestion in the Houston-Galveston region. Several reports and technical memoranda can be found on the study website at: http://mobility.tamu.edu/resources

The key aspects of this paper include the following issues and challenges:

- Current Environment for Mobility Planning Efforts
- Benefits from Mobility Planning
- Relationship To Current Planning and Development Processes
- Crafting a Mobility Plan
- After the Mobility Plan – What's Next?
- Conclusions – Why Prepare a Mobility Plan?
- Appendices

The mobility planning process that Houston is engaged in is one of only a few such efforts in the country. The goal of identifying the need for additional transportation capacity, operational improvements, changes in demand patterns and alternative land use arrangements is not required by federal standards. Estimating the benefits from increased investment in mobility improvement using terms that the public, decision makers and business leaders find relevant is also an element of the mobility plan that is not typically seen. These are key elements that, in some sense, represent a return to previous transportation planning practices that focused on achieving community goals using a set of transportation projects.

Each major section of this paper has a series of recommendations or findings and supporting information. While goal-oriented planning is not new, the recent efforts in federally mandated planning have focused less on vision and more on matching financial constraints to the programs and projects that are being placed in the plan. This is a very useful activity, but in isolation it lacks the ability to convey the complete message about future transportation options. An activity like a mobility plan is a very worthwhile additional element.

Region and State Mobility Plans

Six significant mobility planning efforts were used as background and resource material for the paper. Each took different analytical and reporting approaches, but all were fundamentally about achieving some different outcome than current trends suggest. There is much more detail on the websites and in the reports noted for each effort. There are also several other efforts in states such as California, Washington and Minnesota that have resulted in improvements in the transportation funding situation and, therefore, in their mobility futures.

Background – Houston 100% Solution (2)
http://2035plan.org/
One lesson from the initial vision-oriented plan in Houston (dubbed the "100% Solution" due to its goal of eliminating all of the serious congestion) was that too many specifics may not be productive. Staff in the Houston-Galveston Area Council attempted to estimate the amount of road capacity that could be added to each arterial by adding lanes and implementing operational and public transportation improvements. There was never a suggestion that the lanes would be added without the appropriate public participation process, but some of the value in the exercise was lost to critics of road capacity additions (*3*).

Background – Atlanta Aspirations Plan (*4*)
http://www.atlantaregional.com/documents/Envision6_RTP.pdf
The Aspirations Plan was an extension of the financially constrained Regional Transportation Plan developed by the Atlanta Regional Commission. The ARC prepared a list of several projects beyond those that could be accomplished with the projected available funds. The projects addressed key congestion problems or provided significant enhancements to regionally important facilities. The $74 billion cost of the Aspirations Plan was an increase of $25 billion above the financially constrained list of projects, programs and policies. The goal of the Aspirations Plan was to improve the information available to the public and decision makers about mobility solutions.

Background – Atlanta Congestion Mitigation Task Force (*5*)
http://www.atlantaregional.com/html/1535.aspx
Georgia's Governor requested that the four state agencies with a transportation mission address the congestion problems in 2005. The agencies formed a task force that developed a regional mobility target and agreed to alter their project prioritization processes to place more weight on the reduction of congestion in selecting projects and programs to be funded. The regional target was based on data from the long-range planning model with modifications to include operations treatments and public transportation service.

Background – Texas Governor's Business Council (*6*)
http://www.texasgbc.org/Reports3.htm
A group of business leaders that offer advice to the Texas Governor on a variety of important issues developed a needs estimate in 2003. The Council sanctioned a review of the progress three years later and expanded the estimate of benefits that may flow from improved mobility. The objective was stated in the title of the report: "Shaping the Competitive Advantage of Texas Metropolitan Regions: The Role of Transportation, Housing and Aesthetics." The business leaders saw mobility as one key aspect that can be used to improve the Texas economy. The report outlined the size of the problem, offered some methods to solve the funding crisis and identified the benefits that Texans will experience.

Background – Texas Mobility Plans (*7*)
Texas Metropolitan Mobility Report: Breaking the Gridlock. 2004 Report of Progress and Action Plan for Continued Success, TxDOT, October 28, 2004.

Example report from a region (*8*):
http://www.campotexas.org/pdfs/Final_2006TMMP_Web.pdf
Following a request by the Governor that was, in part prompted by the Governor's Business Council report (*6*), the Texas DOT and the Metropolitan Planning Organizations developed a process for estimating the cost of eliminating serious congestion problems in the long-range transportation plans. The cost was estimated using the amount of roadway required to eliminate sections of seriously congested road (defined as volume/capacity ratios greater than 1.0). The plans noted that the actual projects, policies and programs that would be required to solve the congestion problems would be determined as funding and/or partnerships were identified.

Background – Texas 2030 Committee (*9*)
http://texas2030committee.tamu.edu/
The Texas Transportation Commission sanctioned an examination of the mobility and preservation needs by an independent committee of business and transportation experts. Using previous research and supported by researchers from the Texas Transportation Institute and the Center for Transportation Research, the committee estimated the funding required for the period from 2009 to 2030. The group identified the investment levels required to meet a range of goals, the benefits of achieving them and the consequences of lower investments.

THE CURRENT ENVIRONMENT FOR MOBILITY PLANNING EFFORTS

Houston is congested by any measure. Like most major metropolitan regions, congestion causes extra travel time, fuel consumption and a variety of effects to businesses, shippers and travelers. Congestion also exists on the weekends, on holidays and in some cases, the rural areas around Houston. There is not as much congestion during off-peak periods and weekends, but the system is stressed and incidents, special events and road work cause congestion to grow dramatically on some days.

The Significant Challenge of Growth

As if the high congestion levels are not enough of a challenge, Houston's growing economy will present decision-makers and citizens with more demand over the next two decades. From the perspective of citizens, transportation is only a part of a much larger system that influences their lives. Land use, employment and population patterns define transportation needs and effects. Mobility and related concepts such as accessibility are components of urban life, but are often not "the" concern of the public. The challenge of mobility planning is to relate the benefits and costs of congestion reduction (along with safety, environmental and other concerns) to other important urban issues such as education and health care.

It is important to view transportation as one of several "input" factors that determine the quality of life and economic development experienced by the residents of an area. Viewed this way, mobility issues and solutions can be related to agency missions and to what the public wants from the agency services. Visions, goals and missions can be very different depending on the region and the agency. The plans can also be different depending on the needs and issues of the region, but several common elements appear consistent and important.

Background – Reasons for a Mobility Plan

Mobility plans are worth developing if they are used by decision makers and the public to understand the challenges and opportunities facing transportation systems. When used properly, they relate the current and future condition and performance of the facility with a range of possible future outcomes. A plan can describe the location and nature of problems and the magnitude of the solutions needed to meet community and mobility goals. The performance measures and procedures in the mobility plan can also be used in regular reports by operating and planning agencies.

Transportation improvement programs come in a variety of compositions and financial arrangements. There are expansions of tax-supported capacity, a variety of tolling and pricing projects, operational improvements and strategies that provide incentives for employers and travelers to shift their travel patterns away from congested areas and times of day. Estimating the amount of projects, programs, and policies required to achieve congestion reduction can help focus the public discussions on mobility targets and alternative investment levels. The public

input process can identify those programs that the public will support, the role of alternative funding strategies, and the needs for mobility improvements.

Regional planning efforts and state plans incorporate several types of mobility improvement programs, illustrating a general tendency to use all available technologies and programs. The fact that these projects are chosen and funded in a variety of ways suggests that a mobility plan should include a range of flexible performance measures that speak to a variety of different audiences with relevant messages and a variety of analytical and communication techniques. The analyses may be conducted using several technical measures, models, data elements or estimation techniques.

