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Review of Proposals and Alternative Concepts for Significant Systematic Expansions to the U.S. Highway Infrastructure

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Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

This paper presents information on an array of highway infrastructure expansion issues over to the next 50 years. Economic and population growth is increasing system-wide highway demand, albeit at a slower growth rate now that most eligible adults have a driver's license and most households have one or more cars. But the types of trips being made are changing, with faster growth rates for freight, rural travel and recreational trips, resulting in a shift in the nature of highway capacity demand. This paper examines the effects of systematic expansion of the transportation system, rather than of independent, incremental investments to a static highway infrastructure network. The paper identifies economic and other policy objectives to be addressed and system areas (e.g., freight corridors) for targeted investment in the context of this systematic expansion. Finally, this review also examines several examples of existing concepts and proposals for infrastructure expansion, and comments on the potential overall success of highway expansion to meet future demand and objectives.

Background and Key Findings

Demand forecasts and underlying economic, demographic and land use trends indicate that current highway expansion plans, especially under current financial constraints, will not fully meet tomorrow's needs. There are particular concerns regarding systemic (aggregate demand; interconnectivity), geographic (bottleneck and corridor problems) and categorical (long-haul and urban freight; urban congestion) disparities of supply and demand.

This capacity shortfall will result in substantial economic impacts and other costs if not addressed. The economic costs cross the spectrum from impacts to individual travelers and firms; to impacts to metropolitan and regional economies; and to impacts to national productivity and global competitiveness Military and emergency preparedness, interregional equity, and environmental impacts are also affected delays from overcrowded highways . Improvements to the highway infrastructure system are necessary, and must be certain to address the demands, system limitations, and areas of impact described above. Among the key messages of this study are:

- *Finding 1:* Highway demand is expected to increase at a rate of around 2.1 percent for the next 20 years, a decline from the 2.5 percent of recent trends. This will still outpace planned rates of infrastructure expansion. Faster growth in freight and rural transportation is expected, and additional, as yet unidentified, trends could emerge in the 20-year timeframe due to demographic, technological or economic factors.

- *Finding 2:* Key objectives of highway system expansion include congestion relief, freight transportation efficiency, global competitiveness, interregional accessibility, system reliability and extension to under-served urbanized areas. These and several non-transportation factors (e.g., financing, environmental factors, political feasibility) should be key criteria for decisions about systematic and incremental expansions.

- *Finding 3:* The primary highway system elements to be targeted for systematic expansion are aggregate capacity, freight corridors, urban mobility, intermodal connections, bottlenecks of national significance, system connectivity, regional access, and military deployment/emergency response corridors.

- *Finding 4:* Current federal, state and local efforts will not keep pace with future demand, largely due to financial and political constraints on raising motor fuel taxes and urban highway infrastructure expansion. However, innovative approaches, including varying forms of private participation, are underway. In addition to lane-mile or similar capacity expansions, hybrid investments spanning infrastructure and operations (e.g., HOT lanes, ITS systems) are also important tools.

- *Finding 5:* Systematic expansion should use a combination of broad infrastructure programs and more targeted investments, private participation and hybrid operational elements to cost-effectively address future demand. A systematic expansion plan, while optimized to serve current travel demand forecasts, should also account for other criteria (e.g., military deployment, highway network coverage and connectivity) and preserve flexibility to meet changing demands.

Future Demand for the Highway System

Vehicle miles of travel (VMT) projections reported in the U.S. Department of Transportation 2004 Conditions and Performance Report forecast growth of 2.07 percent per-year from 2003 to 2022, while historic average annual VMT growth between 1993 and 2002 was higher at 2.5 percent per year. Travel projections show growth will be faster in rural areas (2.29 percent rural and 1.93 percent urban), for freight transportation and on Interstate highways.