Recommendation: Recognize that a mobility plan is part of a larger effort to communicate the importance of transportation. Accountability and transparency are forces that also play a role in shaping the needs of a comprehensive mobility plan. Business leaders, elected officials and the public expect their transportation funds to be spent wisely and a mobility plan can feed information into such efforts; when combined with reporting on current situations, a mobility plan can connect current challenges with solutions. Recent successes in obtaining additional revenue or increased flexibility in project development have several of the following attributes:

- Accurate reporting about the effects of current spending – Clear and unbiased reporting about current agency activities have been a way for the public to be informed about the numerous transportation challenges and what agencies are doing to address them
- Communication of good agency performance – An agency or region with a reputation for good performance and cost-effective use of public funds has a better chance of engaging the public in a discussion about additional strategies or funding. The perception issue is certainly related to the performance, but also to the quality of communication and information transparency.
- Delivering projects and programs in a timely and cost-effective manner – Agencies are increasing the amount of information about delivery time and cost status in their public reporting programs. These offer data to judge the "follow through" on transportation funding plans.
- Specific spending plan – Providing the public with a clear idea of which projects or programs will be funded is a significant element of most recent tax, fee or policy flexibility elections. It is difficult to obtain voter approval for a general tax or user fee increase.

It is interesting to note that reliability is an element of many of these program elements. Reducing the variability in travel time for people and freight is an increasingly important goal, but reliability also extends to information presentation, maintaining implementation schedules, updating funding allocations and measuring the effect of previous projects and programs.

BENEFITS FROM MOBILITY PLANNING

Congestion problems are important issues in the Houston-Galveston region, but the transportation improvement strategies will provide benefits in many areas. Congestion can be presented as the "brand name" under which all of the concerns are examined, but travel time improvements, delay reduction and benefit/cost ratios are not the only metrics that should be used to identify and prioritize the projects, programs and policies that might be pursued. Metropolitan areas and sub-regions typically have several goals, including air quality, quality of life, economic development, etc. for the results of the transportation expenditures. These should be incorporated into a broader definition of what constitutes the "costs" and "benefits."

Mobility planning, as it evolves in the coming years, will become part of the congestion management process and used to identify projects and programs that can improve congestion, quality of life, the environment and provide support for achieving a variety of other Houston area goals. This process will undoubtedly draw heavily on existing programs and processes, but it also provides an opportunity to re-examine those programs and assumptions in light of the vision-oriented approach. It also supports the interest in scenario planning efforts that examine a variety of land development alternatives.

The Texas Mobility Plans developed in 2004 and 2006 (*7*) focused on estimating the cost to achieve a target mobility level. Discussion continued during recent years on what the cost estimate includes and how to pay for the projects, but most of the public statements can be characterized as "we are not sure of the need, but it is large." There was also more discussion about transportation needs and how to pay for them in the 2007 Texas Legislative session than in recent sessions. Funding increases were not enacted during the 2007 regular Legislative session; they were ultimately overshadowed in the transportation committees by discussions over private road concessions and rural road network issues.

The 2030 Committee report (*9*) prominently considered the benefits of additional investment beyond the currently identified funding levels at the state and regional levels. Both individual and business effects were evaluated, with the business leaders pointing to congestion and unreliable travel times as causing additional business investment needs (e.g., additional distribution centers or trucks to serve the same population as a decade ago) or competitive problems. These problems have roots in the issues measured by the traditional benefit/cost analyses, but the dialogue proceeds beyond the "extra travel time to work" issue to address the broader society and economy effects.

Recommendation: Use the estimation of benefits as a way to make a case for transportation's role in the economy and society. Mobility plans should be about describing an alternative vision and the actions and funding required to achieve that goal. This approach will not be successful unless the public, business community and decision-makers see benefits in ways that justify spending on transportation systems rather than other important societal needs.

RELATIONSHIP TO CURRENT PLANNING AND DEVELOPMENT PROCESSES

A mobility plan does not exist as a stand-alone document or in isolation from other planning processes and decisions. It should provide supporting data and a forum for consideration of alternative future growth scenarios. Current planning processes in some regions – Washington, D.C. and San Francisco-Oakland among them - have adopted a policy of considering a range of land use scenarios focused on developing community consensus about development patterns, densities and types. These vision elements are used to grade alternative transportation strategies and to identify the appropriate mix of the "6 Ps" referred to in the North Central Texas Council of Governments long-term planning documents (projects, programs, policies, plans, performance and partnerships) (*10*).

The mobility element of this process does not need to include specific improvements, rather it should identify the general scale of investment and the resulting mobility levels – in the same way that a regional plan identifies the type of land uses but does not identify the style of houses or the names of the neighborhood streets in future subdivisions. Early versions of Houston's "100 Percent Plan" included an estimate of the amount of additional roadway that could be added within the right-of-way or by taking "realistic" rights-of way on specific streets and freeways. This was a planning estimate only and the effect of several elements of intelligent transportation systems and public transportation were also included. The goal was to determine what might be possible and contribute to a feasibility assessment of fixing the problems. The effort was portrayed in a much more definite light and criticized for "fast tracking" the public approval process. (*2,3*) Subsequent generations of the mobility plans have been more general and have emphasized the connections with other well-established planning and community involvement programs.

The analysis of development trends inside the I-610 Loop (*11*) indicated the growth in urban development was the product of several elements. The interest from home buyers and commercial developers was a key element. Other factors – notably improvements to public infrastructure and public safety improvements as well as increasing congestion – also played important roles.

Recommendation: Focus on the needs analysis process as the main product of a Mobility Plan. The initial Houston planning analysis of the amount of congestion that could be alleviated may have created a more accurate mobility picture, but it was somewhat in conflict with the vision element of the long-range transportation and regional land use plans. If the goal of scenario planning is to "create something different," an analysis based on continuation of the current pattern may not be seen as useful or relevant.

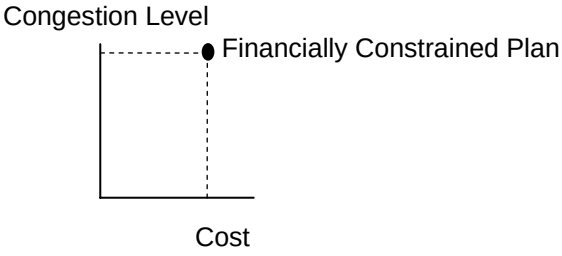
Recommendation: View the Mobility Plan as a method to consider options. A document like a mobility plan tends to raise expectations. If the plan has a set of specific projects, it may be difficult to make the reductions from a relatively costly set of projects, policies and programs to the financially constrained long range plan. The mobility plan, however, may be viewed as a process of identifying the options for the future, rather than as a single outcome. Emphasizing

the continuing elements of the planning process and need to incorporate future improvements will ensure that the Houston area will get the most benefit from the recent efforts.

The discussion about which projects should be pursued, how those should be implemented and benefits of additional funding will require more than a single plan. The public and decision-makers should be engaged in the dialogue so that the alternative futures can be considered in concert with the amount and source of funding or changes to policies or service cut-backs.

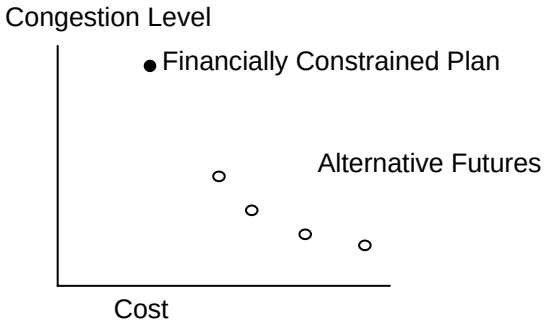
The difference between the goal of the mobility plan and the financially constrained planning requirements might be illustrated by the graphs in Exhibits 2 and 3. Current regulations focus on preparing the financially constrained plan. This results in, essentially, one plan with one congestion level estimated for the horizon year. This ISTEA-era requirement (produce a list of projects that can be achieved with expected revenues) has, without a doubt, improved the usefulness of the plan. The lack of a "transportation vision" element in most plans, however, means that it is more difficult to have a discussion about the level of mobility improvement that might be achieved by increased investment or a different mix of investments. The mobility plan process, in simple terms, seeks to add points to the Exhibit 2 graph and answer questions depicted in Exhibit 3 – like "how much better would mobility (and consequently quality-of-life and economic competitiveness) be if we spent $1 billion more?"

Exhibit 2. Depiction of the Minimum Planning Requirements



The typical long-range plan only includes an estimate of expected funding and the resulting condition.

Exhibit 3. Depiction of the Outcome of a Mobility Plan



A mobility plan includes several cost scenarios, and can also include a variety of alternative land-use development options.