Both the total amount of future highway demand (VMT) and its composition (urban/rural, passenger/freight, trip purpose, etc.) are critical factors in understanding how best to provide additional capacity. Emerging trends in highway travel demand, based on rapidly increasing trade flows and freight demand, a decreasing rate of suburbanization, immigration and aging demographics, among others, are well-recognized. Other trends yet to emerge (e.g., saturation effects) could appear in forecast out years, but within highways' lifespan. Their potential emergence requires accounting for forecast uncertainty by way of protecting flexibility (e.g., preserving adequate rights-of-way) and other future options.

Factors Driving Aggregate and Per Capita VMT – Historical and Future

Historical growth rates for passenger and freight VMT have been driven by demographic and economic trends, including factors that are no longer as prominent in society today or are unlikely to change significantly from present conditions. Among these changing factors are the following:

Population growth in the last 50 years averaged around 1.4 percent annually, doubling the national population. Future growth rates are expected to be 1.0 percent or less, even with extensive immigration. Further, key historic demographic drivers of VMT (e.g., increased workforce participation and proportion of persons of peak travel age) are expected to be much less significant looking forward.

The U.S. witnessed a multi-decade explosion in ***vehicle ownership and driver licensing*** that will not be repeated. We are already nearing license and vehicle saturation among most households, and with licensing rates approaching equality between women and men for all age cohorts, the last area of significant growth has occurred.

Growth in ***GDP and per capita income*** and corresponding VMT increases will continue, but there are saturation effects regarding income effects. Threshold increases in household VMT occur with first and second vehicle ownership, which increasingly large—but by no means all—segments of the society have passed.

While continued ***suburbanization*** is expected, its growth rate is already declining, and should continue to do so (in part because the suburbs are already the dominant residential location). There will not be further dramatic shifts at the national level, although there may be significant effects on per capita VMT growth rates in some localities.

Current and Future Trends in the Characteristics of Travel Demand

Changes in the structural nature of demand are also important in planning for systematic expansion of the highway system. Some of the bases for both short-term and longer-term structural demand changes can be examined through the factors below.

Freight commodity flows are currently increasing very rapidly. The U.S. economy is forecast to grow at a compound annual rate of 2.8 percent over the next 30 years. At this rate, the demand for freight transportation will nearly double between 2005 and 2035. But there is uncertainty regarding sustainability of these growth rates and the changing geography of demand. Volatile geopolitics, emerging/changing trade partnerships, energy or climate change factors, for example, could alter the degree of globalization or location of trade flow corridors. Increases in ***urban truck VMT*** will, of course, interact with personal travel—if urban congestion is not addressed, there may be spillover effects on the whole freight transportation system. ***Commodity mix***, in terms of value, time sensitivity, and density, and supply chain patterns may also shift, influencing freight transportation patterns. Both ***intermodal connections*** **and** ***other modes' competitiveness*** may also influence highway freight patterns. ***Truck size and weight limits***, and achieved ***load factors***, could result in both increased freight flows and decreased VMT in some corridors.

National 20 year growth rates from HPMS forecast that VMT on ***rural systems*** will grow faster than urban systems—an annual increase of 2.41 on rural Interstates and 1.95 on urban Interstates. While local passenger trip-making grows by about 20 to 30 percent, ***long distance highway passenger travel***, much of it recreational, is expected to grow in the range of 50 to 100 percent. Demographics and past trends also indicate the ***decreasing share of commute trips***. Along with congestion pricing, this may decrease demand peaking, leveraging capacity expansions. Lastly, changes in ***vehicle occupancy***, both within and across trip purposes, could have relatively significant effects on VMT.

While all of the above factors are widely recognized, modeling their effects and, especially, predicting their extent can be difficult. The number of factors enumerated here illustrates the uncertainty at the national level, and even more so at the corridor or regional level, in predicting the magnitude and composition of future demand, especially in the out years.