CRAFTING A MOBILITY PLAN

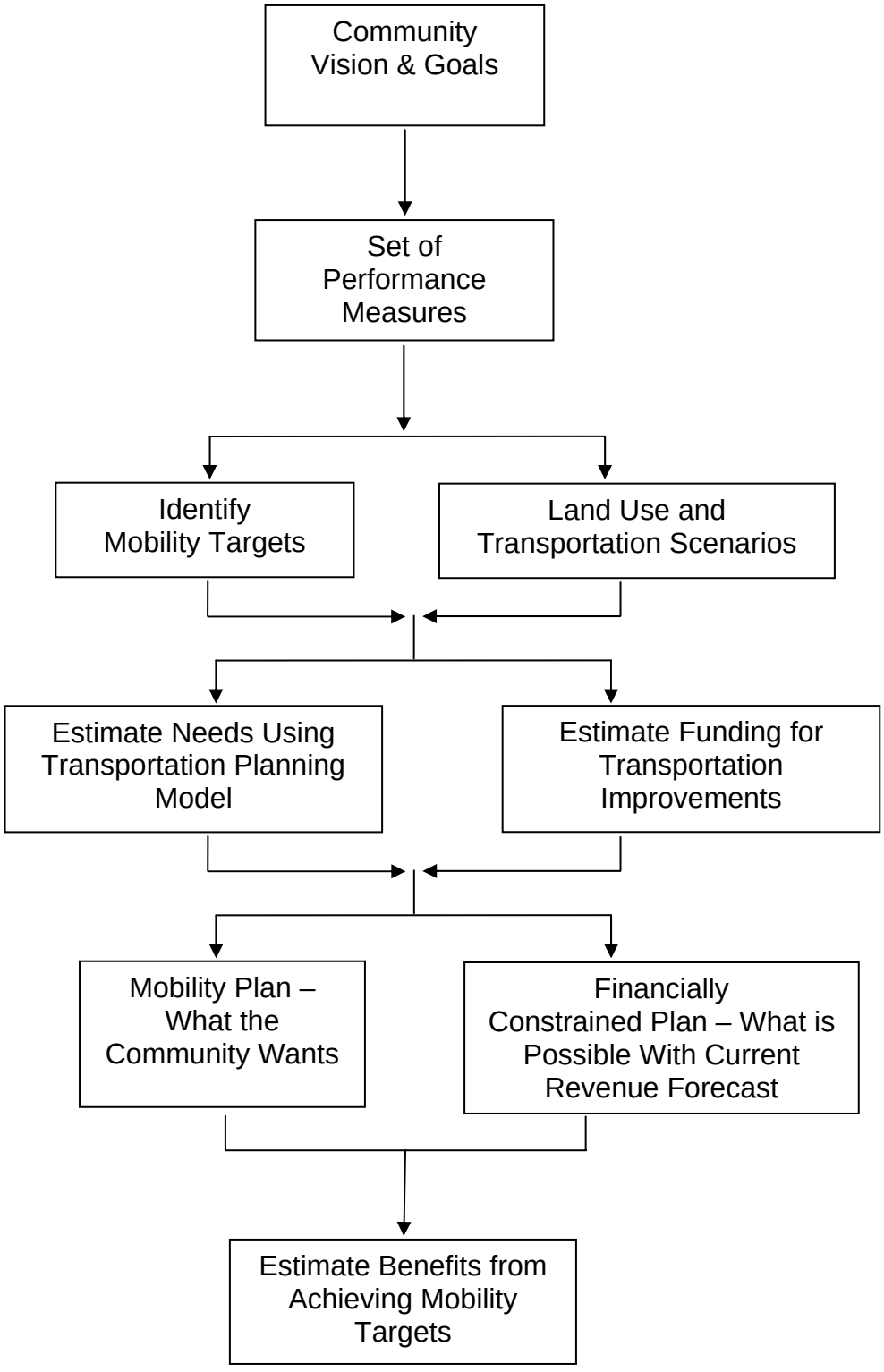
There are several key elements and steps in developing a mobility plan. Some steps will depend on local conditions, other planning processes that are in place and local institutional issues, but this section provides a set of steps that appear to be important in achieving a useful mobility plan (Exhibit 4). There are also elements or conditions that make the mobility plan easier to accomplish. In general, the mobility plan should be one component of an effort to improve the transparency of information about all aspects of transportation. The mobility plan can be connected to other efforts that demonstrate that the agencies and planning efforts are holding themselves accountable for current missions and funding levels, as well as building a decision structure that identifies resources needed to accomplish long-term goals.

Key Elements In Developing A Mobility Plan

Mobility plans can take many forms; the best ones are those that accomplish the goal of improving the information about mobility choices. The set of elements that achieve that result for a region or state is, by definition, the right set. The set of factors below seem to be on the list of elements to consider in crafting a mobility plan.

- Vision – What does a region want to look like? Any set of transportation improvement actions must be tied to the attainment of an end result. The vision in this sense might be derived from community input during the long-range plan development or it could be part of a separate community outreach effort tied to scenario planning or the mobility plan itself.
- Set of performance measures – Communicating the results and monitoring progress toward the targets should include performance measures that accomplish a variety of missions. Improved operation, management oversight, financial analyses and communication elements can all tie the mobility plan to daily and annual decisions while emphasizing the principles of transparency and accountability.
- Mobility targets – Developing a goal condition is important to understand the type and magnitude of additional investment and policy or program change. Desirably these will be expressed in travel time and delay terms that a general audience can understand. The target is a component of broadening the discussion from the “continue to get worse” results achieved when the only plan is a financially-constrained plan.
- Travel demand model analysis – The long-range transportation planning model should be used in the analysis of future conditions because it can assess the contribution of both land use changes and transportation improvements.
- Benefit estimate – There is rarely enough discussion about the benefits from transportation investment or consideration of the trade-offs between higher taxes/fees and the services provided for those fees. A mobility plan should include a benefit estimate using components that resonate with the public.

Exhibit 4. Mobility Plan Development Framework



Vision

Recommendation: The "vision" element should be the start and the foundation of the mobility planning process. This information should be compiled from several sources. The long-range transportation plan, public surveys, web site feedback, or election campaign and media information all provide evidence of the direction that the community wishes to proceed. The mobility plan, then, identifies the scale of transportation improvements needed to move the region toward that vision.

This approach could also apply when planning an individual route, a service or an operating policy. While the improvement options may not be as broad and the financial investment may not be as great, it may be useful to think about how the vision connects to possible outcomes before beginning an analysis. This ensures that all relevant options are considered and the analysis tools and performance measures are more likely to evaluate the full range of alternatives.

Clearly there should be expectations for transportation system availability and performance. These should relate to individual modes and system elements to connect the long-term goals in the mobility plan with a regular agency report on the same elements. The significant vision elements should be a description at the system or regional level of the quality of mobility and how that may relate to other aspects such as land use patterns and community development goals. A subsequent discussion in this paper about mobility targets suggests that the amount of day-to-day variation in congestion should be a part of the vision as well as targets for average congestion levels.

Select a Set of Performance Measures

Recommendation: All factors that might be important should be considered when developing a list of performance measures. The "stories" that might be told about the programs, projects, effects, and costs should be considered when choosing the measures. These stories provide a comparison between where a region is and where they wish to be on the important issues. The region might think of this as "beginning with the end in mind" – another vision-oriented element that asks "what is needed?" rather than "what do we have?"

The mobility plan should also consider how the system or regional performance measures might be used in corridor or subarea studies. Index-type measures that eliminate the effects of distance and the amount of freight or number of travelers can be effective in comparing problems between corridors, but total volume served and total delay hours are also relevant for investment decisions. The mobility plan can make the most of these comparisons by including the same metrics for the system level. This not only begins to "brand" the measures as relevant for a broad set of discussions, but over time it also can allow the public, decision-makers and professionals to use the same "mobility vocabulary" with greater understanding among all readers. Using a real-time website to communicate travel time to travelers should be seen, therefore, as a component of the education process not as a separate element.

Any broad set of measures will also include agency activity measures that describe the actions that are being taken and the efficiency and effectiveness of those programs; those elements are not typically a part of a mobility plan. This broader set of measures should tie into the mobility plan where possible, especially as they relate to regular reporting procedures. The process should also connect the evaluation of agency operations (e.g., incident response times) with the public's view of the results of the operations.