Focus Areas for Highway Capacity Expansion

Forecasts of the growth in demand and changes in its composition significantly inform decisions regarding how and where to pursue highway expansion. Non-transportation and qualitative transportation goals and criteria, often highlighted by stakeholder input, are also critical in making determinations regarding present and expected highway needs. From these sources, a variety of conceptual areas on which to focus expansion efforts can be developed. Each of these focus areas is described here at the strategic level, in keeping with the goal of reviewing systematic concepts for infrastructure expansion.

In addition to discussing these focal areas as strategic elements of systemic infrastructure expansion, they are also discussed in the context of the key measures that can be undertaken to realize them. The focus areas can be viewed in one sense as a source of issue areas to be used in developing a proposal or strategic plan for expansion. They may conversely be used as a partial check-list in analyzing whether a proposal or alternative concept accounts for many of the key areas of need.

Interregional Connectivity

One focus area for expansion is improvement in the NHS', and particularly the Interstate System's, interregional connectivity. This focus area in particular requires particularly strong federal direction because of the inherently multi-state nature of the element, and because many of the benefits from each road segment accrue to through-traffic rather than to the jurisdiction in which the highway is located. Improving interregional highway connectivity and level-of-service is in part a priority in light of it comprising the portion of the NHS with most rapid growth and structural changes in highway travel demand – both passenger and freight. Intraregional needs for improved levels-of-service are also very important, but are growing less quickly and are more amenable to technological and operational changes relative to infrastructure expansion.

An element of improving interregional connectivity is to establish access to additional urbanized and other areas not presently connected to the Interstate System. Similarly, improving network connectivity, including through the upgrade or conversion of existing routes to NHS or Interstate levels, could improve access to both localities along the route and to users of the network as a whole (by reducing circuity, increasing network redundancy, and enhancing flexibility).

Another important element of improving interregional connectivity is improvement to levels-of-service in key portions of the network. This is best illustrated by bottlenecks of national significance, where delays, capacity shortfalls, and deteriorating travel time unreliability hinder not just local traffic but national through-traffic. Delays increase both the local and the national economic cost of doing business. This element should be considered to include both the expansion of congested inter-city corridors (e.g., I-95, I-81, I-35, etc.) and the upgrade of highly congested NHS segments to Interstate Highway standards.

Freight Corridors

Major trucking corridors, including both long-haul routes and heavily traversed urban corridors, are another important focus area for highway expansion. These corridors are of special national interest because they affect local economies and the profits of individual firms, and also have macroeconomic effects on access to markets, productivity, business reorganization effects, and economic competitiveness. Many of these corridors serve both domestic and international trade.

Improvements to freight corridors may involve highway widenings to meet forecast demand. When combined freight and personal vehicle flows warrant, the partial or full segregation of heavy-duty and light-duty vehicles in new or reconfigured lanes (e.g., the northern New Jersey Turnpike) may additionally be undertaken for the safety, productivity, and mobility benefit of either or both vehicle types. A more extensive example of this is the proposed Trans-Texas Corridor, which would include separate tolled car and truck lanes along with intermodal facilities on high volume trade corridors. Another means of addressing the need for freight corridors could be through the development of designated longer combination vehicle (LCV) corridors, possibly fully segregated. Such LCV lanes could function as part of the potential development of a nationwide LCV network, as well as incrementally in congested truck corridors and/or urban areas.

A key aspect of freight corridors is that it is rarely just the line-haul portion of the corridor that requires infrastructure expansion. Bottlenecks along the corridors, at key junctions, or at intermodal connections are often the primary elements of a corridor to be addressed. Care must be taken that the relief of individual bottlenecks does not merely result in a cascade effect where a new bottleneck appears further down the traffic stream. Because of the very important role of major container ports, airports, and rail intermodal yards in trade and freight flows, particular attention should be focused on bottlenecks at these intermodal facilities which often occur in already congested urban environments.