Recommendation: Consider the multiple audiences and uses for mobility information. There are two general purposes for mobility plan performance measures. One is for technical staff that plan, design, operate, and manage the roadway network. The other, and arguably the more important audience, is the non-technical users of the transportation system. These non-technical audiences include the general public, the media and the political decision-makers who decide to fund the construction, maintenance, and operation of the system. The two audiences are related. If the agencies are perceived as doing a good job and the public is happy with how their money is spent, they also are more likely to vote for expanded programs and support leaders who approve more spending or innovative finance and operations programs. This connection between the two audiences and between the technical activities and the public is central to understanding the information needs from a mobility plan.

The two different audiences do not change the nature of the analyses that are performed with the data. The two different audiences usually need or are interested in the same data and results. They just need it presented at different levels of detail and explained in different ways.

Recommendation: Use simple measures and terms. The performance measures that are used in public communications should be relatively simple and easy to understand. The data collection, estimates and analysis methodologies can be complicated, involved and technical, but the "public face" of the plan should include measures that the public and decision-makers understand and care about. The volume-to-capacity ratio on road links, for example, is difficult to directly relate to individuals, but the same data can be used to estimate speed and travel time.

Recommendation: Include a reliability performance measure. The mobility plan might not be able to create a road and transit system with no congestion, but it may result in less day-to-day variation in travel time. Greater predictability is one component the public uses to evaluate the quality of their trip. Reliable trips might be an easier or less costly goal to achieve, but it will be a product of a set of actions that include increased capacity, demand management and operational efficiencies. The benefits of these treatments may not be as easy to detect with congestion measures that only focus on averages.

While these reliability performance measures cannot be directly calculated from travel demand models, estimation methods are being developed. A mobility plan could be a method to discuss the value of reliable travel times and the actions that are necessary to achieve them. These could be tied to near-term actions as well as being key components of a long-range strategy.

Recommendation: Match the measures to the messages. The types of decisions, the possible solutions that are going to be analyzed and the messages or issues that are going to be communicated are the first elements that should be identified in selecting a set of performance

measures. A broad-based set of measures can support most of the messages and analyses for technical and non-technical audiences. The same datasets can be used for a range of purposes from real-time operations and information displays for travelers and shippers to longer term planning and project selection purposes.

A mobility plan should connect issues the public indicates they care about – for example, congestion – to the technical or policy issues and solutions. Professionals may use terms such as "mobility" or "accessibility" while the public understands the problem as "congestion." There will also be variations in the measures that are used in public presentations from city to city. Accessibility might be a useful concept if it is discussed in measures like "number of jobs within 30 minutes of a home" but such measures can be difficult to communicate.

The measures should include both values that are meaningful to individuals, as well as measures of the magnitude of the problem. The individual measures might express the amount of travel time or delay per person, per traveler or per trip. These relate the problem in quantities that are relevant to travelers and shippers. The regional magnitude values are used in the description of the size of the problem and the effect of the solutions. These might be expressed in total hours or total dollars. Exhibit 5 presents an illustration of how individual and magnitude measures can be paired and developed from the same data set (13, 14). Appendix A includes descriptions of the performance measures listed.

Exhibit 5. Mobility Plan Congestion Performance Measures

Individual Measures	Total Measures
Delay per person	Total delay
Travel time per person	Total travel time
Congestion cost per person	Total cost
Travel Time Index	
Buffer Index	

Sources: References 13 and 14

Mobility Targets

Recommendation: Use a mobility target to provide a method to benchmark progress in the short term and in the long-range plan. Setting a target mobility level usually requires an analysis of current conditions and past trends, as well as future trends and vision. Planners must understand how the target levels relate to the current conditions and decide whether "realistic" targets, "desirable" conditions or some combination of the two are used. The performance targets can be stated in absolute terms (a fixed number) or in relative terms (e.g., annual percentage reductions) or as achieving the mobility levels experienced in some previous year.

Target conditions can also provide very useful guidance to system planners, operators and engineers if they are the result of public input. They can illustrate the balance that the public wishes to have between road space, social effects, environmental impacts, economic issues, and quality of life concerns. Areas or system elements where the performance is worse than the target can be the focus of more detailed study. A corridor analysis, for instance, might indicate a

problem with one road or mode, but the solution may be to improve another route, mode or program that is a more cost-effective approach or one with wide public support to achieve the target corridor value. (*13)*

Free-flow conditions will not be the goal of most large metropolitan regions, but using them as one component of a measurement system provides a consistent benchmark relevant for year-to-year and city-to-city comparisons. The "attainment of local goals" might also be used at the national or state level, but local goals are more often discussed in light of planning and project prioritization decisions.

The role of a target or goal condition in a mobility plan is to act as both a benchmark against which to measure progress and as a communication centerpiece. However "needs" are identified, there will be an estimate of the cost to achieve the target condition. There may also be a general set of strategies or solutions that can be used to achieve those goals.

Exhibit 6 shows a set of example target TTI values arranged by area type. The values are desirably the result of a process that is integrated to the development of the long-range plan with input from citizens, businesses, decision makers, and transportation professionals. The level of information needed to carry out this type of process at an optimum level is not currently distributed in most urban areas. As a beginning, however, the values might be interpreted from existing public input processes.

Exhibit 6. Travel Time Index Values Used to Illustrate Congestion Targets
EXAMPLE

Area Type	Peak	Off-Peak
Central Business District	1.7	1.2
Urban	1.5	1.1
Suburban	1.3	1.0
Fringe	1.0	1.0

The approach taken in Exhibit 6 uses different targets depending on the characteristics of the neighborhood or area as defined by the "area type" designation used in most transportation planning models. Neighborhoods or activity centers which have denser land developments are more likely to see higher levels of road congestion. They are also, however, more likely to have several travel options and have a higher percentage of walk, bicycle or transit trips, making higher congestion levels not as onerous. Likewise, the amount of acceptable congestion in rural areas is low.

A set of travel time index values like those shown in Exhibit 6 would be calculated for corridors or sub-regions, rather than for individual roads. In this approach, the persons moved on high-speed and reliable systems such as high-occupancy toll lanes or grade-separated rail could be averaged with congested freeway and street lanes to calculate a corridor performance measure that could be compared to the target conditions. These statistics could indicate where additional investment is required to meet the expectations of travelers and shippers. The beneficial effects of a range of transportation and land use improvements that might be deployed in corridor would be included in a structure that focuses on person and freight movement, rather than the performance of specific road segments. The measurement scheme recognizes that rural areas

have fewer travel options, perhaps a higher percentage of travel by freight modes and a different set of improvements than an urban region corridor.

In the initial Texas needs estimates, the goal was expressed as eliminating all locations of serious congestion, while the Atlanta plans used a regional average congestion level goal. Either of these approaches, or some other version, can work for a region. The goal might be a "stretch goal" – one that is unlikely to be achieved – or a more easily funded improvement from the current trend. The key factor seems to be making a connection between the goal, the condition indicated by the goal, the public's desire for improvement and the communication techniques used by the agencies.

Using the Transportation Planning Model

Recommendation: Use the long-range planning model to assess improvements from transportation and land use changes. Incorporating various land use patterns and congestion level targets in a scenario planning effort provides citizens and decision-makers with an idea of the trade-offs involved in different investment programs. The long range planning model can be used for this analysis. One improvement to typical practice is to identify the road links that are more congested than a target level and estimate the number of lanes required to "solve" that congestion. A utility program for TransCAD models was developed by TTI (*12*) based on a concept described by NCTCOG for TMMP. The utility provides an automated process for examining the amount of road space needed to address congestion problems. This process is described in Appendix B.

The solution, in many cases, will not be as simple as only adding lanes, but the level of investment required to accomplish those goals can be a good surrogate for the cost of a range of transit and road projects, operational improvements and demand management treatments that will be used to address the problems. The model and performance measures can be used to evaluate congestion at more detailed levels (e.g., corridors, sub-areas, regional activity centers, counties) and can be mapped and correlated with the Congestion Management process.

Estimate the Benefits

Recommendation: Examine the benefits of a range of scenarios. The potential funding choices and solutions in the mobility plan are best communicated as a part of different investment "portfolios" that might include more capacity, improved operations, demand management, land use pattern changes, pricing, maintenance and reconstruction. A key element of this communication strategy is including the benefits for the public, business community and other stakeholders. (*6*) The vision component of the mobility plan provides a framework to discuss the role for, and benefits of, various portfolio options in accomplishing community goals. In too many cases, the discussion of these options is focused solely on cost. Estimating the benefits typically results in a greater understanding of the reasons and urgency for action, an appreciation for the diversity of solutions and how the strategies address the current and expected problems.

AFTER THE MOBILITY PLAN – WHAT'S NEXT?

The public's view of the mobility plan is affected by the performance of the agencies, their ability to implement projects or programs within the budget and time forecasts and the policies and processes that are enacted to guide improvement efforts. The plan should be a catalyst or one element of several actions that move the region toward a broader discussion about the role of transportation and land use actions that will achieve the goals and vision for the future.

If the agencies are improving their programs and if they have an open communication process about those actions, it will be easier to convince the public to support the new programs, policies or projects and the funding or partnerships needed to accomplish those improvements. Agencies that have been successful at increasing transportation funding or re-aligning funding priorities, have found that the public perception of the agencies has been very important. The Washington State DOT received public support for a limited-term five-cent per gallon gas tax increase, in part, due to the promise to construct a set of specific projects and use an open process to track and report the progress of the projects. A subsequent nine-cent per gallon tax increase followed the same model.

The steps for creating support for investment in transportation programs are relatively few and easy to describe, but not easy to accomplish.

- Do a good job – Use low-cost, quick action strategies to improve operations where possible in the near term.
- Report the status, performance, accomplishments and challenges –
    - Focus agencies on performance and delivery of the program
    - Identify the processes that can be used and those that need strengthening
    - Show the public where the funds are spent and the effect of the program
- Identify strategies that address the problems and take advantage of the opportunities

Recommendation: Compare the performance of the strategies with the goals. Each strategy will address a set of elements, factors or characteristics of the transportation system. These should be included in the mobility plan. The evaluation of alternative strategies should look to maximize the return on investment toward achieving the set of targets or goals. There should be a regular report on the status of each performance goal, incorporating the measures from daily or monthly operational reports and connecting to the measures in the mobility plan as it is updated.

The key to sustaining a mobility focus is the ability to identify and explain the costs and benefits of improvement programs as they relate to mobility and other goals and detect trends in these effects. Supplemental data, other performance measures, or additional studies can be used to further explain resulting trends or outcomes as required. It is important to think about using a range of measures because this will lead to a data collection and analysis system that because the measures may be needed at some point and flexible systems require more planning. The selection of a set of measures is only partly used to define which data should be collected. The process also is designed to identify how the measures should be presented to meet the communication needs of the analysis and the understanding of the audience.

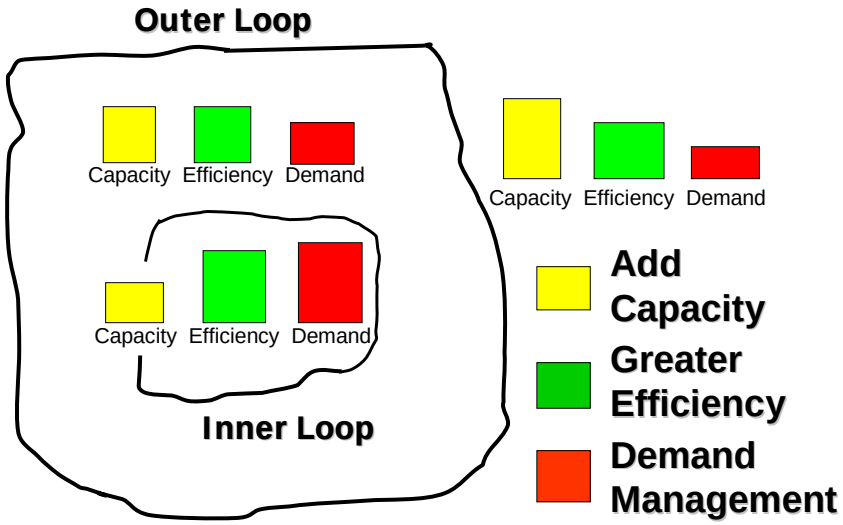
Reporting needs change over time as audience understanding grows. This may appear as a "moving target" problem, but in most cases it is a reaction to the new knowledge and increased interest in understanding the effectiveness of improvement projects and programs. Once an important question has been answered, the public and elected leaders may stop asking about it and either ask for more information or move to another subject. The performance measures used to answer those questions may become less important or the need for reporting may become less frequent. Similarly, when a new issue becomes important, there may be a need to start reporting on that instead, with new performance measures. In some cases, the measure values begin to have less relevance and readers begin to examine the change in measure values or the relationship to targets or goals.

Recommendation: Implement a variety of solution types. The mobility plan should consider the full range of transportation and land use plans, policies, programs, projects, performance and partnerships (the "6 Ps"). (*10*) Larger or long-term projects and policies must be combined with near-term improvements to form a comprehensive program. Some examples:

- Seek solutions to bottlenecks in the road and transit networks. These are places where improving a constriction can allow remaining portions of the system to accept more traffic. Some are small and not costly; some are large and take a long time.
- Actively manage the roadway. Using the available capacity to provide as much person movement in smooth traffic flow is a goal that appears to be more attainable with new technology. For example, a package of peak period strategies might include re-defining freeway shoulders as general traffic lanes or allowing buses to use the freeway shoulders, and altering the speed limits to slow traffic in order to maintain traffic volume and improve safety can be deployed to maximize the productivity from the freeway.
- Is there enough incident management funding and are the responders clearing crashes and vehicle breakdowns as rapidly as possible? Are there good working relationships and defined procedures among the responders? Cities with a reputation for good operations may be able to take other actions that, with some additional attention and funding, could improve the services and system performance.
- Coordinate the traffic signals. Typically this will require local agencies to work together, which will have other institutional benefits. It is also an improvement that is relatively quick to enact and has good public support. It may, however, require a re-allocation of operating budgets and may lead to an increase in the mobility plan funding levels, as well.
- Access management treatments and development regulations have a beneficial effect on maintaining the operating quality of the street capacity.
- The effect of land use actions enacted by local agencies should be accommodated in the mobility plan. Coordinating the development strategies with transportation programs can maximize the benefit of both investments. The land use regulations and policies in the cities can allow jobs, shops and homes to be located together in relatively dense locations served by high capacity travel systems. And suburban single-family developments can likewise be supported by a different set of strategies.
- Additional road and public transportation capacity is important in regions or portions of regions that will see population and employment growth.

The mix of solutions will vary by the location within the metropolitan area (Exhibit 7). There may be more capacity addition projects in the suburbs and a greater reliance on demand and system management in built-up areas, but many treatments have some application in every area.

Exhibit 7. Example of Solution Mix Within a Metropolitan Region



Source: Reference 1

CONCLUSIONS – WHY PREPARE A MOBILITY PLAN?

The mobility planning effort used in the Houston-Galveston region allows consideration of a broader range of issues and potential elements than is possible under the process most other cities are using within their long-range plans. Analyzing a range of cost and congestion solutions provides more detail and information for the discussion about solutions, financing options and the desired outcomes and congestion levels. The effect of land use options, operational strategies and any other elements that are being pursued should be accommodated in the mobility plan process, providing the basis for a very robust analytical and communication process.

Mobility planning is part of a performance-based planning process. It combines the typical elements of long-range planning – vision, goals, performance measurement, improvement strategies, evaluation of alternatives, implementation – with the benefits of the financially constrained planning process. Mobility planning can be thought of as an expression of the level of investment required to meet a vision, before the consideration of specifics. Because the projects, programs and policies to meet the vision will ultimately be crafted through a public participation process, the mobility plan can concentrate on identifying the level of needed improvements and the benefits from additional investments. Benefits are not part of the discussion in many regions. A mobility plan is a good method to raise awareness of the benefits and the importance that planners and project developers generate those estimates. Transportation is far behind other sectors in communicating this message. For example, if students only knew the cost of college, rather than understanding the life-long benefits of higher education, fewer would attend.

As the participating agencies and their leaders review the measures, targets and computer models they would be well-served to remember that these are only tools for evaluating the mobility plan elements. Individual measures or analysis products should not be considered "prescriptions." Future growth scenarios and the possible responses may also be a desirable aspect. These might draw on past experiences and community input. What, for example, should be the response if population and employment growth is 15% greater than projected? Congestion growth may be faster than desired, but this may be an acceptable trade-off for economic growth. If it is not, what actions will be taken to address the problems caused or to slow or re-direct growth?