Urban Highway Capacity Expansion

Physical capacity expansion (widening) of existing Interstate or other major highways in urban areas is a delicate issue. Political concerns related to land takings, environmental impacts, induced demand, construction delays and other factors have impeded numerous projects. Such expansions usually must meet a tough standard determining where they are warranted by congestion, desirable in terms of cost-effectiveness, and politically feasible with regard to impacts and externalities.

In addition to widenings, expansion can also occur in the form of expanding suburb-to-suburb connections through either new facilities (e.g., the InterCounty Connector in Maryland) or through the upgrade of existing roadways. In either case, bottlenecks are again a critical area

upon which to focus. In urban areas, both intermodal and highway-only bottlenecks can occur which effect other elements of the highway network, as proximity and queuing result in the spillover of hyper-congestion to other network links. Because of their limited scope and discrete nature, however, bottleneck relief can be easier to put into action than new facilities or widenings at the corridor level.

Because of the impediments to physical infrastructure expansion in urban areas, systems management/operations investments are a key component of metropolitan capacity expansion. HOV/HOT lane options, where indicated by high levels of congestion and by limited capacity expansion opportunities, are an increasingly popular means to address urban congestion and capacity needs. HOV/HOT lanes can also be leveraged with measures such as congestion pricing, bus rapid transit, and park-and-ride facilities. Ramp meters, incident response, traveler information and other elements of integrated corridor management are additional operational strategies that are highly cost effective and less politically difficult in the context of urban highway capacity expansion..

Military Deployment and Disaster/Emergency Response Needs

National defense was one of the original stated rationales for development of the Interstate Highway system. Capabilities for military mobility and rapid deployment, including the National Guard for its various domestic duties, remain important, although at times appear to be overlooked.

Highway connections of some military facilities to the Interstate system are lacking, and highway expansion to achieve this should be examined as an element of systematic infrastructure provision of military needs. “Fort-to-port” connections are a notable example of serving these military deployment needs. Thus, expansion of the NHS network and selective upgrade to Interstate standards should be examined as well as the enhancements noted above.

Emergency response capabilities of the NHS, particularly the Interstate component, are a largely parallel set of focus areas. Infrastructure investments in vulnerable areas may be needed to help withstand earthquake, hurricane, or even future climate change (as per the Gulf Coast study) damage. An element of this is provision for reversing highway flow on inbound lanes in the case of major evacuations, but at the same time being able to preserve inbound lanes for disaster/emergency response. Network redundancy, preserving access should a single route be rendered inoperative, will improve the reliability of response capabilities and allow for more flexible response.

Recent Activities Addressing Highway Expansion Needs

Many states have been grappling with the provision of highway capacity because of other financial demands and constraints on resources. Revenue from fuel taxes have been decreasing relative to highway needs, as the federal and many state taxes have not kept up with inflation, leave alone with highway construction costs that have exceeded overall inflation. Highway expansion activities also have been constrained by the restoration, rehabilitation, reconstruction, and resurfacing needs of the current Interstate Highway System, especially due to the concurrent approach to the useful lifetime of many facilities.

In the context of these challenges, several states and regions have developed strategies for addressing their highway expansion needs. These strategies are examined because of their value as real-life examples, although the context of today's specific set of constraints must be accounted for if their illustrative value is to be best applied to reviewing proposals for future expansion efforts.

Corridor Case Descriptions

Trans-Texas Corridor - The Trans-Texas Corridor is the largest engineering project ever proposed for Texas. The planning and work involved in the corridor would exceed any public works project in the state's history. The concept for the Trans Texas Corridor involves connecting the entire state by a 4,000-mile network of corridors up to 1,200 feet wide with separate lanes for trucks (two in each direction) and passenger vehicles (three in each direction). Currently, four corridors have been identified as priority segments of the Trans Texas Corridor. These corridors roughly parallel I-35 from Denison through Dallas to the Rio Grande Valley, I-69 (proposed) from Texarkana to Houston to Laredo, I-45 from Dallas-Fort Worth to Houston, and I-10 from El Paso through San Antonio and Houston to Orange.