REFERENCES

1. David Schrank and Tim Lomax. *2007 Annual Mobility Report*. Texas Transportation Institute, September 2007. http://mobility.tamu.edu/ums
2. *The 100 Percent Solution Plan For the Eight-County Houston-Galveston Region***,** Houston-Galveston Area Council, August 2003. http://2035plan.org/
3. U.S. Representative Sheila Jackson Lee. *Derailing Metro Transit Plan Isn't an Alternative*, Viewpoints, Houston Chronicle. October 23, 2003. http://www.lightrailnow.org/features/f_hou006.htm
4. *Envision 6 Regional Transportation Plan, Volume 1.* Atlanta Regional Commission, 2005. http://www.atlantaregional.com/documents/Envision6_RTP.pdf
5. *Congestion Mitigation Task Force Final Report and Recommendations.* Atlanta Regional Commission, December 2005. http://www.atlantaregional.com/html/1535.aspx
6. *Shaping the Competitive Advantage of Texas Metropolitan Regions: The Role of Transportation, Housing and Aesthetics.* Governor's Business Council Transportation Task Force, November 2006. http://www.texasgbc.org/Reports3.htm
7. *Texas Metropolitan Mobility Report: Breaking the Gridlock. 2004 Report of Progress and Action Plan for Continued Success*. Texas Department of Transportation. October, 2004.
8. *Texas Metropolitan Mobility Plan.* Capital Area Metropolitan Planning Organization, July, 2006. http://www.campotexas.org/pdfs/Final_2006TMMP_Web.pdf
9. *Texas Transportation Needs Report (Draft),* Texas 2030 Committee, December 2008. http://texas2030committee.tamu.edu/
10. *Regional Transportation Status Report: 6 P's.* Public Meetings September 8 and 9, 2008. http://www.nctcog.org/trans/outreach/meetings/StatRpt.pdf
11. *The Effects of Increased Development Inside Loop I-610 -- Implications For The Transportation System, Technical Memorandum Number 4.* Texas Transportation Institute, April 2007.
12. Kevin M. Hall, Tim Lomax (Texas Transportation Institute) and Greg Lancaster (Texas Department of Transportation). *Identifying the Long Range Transportation Improvement And Funding Needs for Urban Areas in Texas.* Transportation Research Board Planning Applications Conference, 2006.
13. *Keys to Estimating Mobility.* Texas Transportation Institute, 2005. http://mobility.tamu.edu/ums/resources/estimating_mobility/complete_report.pdf
14. *Guide to Freeway Performance Measurement.* Transportation Research Board, National Cooperative Highway Research Program, Web Document #97, 2007. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w97.pdf

APPENDIX A – PERFORMANCE MEASURES

This Appendix provides a brief overview of some performance measures that have been used in mobility analyses. (*1, 6, 7, 9, 13, 14*) A typical mobility plan includes measures of the total congestion problem *and* measures at an individual level. The magnitude of regional congestion and the change due to varying investment levels provides a way to understand the economic and quality of life effects for a region. Total measures have also been used at the sub-regional level to describe variations due to different growth and land use patterns. Measures that present congestion in terms that relate to individuals are required to "bring the problem home" to area residents and businesses.

These measures are based on travel time and speed quantities – the type of elements that are easily understood by the general public and decision-makers. Communicating the results of a mobility plan to a broad audience is a job for professional communications staff, but the performance measures developed by the analysis can be a very useful component of that plan.

Individual Traveler Mobility Measures

Delay per peak period traveler (in daily minutes or annual hours). A value that individuals can relate to can be used to reduce the regional travel delay value to a figure that is more useful in communicating to non-technical audiences. Using the number of people on the transportation network during the peak congested periods can communicate the effect of a broad array of transportation and land use options. The key aspect in many large regions is to be able to compare the effect of regular roadway capacity and operating improvements to mobility projects that handle much higher person demand than other alternatives or land use options that alter travel patterns.

This measure works better as a regional measure rather than a route or corridor measure, because it is easier to capture all the trips and all the distance with a larger geographic region. Calculating the delay (the "top" number in the ratio) can be accomplished with a variety of programs and post-processing procedures. In some cases, these can include irregular delay (i.e., from weather, crashes, stalled vehicles, special events). To the extent possible, the analysis should include as much of the demand and capacity improvements as reasonable. There are a number of options for the "bottom number" also. The quantity might also be titled "commuters" although technically peak period travel includes many trips other than those for work-related purposes. Regional population might also be used. Equation A-1 illustrates the computation of delay per peak traveler in annual hours.

$$\text{Delay per Traveler (annual hours)} = \frac{\left(\begin{array}{c}\text{Actual Travel Time} \\ \text{(minutes)}\end{array} - \begin{array}{c}\text{Free Flow Travel Time} \\ \text{(minutes)}\end{array}\right) \times \begin{array}{c}\text{Vehicle Volume} \\ \text{(vehicles)}\end{array} \times \begin{array}{c}\text{Vehicle Occupancy} \\ \text{(vehicles)}\end{array} \times \frac{250 \text{ weekdays}}{\text{year}} \times \frac{\text{hour}}{60 \text{ minutes}}}{\begin{array}{c}\text{Vehicle Volume} \\ \text{(vehicles)}\end{array} \times \begin{array}{c}\text{Vehicle Occupancy} \\ \text{(vehicles)}\end{array}}$$

For an average day on each road segment

(Eq. A-1)

Travel Time Index The TTI is a dimensionless quantity that compares travel conditions in the peak period to travel conditions during free-flow or posted speed limit conditions. For example, a TTI of 1.30 indicates that a trip that takes 20 minutes in the off-peak period will take 26 minutes in the peak period (or 30 percent longer). TTI reflects travelers' perceptions of travel time on the roadway, transit facility, or other transportation network element and can be applied to multimodal systems or combinations of roadways with different free-flow or posted speeds. The Index can be used to illustrate trends – both historic and estimated future – and can be used in a goal setting process at many levels.

The measure can be averaged for freeways and arterial streets using the amount of travel on each portion of the network. An average corridor value or regional average can be developed using the number of persons using each road type or mode to calculate the weighted average congestion levels.. The Travel Time Index in Equation A-2 compares peak period travel time to free-flow travel times for any combination of freeways and arterial streets. Index values can be related to the general public as an indicator of the length of extra time spent in the transportation system during a trip of any length. Equation A-2 illustrates a relatively simple version of the calculation using vehicle-miles of travel, but person-miles of travel could also be used, as could a calculation that incorporates the value of person and freight travel.

$$\text{Travel Time Index} = \frac{\left[\frac{\text{Freeway Travel Rate}}{\text{Freeway Free-flow Travel Rate}} \times \text{Freeway Peak Period VMT}\right] + \left[\frac{\text{Principal Arterial Street Travel Rate}}{\text{Principal Arterial Street Free-flow Travel Rate}} \times \text{Principal Arterial Street Peak Period VMT}\right]}{\text{Freeway Peak Period VMT} \times \text{Principal Arterial Street Peak Period VMT}}$$

(Eq. A-2)

Note: Travel rate expressed in minutes per mile (inverse of speed).

Buffer Index The Buffer Index (BI) is a measure of travel time reliability that expresses the amount of extra (or "buffer") time needed to be on time for 95 percent of the trips (e.g., late for work only one day per month). The measure would be explained as "a traveler should allow an extra BI percent travel time due to variations in the amount of congestion delay on that trip." Indexing the measure by dividing the 95th percentile time by the average time for the same trip provides a time and distance neutral measure that can be used as a regional or corridor measure (Eq. A-3). This relates well to the minutes of travel time that individual travelers use for their particular trip. The measure is probably more applicable to current conditions because the best method of calculation uses continuous data (for example, from traffic management center monitoring information). Estimation techniques can also be used in conjunction with planning model derived data or post processed statistics.

The 95th percentile travel times as a basis for comparing trip reliability is derived from the communication of the effect of irregular events. The message is that for an important trip, a traveler should be on-time for 19 of 20 trips. "Your boss might let you be late to work 1 day each month, but you are expected to be on-time the other 19," is one way the measure is presented.

$$\text{Buffer Index (\%)} = \left[\frac{\begin{matrix}\text{95th Percentile Travel Time} \\ \text{(minutes)}\end{matrix} - \begin{matrix}\text{Average Travel Time} \\ \text{(minutes)}\end{matrix}}{\begin{matrix}\text{Average Travel Time} \\ \text{(minutes)}\end{matrix}}\right] \times 100\% \qquad \text{(Eq. A-3)}$$

Note: Calculated for each section of road or transit route; sections are combined by calculating the weighted average using person-miles of travel.

The buffer time concept appears to relate particularly well to the way travelers make decisions. Conceptually, travel decisions proceed through questions such as: "How far is it?" "When do I need to arrive?" "How bad is the traffic going to be?" "How much time do I need to allow?" "When should I leave?" In the "time allowance" stage, there is an assessment of how much extra time has to be allowed for uncertain travel conditions. This includes weather, incidents, construction zones, holiday or special event traffic, or other disruptions or traffic irregularities.

Planning Time Index Planning Time is the measure of the 95th percentile travel time – the amount of time that a traveler must allow for a trip to be made. The Index represents the total travel time that should be planned when an adequate buffer time is included expressed in a ratio of the average travel time for the same trip. The Planning Time Index differs from the Buffer Index in that it includes typical delay as well as unexpected delay. Thus, the Planning Time Index compares near-worst case travel time to a travel time in light or free-flow traffic. For example, a Planning Time Index of 1.60 means that, for a 20-minute trip in light traffic, the total time that should be planned for the trip is 32 minutes (20 minutes × 1.60 = 32 minutes). The Planning Time Index is computed as the 95th percentile travel time divided by the free-flow travel time as shown in Equation A-4.

$$\underset{\text{(no units)}}{\text{Planning Time Index}} = \frac{\text{95th Percentile Travel Time (minutes)}}{\text{Travel Time Based on Free} - \text{Flow or Posted Speed (minutes)}} \quad \text{(Eq. A-4)}$$

A Note About Door-to-Door Travel Time Measures

The measure of system performance that best represents traveler concerns is door-to-door travel time. Any performance measure should relate to door-to-door travel time as closely as possible, recognizing that travel time does not function well in regional values of total and individual mobility. As a way to connect individual experiences with regional measures, periodic public opinion surveys could be used to adjust the targets for corridor and regional mobility or reliability levels. Several pairs of origin-destination trip patterns, for example, could be used to show the change in travel time from current to future network configurations. The information for these key travel patterns can be updated daily, monthly, or annually with system monitoring equipment. Updates to the mobility plan could review the travel time origin-destination pairs to determine their ability to represent existing and future land use development patterns and transportation systems.

Regional Mobility Measures

The mobility measures described in the previous section mainly relate to the individual traveler. The measures described in this section are area measures where the area may be a corridor or region.

Total delay (in person- or vehicle-hours). This can be calculated for a transit or roadway segment; it is the sum of time lost due to congestion. Delay can be expressed as a value relative to free-flow travel or relative to the posted speed limit. Total delay in a corridor or an urban area is calculated as the sum of individual segment delays. This quantity is used as an estimate of the impact of improvements on transportation systems. The values can be used to illustrate the effect of major improvements to one portion of a corridor that affects several other elements of the corridor. The quantity is particularly useful in economic or benefit/cost analyses that use information about the magnitude of the mobility improvement for cost-effectiveness decisions. Equation A-5 shows the computation of delay in person-hours. In addition, using a delay measure of hours per mile of road, hours per 1,000 miles traveled, or hours per 1,000 travelers might be more meaningful to agencies at the corridor level, but the public may not understand these measures since it is difficult to relate to key decisions or travel experience.

$$\begin{matrix}\text{Total Delay}\\(\text{person}-\text{hours})\end{matrix} = \left[\begin{matrix}\text{Actual}\\\text{Travel Time}\\(\text{minutes})\end{matrix} - \begin{matrix}\text{FFS or PSL}\\\text{Travel Time}\\(\text{minutes})\end{matrix}\right] \times \begin{matrix}\text{Vehicle Volume}\\(\text{vehicles})\end{matrix} \times \begin{matrix}\text{Vehicle Occupancy}\\(\text{persons/vehicle})\end{matrix} \times \frac{1\text{ hour}}{60\text{ minutes}}$$

(Eq. A-5)

Accessibility. There are many ways to calculate this performance measure. In general, it relates the ease of access to certain travel destinations. These might be accessibility to jobs, homes, a transit station, or other land use or trip attractor of interest. Accessibility is satisfied if the travel time to perform the desired activity is less than or equal to the target travel time as indicated in Equation A-6. The advantage of such a measure is that it matches nicely with the private sector judgment of market areas or employer ideas about the desirable commuting distance for their employees. Fewer workers within a reasonable commute may mean higher salaries must be paid or expansion plans must be re-evaluated. Travel times can be minimized by transportation investments, by changes to the development pattern toward denser land uses, or plans to mix the employment centers, shops and homes, rather than segregating each type. In this way it provides an easy method to compare a variety of solution strategies. The disadvantage is that it has been difficult to communicate the results of the analysis. Typically accessibility is displayed as maps of the regions that can be reached within a certain time under different investment and policy options.

$$\begin{matrix}\text{Accessibility}\\(\text{opportunities})\end{matrix} = \begin{matrix}\Sigma\text{ Objective Fulfillment Opportunities}\\(\text{e.g., jobs}), \text{Where}\\\text{Travel Time} \leq \text{Target Travel Time}\end{matrix}$$

(Eq. A-6)

APPENDIX B - USING THE LONG RANGE TRANSPORTATION PLANNING MODEL TO ASSESS MOBILITY NEEDS

Introduction

In combination with other processing steps that have evolved from air quality analysis procedures refined for many regions in Texas, the travel demand model provides a comprehensive estimation procedure for urban area congestion levels. The Texas Department of Transportation (TxDOT), in cooperation with the 25 Texas metropolitan planning organizations, developed and implemented an innovative process for estimating the mobility needs and financial costs over the 20 to 25 years of an urban area's Metropolitan Transportation Plan (MTP). The key result of developing such a process was the creation of an analytical tool that could easily communicate the mobility differences between the financially constrained Metropolitan Transportation Plan and a "needs-based" plan that achieves a target mobility level. The process utilizes the regional travel demand models (TDMs) to estimate the capacity needs associated with addressing the targeted congestion problem. The summary produces a broader set of statistics and richer information base for discussions with decision-makers and the public about the trade-offs between investment and congestion levels. This Appendix describes the primary analytical tool used to develop the regional mobility needs estimates. (*7, 8, 12*)

Analytical Overview

A needs-based plan is an extension of the metropolitan transportation plan; the vision of a mobility plan is to extend the knowledge and consensus building activity of the metropolitan plan to identify the unmet needs of the financially constrained plan. The federally-mandated transportation planning process produces a list of projects, programs and policies that can be funded for the next 20+ years to address congestion and mobility needs within the larger context of regional goals. There is no requirement, however, to develop a list of strategies that would be pursued if there were more funding. There is also no generally accepted process that determines the benefits of implementing such a plan.

A "needs-based" plan is a strategic element that enumerates the cost of implementing various congestion relieving programs to achieve a congestion goal (for example, eliminate all locations of severe congestion) in the forecast year of the MTP. These costs are beyond what will be accomplished by the financially constrained plan, but the estimate is developed in a way that is consistent with the planning goals and processes. Unlike the MTPs, the "needs-based" plans are not a specific list of projects. The "needs-based" (or mobility) plans could be characterized as a return to a vision-oriented approach to transportation planning in the state of Texas. In practice, if additional revenue were identified, the mobility goals for each of the urbanized areas will be achieved by a mix of multi-modal corridor solutions that not only involve automobile solutions, but also strategies that improve travel conditions for people, transit, and freight. The needs-based planning element developed for the Texas Mobility Plan standardizes the process for developing mobility goals and the strategies used by each urban area to meet their locally determined goals. One element of these plans was the development of a set of congestion performance measures to be used for both analytical and communicative purposes.