I-95 coalition - The I-95 Corridor Coalition, supported by congressional high-priority-corridor ITS funding, has been able to establish a stable program focusing on multi-state freight operations and improvements. The Coalition has succeeded in identifying critical freight and passenger bottlenecks and quantifying the benefits of improving them. But while it has focused attention on major highway and rail bottlenecks, it has not yet found an institutional and financing mechanism to systematically fix them.

Ohio Interstate bottlenecks - The Ohio DOT analyzed major highway bottlenecks across Ohio, identified specific choke points within its bottlenecks, and estimated the number of trucks and the type, value, and origins and destinations of the freight caught in them. For example, Ohio DOT estimates that selective redesign of portions of the I-70/I-71 corridor through downtown Columbus could eliminate upwards of 80 percent of the delays and crashes experienced today. The project would involve reconstruction of approximately two miles of the corridor, converting slopes to retaining walls to make space for a new through lane in each direction, consolidating ramps to reduce merges, and using new frontage roads to collect and distribute traffic. But they also found that less aggressive, more precisely tailored improvements such as redesign of a single ramp or repositioning of a weave or merge lane as well as operations strategies could cost-effectively reduce delays at some congested bottlenecks. Ohio DOT estimated that actions like these could reduce the growth of congestion at major bottlenecks within the state from four percent annually to less than one percent annually and could generate significant user benefits as well as benefits to the state and regional economies.

Current Revenue Activities for Capacity Expansion

In 2002, the Ohio state legislature approved a 6-cent increase to the State's motor fuel tax, to take effect in 2-cent increments over the following three years (2003-2005). This adjusted Ohio's motor fuel tax rate from 22 cents per gallon to 28 cents per gallon. The key factors in the Ohio state legislature's willingness to accept the tax increase – despite an ongoing recession and political pressure to reduce taxes generally – were the perception that Ohio DOT was operating as leanly and efficiently as possible; an acknowledgment that Ohio DOT had made a clear and compelling technical case for major, corridor-level, infrastructure improvements; and a

consensus that the tax increase would benefit the programs of county and local governments as well as the programs of the Ohio DOT. The Ohio case demonstrates that it is politically feasible to increase the motor fuel tax, but also establishes the importance of building a prior reputation for prudent management and good stewardship, building a broad constituency, and targeting the proposed increased revenues on needed and publicly visible capacity improvements.

Florida has used tolling extensively to provide new urban and interurban highways, to improve capacity, and to maintain high-quality service on its existing toll roads. In recent years, the State has derived between 8.2 to 11.2 percent of annual highway revenue for all levels of government from tolling. Florida's toll agencies have built two-thirds of all new lane-miles and nearly all new limited access highways in the State in the past 15 years. Since 1990, Florida's Turnpike (now called Florida's Turnpike Enterprise) has used toll revenue to open nine new system interchanges, add 39 lane-miles of widening projects, make substantial facilities improvements, and invest in a new electronic toll collection system. The Florida Transportation Commission has recommended that "direct user fees, open-road tolling concepts, express lanes …, [and] variable rate pricing" be utilized to accelerate the construction of needed transportation facilities.

Alternative Concepts for a Systematic National Strategy of Capacity Expansion

Implementation of Highway Capacity Expansion

Implementation of improvements to serve the focus areas presented above includes widening of the existing Interstate System and NHS for additional capacity where feasible, selective upgrades of existing facilities (primarily NHS) to Interstate standards, and establishment of special lane options. The latter includes segregated, hardened pavement and structures design as appropriate, and managed lanes implemented as HOT lanes, truck toll lanes including LCV concepts, and a deployment and disaster response network. Analysis from the NCHRP Project 20-24(52) Future Interstate Study found:

- New additions to the Interstate System will be needed if the system is to continue to serve growing national economic and mobility needs while existing corridors are reaching their capacity limits;
- The 2,600 to 2,700 new lane-miles needed each year to meet demand growth on the existing Interstate System compare to about one fifth that number being added in recent periods;
- The level of service on the existing system will deteriorate over the thirty year period if lane additions fall below the rate of 2,600 to 2,700 per year;
- Potential additions of new corridors to the Interstate System can be identified from largely existing NHS routes to better serve metropolitan area growth, trade corridors, defense corridors, and new corridors connecting under-served urbanized areas;
- For the existing Interstate System, cost-effective capital investments can serve 80 percent more VMT over the next thirty years, with just less than 40 percent more lane miles;
- The existing Interstate System will eventually run out of capacity at current lane throughput levels, because it will not remain feasible to continue to add new lanes to these facilities.

And for infrastructure capacity management:

- Management regimes are very important, but alone will not eliminate the need for the cost-effective capital investments above, especially with regard to recurring congestion;

- Tolling of general purpose lanes, truck lanes or high occupancy toll (HOT) lanes are important alternatives to the tradition of untolled Interstate facilities to improve performance and to help finance expansion;
- Safety will be significantly improved by the conversion of highly traveled NHS miles to Interstate standards, the separation of autos and trucks in dense corridors, and the application of management and operations strategies;
- Available operations and ITS deployments can be implemented that will have tremendous safety and performance benefits in relation to their costs and will also substantially leverage the effectiveness of new capacity;

Themes/Criteria for Systematic Expansion

Development of alternative concepts for capacity expansion first needs to account for key objectives. Among these, global competitiveness and support to the national economy are generally derived from improving freight flows and interregional competitiveness. Improving urban congestion and access additionally is a factor in the national economy, but also has substantial effects on deadweight losses from time delays and decreased quality of life. Non-economic objectives such as defense mobility and emergency response, environmental impacts, and safety are also important criteria.

While they are the subject of separate briefing papers, influences from rail investments, capacity management and operational improvements, ITS and technological applications, etc. must of course also be accounted for in developing expansion alternatives. Several of the relevant planning, design, operations and financial issues need to be addressed in a coordinated fashion in developing these alternative concepts for highway expansion. Planning for highway capacity expansion must also consider other elements of our intermodal transportation system. When evaluating expansion proposals the financial and political feasibility, and resources, needed for their implementation must also be addressed. Together, the above factors provide a broad range of desired performance outcomes and criteria for developing a strategy for systematic highway capacity expansion.

Conclusions

Highway demand will continue to outpace planned rates of infrastructure expansion. Growth in demand will be fastest for freight and for rural transportation, but virtually all elements of the system will feel demand pressure. The likelihood is that there will be new demand trends – based on shifting demographics, new transportation vehicle or ITS technologies, structural shifts in trade or the economy, etc. – but that their emergence, strength and nature are difficult to predict; long-term strategic planning must factor in corresponding flexibility.

Financial and political constraints are two important reasons current federal, state and local efforts will not keep pace with future demand. These are mostly comprised of political unwillingness to enact user fees (especially the gasoline tax) or taxes keep pace with inflation and highway demand. Many innovative approaches involve varying forms of finance leveraging tools and private participation are emerging.

The primary highway system elements to be targeted for systematic expansion are aggregate capacity, freight corridors, urban mobility, intermodal connections, bottlenecks of national

significance, system connectivity, regional access, and military deployment/emergency response corridors. Systematic expansion using a combination of traditional and alternative concepts can cost-effectively address future demand. In addition to lane-mile or similar capacity expansions, hybrid investments spanning infrastructure and operations (e.g., HOT lanes, ITS systems) are also important tools.

Key objectives of highway system expansion include congestion relief, freight transportation efficiency, global competitiveness, interregional accessibility, system reliability, and extension to relatively under-served urbanized areas. These—and several non-transportation criteria (e.g., military deployment and disaster response, financing, environmental factors, political feasibility)—should be the key criteria for determining systematic and incremental expansions.