Mobility Target Used in the 2006 Mobility Plans

A cooperative effort between the Texas MPOs, TxDOT and TTI determined that the target mobility level for each urban area would be to eliminate serious congestion. This was operationally defined as all links in the travel demand model that exceeded a volume-to-capacity (v/c) ratio greater than 1.0. The needs-based plan, then, is an estimate of the cost to eliminate any condition that represents a level-of-service (LOS) of F. Other mobility targets can also be studied with the approach described in this Appendix to examine other trade-offs.

Performance Measure - Texas Congestion Index

The primary result of the process is a performance measure called the Texas Congestion Index (TCI), which is the ratio of the value of congested travel time to the value of free-flow travel time (*7,8,9*). Several other elements of the performance measure technique expand the information provided by the regional travel demand models. The spreadsheet-based process also includes estimation procedures for travel delay (including the effect of irregular delay due to crashes, vehicle breakdowns, weather, etc.), operational treatments, HOV lanes, and incorporating the effect of rail freight improvements. The performance measures are expressed as both individual (e.g. total travel time per person, delay per person and cost per person) as well as regional values (e.g. total travel time, total delay in hours, etc.).

The TCI is a ratio used to communicate with the general public and decision-makers; these audiences understand concepts related to travel time (*7,9*). The ratio relationship of peak period to off-peak conditions is also easily understood. A TCI value of 1.0 indicates travel at freeflow conditions. A value of 1.30 would mean trips take, on average, 30 percent longer in the peak than at freeflow conditions; with a TCI of 1.30, a 20-minute freeflow trip will take 26 minutes in the peak.

Travel Demand Models in Texas Urban Areas

The majority of travel models in the state of Texas are 24-hour based models. Only a few large urbanized area travel demand models have peak period assignment capabilities – Dallas-Fort Worth, Houston, Austin, and San Antonio. The primary developer of models in the state of Texas is the Transportation Planning and Programming (TPP) Division of TxDOT with the exception of Houston, Dallas-Fort Worth, San Antonio and El Paso. Because TxDOT's TPP Division centralizes the development of models for the state, there is a standard approach that is consistently applied statewide.

Because the models are primarily 24-hour based, the TCI process uses a combination of other processing steps to provide a comprehensive estimate of congestion levels that are refined to hourly volumes. The process uses an approach similar to the air quality conformity analysis performed for many Texas regions.

The mobility measurement process examines the results for freeway and arterial facilities for the two peak periods – 6 to 9 a.m. and 4 to 7 p.m. Public transportation trips are removed from the road demand before the congestion measures are estimated. The calculations are performed at a level of detail that allows the user to examine congestion in each hour within each area type within a county. The process is spreadsheet-based and the analyst can modify many input parameters. The level of detail provides data for summary presentations and allows the analysis of "what-if" scenarios of investment levels and mobility targets.

"Needs-Based" Travel Demand Model Process

Several different scenarios were examined with current travel demand models to support the development of TCI values as a part of the mobility (or needs-based) planning process. The following scenarios were developed using the latest available travel model.

- *Base year*: The base year condition was applied and used for comparative purposes.
- *Metropolitan Transportation Plan (financially constrained plan)*: The MTP horizon year (forecast) demand and road supply was used as a comparison base for future conditions.
- *Mobility Needs Scenario*: This application included the forecast demand on a network that had been edited with additional lane-miles and corresponding capacity to eliminate a pre-determined congestion threshold value (example: all serious congestion in the forecast year).
- *Innovative Financing Option*: Several urban areas in the state of Texas are considering alternative solutions that have not been a part of traditional congestion relieving programs. Projects that include traditional and non-traditional tolls (i.e. "pass-through" tolls), managed lanes, utility fees, local option sales taxes or vehicle registration fees or other innovative financing techniques to address corridor needs are being considered to address growing mobility demands in the urbanized areas. The models were applied to determine the region's mobility levels with a variety of strategies in addition to the accepted long-range plan.
- *Interim years*: For study areas where interim year forecasts were available – primarily those study areas that needed an interim year forecast for the purposes of supporting air quality conformity – the model was applied.

In addition to alternative investment strategies, the mobility consequences of alternative land use scenarios can be examined with the needs-based approach. Each land use pattern will be associated with transportation system configurations representing the optimal method of serving the trips generated from the developments. There will likely be, for example, more public transportation service in dense residential or office developments than in traditional auto-oriented residential suburbs.

The key to analyzing any combination of land use and transportation scenarios is to include a set of performance measures that describe the effects that are relevant to the goals of each scenario. For densely developed areas where the goal is to have residents live closer to their jobs and shops, for example, a measure related to total travel time (in person-hours) might be more useful than a measure of congestion related to vehicle travel.

Calculation Steps for the Mobility Needs Scenario

A modeling process was developed to provide metropolitan planning organizations with the capability to identify the funding needed to achieve certain mobility targets. The ultimate goal of the needs-based mobility analysis was to incorporate the consideration of varying investment levels as part of the normal planning process. The process, therefore, is primarily automated, utilizing add-on menu items to the travel demand model software. There are essentially six steps for determining the long-range mobility needs using the travel demand models.

The 2006 Texas mobility plans used a common congestion target of eliminating all locations of serious congestion, defined as road links with a volume-to-capacity ratio of 1.0 or higher. This threshold is used in the discussion below, but any target could be used, as shown in the 2008 study of Texas' transportation needs (*9*).

Step 1. **Run the Long-Range Forecast Model:** This model involves the forecast land use and road network that represents the financially constrained transportation plan. It represents conditions that are likely to exist if no significant changes in transportation funding are made and if growth occurs in the projected pattern. The assignment is a traditional capacity-restraint assignment (i.e. user-equilibrium) and key model statistics, such as vehicle miles of travel (VMT) and vehicle hours of travel (VHT), are summarized by functional class (e.g., freeway, major arterial) and area type (e.g. downtown, urban, suburban, and rural).
Product: Regional long range transportation planning model operating statistics with financially constrained system.

Step 2. **Run an "All-or-Nothing" Assignment:** The all-or-nothing assignment is the basis for identifying the needs beyond the financially constrained plan and for determining the costs for implementing such a plan. Trips are assigned to the path with the lowest cost value (i.e. lowest travel time) between the origin and destination without regard to capacity constraints or congestion on those links. The concept essentially assigns trips to the path that travelers would probably choose if congestion did not influence their path.
Product: Regional long range transportation planning model with unconstrained system.

Step 3. Identify the "Congested" Links: The all-or-nothing link volumes in Step 2 are divided by the roadway capacity for that link from Step 1. This volume-to-capacity ratio is compared to the target congestion threshold value. Links where the all-or-nothing trip pattern volume/ capacity ratio exceeds the target ratio are identified and categorized by functional class and area type.
Product: List of regional model links exceeding the target congestion levels.

Step 4. **Edit the Links Exceeding the Congestion Threshold Value:** Each link identified in Step 3 is edited by adding enough capacity (lanes) to reduce the volume/capacity ratio below the target level (and thereby eliminate the "unwanted" congestion in the forecast scenario). This was accomplished in the Texas Mobility Plan through an automated process using software developed by the Texas Transportation Institute on behalf of TxDOT's Transportation Planning and Programming Division. The utility program is designed to work with TransCAD software, but the general operation could be programmed into other software types. The additional roadway lanes that are added to the severely congested links are surrogates for the actual combination of road lanes, public transportation improvements, operational treatments, and demand management programs that will be enacted locally to improve mobility.
Product: List of regional model links exceeding the target congestion levels and corresponding number of lanes required to reduce the volume per lane to target levels.

Step 5. **Use the Needs-Based Roadway Capacity to Estimate Operating Conditions:** The forecast demand is applied to the edited network from Step 4 containing the additional lane-miles. Model results, such as VMT and VHT are summarized by functional class and area type.
Product: Long-range planning model statistics for all-or-nothing assignment on expanded network.

Step 6. **Calculate the Differences Between the Financially-Constrained Plan and the Mobility Goal Network:** The additional lane-miles that are needed to accomplish the mobility scenario goal are summarized by functional classification and area type. The calculation is performed by subtracting the lane-miles on each link of the financially-constrained plan in Step 1 from the model results produced in Step 4 (the "mobility goal" network). The additional lane-miles by functional class and area type are ultimately used to determine the cost of implementing a "needs-based" plan.
Product: Regional Long Range Transportation Planning Model with unconstrained system