Background Information

A Forum on Flexible Design for 21st Century Challenges:

Balancing Competing Objectives and Optimizing Return on Investments

February 23-24, 2009

Minnesota Department of Transportation

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Purpose of Flexibility in Design Forum

On February 23-24, 2009, Mn/DOT is holding a forum on "Flexible Design for 21st Century Challenges: Balancing Competing Objectives and Optimizing Return on Investments". Representatives from the Federal Highway Administration (FHWA) and six other states that have undertaken initiatives to apply greater design flexibility (MD, MA, PA, MO, KY & WS) will share their approaches and experiences. We hope to learn much from their efforts and to "jump start" and tailor a concerted Minnesota initiative to apply greater and more consistent flexibility in transportation planning, design development, and operations statewide. The forum will focus on improving our understanding of opportunities to apply greater design flexibility, how we can use design flexibility to increase the return on our transportation investments, and what institutional challenges we need to address to be more successful. An action plan for implementation will be developed following the design flexibility forum.

The Need for Change

Mn/DOT is faced with many challenges that must be addressed in new ways in the 21st Century. Transportation needs will continue to increase in response to the state's population growth and aging infrastructure. In the face of growing challenges and constraints, the public is still expecting a better transportation system that has less adverse impact on communities and the environment, that does a better job of supporting alternative choices and modes of transportation, that is less likely to encourage sprawling growth and misalignment between transportation and land use development, and that is more likely to enhance quality of life and economic competitiveness. At the same time, financial resources to address statewide transportation needs are limited. "We can't build our way out of congestion" has been a mantra in Minnesota for the last two decades but it is truer today than it has ever been. We know that we must find ways to squeeze more effectiveness and capacity out of our existing systems; we must use retrofit solutions as well as reconstruction; and we must find ways to extend the life of our infrastructure, both physically and functionally. We must make much greater use of new technologies. All of these things must be done while providing a safe environment for all types of transportation users.

In the past, our transportation policies, approaches, and design guidelines have given a high priority to addressing congestion and safety issues through added lane capacity and roadway/interchange reconstruction but without adequate attention to system level considerations and the "right-sizing" or scaling of project solutions to optimize return on investments for competing needs. We need to change transportation policies, planning approaches and design guidelines so that we will have and use greater flexibility to retrofit existing systems, to address community and environmental issues, to accommodate multiple modes of transportation on the same roadway, and to achieve safety improvements more cost-effectively and quickly. This will help us to optimize our return on investments by understanding the points of diminishing returns and by stretching our available dollars to provide the most service to the most people (in the best public interests) while ensuring the safety of our

transportation system. It will also help us to design projects that are more acceptable to our constituents in meeting their needs and the needs of local communities.

Related Initiatives

Context Sensitive Solutions - Mn/DOT has undertaken a number of initiatives in the last decade that have attempted to address these challenges and introduce greater flexibility into design and decision-making processes. Mn/DOT was one of five pilot states selected by FHWA in 1999 to help introduce and advance the concept and implementation of Context Sensitive Design (CSD) – now referred to as Context Sensitive Solutions (CSS). Mn/DOT's selection, as a pilot state, recognized the Department for an exemplary highway project development process and many notable and award winning projects and processes over the previous 30 years. By late 2000, Mn/DOT (in partnership with the FHWA MN Division and the U of MN Center for Transportation Studies) had developed and deployed a Department approach to CSD&S with training, a new design policy (Tech Memo), six core principles (including emphasis on applying flexibility in design), a marketing brochure, and a website. Since that time, Mn/DOT has continued to assess CSD&S implementation challenges while continuing to further develop and deploy periodic training and initiatives in applying CSD&S philosophy and principles inclusive of hosting a 2005 Midwest Region CSD&S Workshop with over 200 participants representing more than 30 states.

Design Flexibility - The impetus for the CSD/CSS national initiative (that was coined and kicked-off at a 1998 national "Thinking Beyond the Pavement Workshop" in Maryland) followed on the heels of two initiatives that set the stage. First, enactment of the 1995 National Highway System Designation Act emphasized and broadened consideration of flexibility in design (for non-interstate new construction, reconstruction, resurfacing, restoration or rehabilitation) more than had ever been stated before (taking into account the built and natural environment of the area; the environmental, scenic, aesthetic, historic, community, and preservation impacts of the activity; and access for other modes of transportation). Additionally, for federal-aid projects off the National Highway System, Congress provided that states have the flexibility to develop and apply design criteria that they deem appropriate. Secondly, the FHWA development and publication of *Flexibility in Highway Design* (in 1997 as a national guidance document) built upon and highlighted the flexibility that already existed in current laws, regulations, guidance, and the AASHTO "Green Book". *Flexibility in Highway Design* illustrated opportunities and successful approaches for using flexibility in design to tailor solutions that fully consider and address the often conflicting objectives of environmental, scenic, aesthetic, historic, cultural, community, safety, and mobility needs along our highway system. The challenge laid out for the highway design community was to use more innovative thinking and creativity to find and tailor design solutions and operational options that balanced these sometimes conflicting objectives. While the Transportation Research Board (TRB), the Institute of Transportation Engineers (ITE) and AASHTO all published documents recommending greater flexibility in design and application of standards in the early 2000s, most FHWA state division offices and most state DOTs have not yet embraced or met this flexibility in design challenge.

Innovative Contracting Methods – Mn/DOT has used several innovative contracting methods to create more flexibility in the delivery of projects, which enables projects to be delivered more quickly. The *Design-build* approach can significantly deliver projects faster than traditional methods. The *Cost plus time (A+B)bidding* approach factors cost and time to determine the low bid. The *Lane rental* approach encourages contractors to minimize road-user impacts. Using *incentives or liquidated savings* approaches can accelerate contract completion times. Mn/DOT's *Indefinite Delivery / Indefinite Quantity Contract* pilot project involves the demolition of buildings on highway construction projects. Contractors provide a lump sum bid for each

property; Mn/DOT awards the contract to the lowest bidder for the whole project. When a structure is ready for demolition, Mn/DOT notifies the contractor and pays for that bid item. The *Warranties* approach guarantees quality and durability for selected work items for a specific time period after construction. The *Pay for Performance* specifications approach relies on final outcomes measured against performance criteria in the contract. Application of *Technology Advances in the Field* is another approach that is helping Mn/DOT to reduce construction time.

Current Activities - Recently, Mn/DOT developed and began implementation of a new and comprehensive statewide scoping model; a new cost management model; a new cost risk assessment and value engineering model; and is in the beginning stages of leading a multi-jurisdictional study to examine the feasibility and cost/benefits of adopting "Complete Streets" policy in Minnesota. Additionally, Mn/DOT recently conducted a self-assessment of CSS understanding and implementation across the organization and has begun work on executive level CSS action planning. In the spring of 2009, Mn/DOT will re-deploy a revamped core CSS training class and a new pilot class in applying advanced flexibility in design. Despite these many initiatives and a number of documented, highly successful, and nationally recognized MN project case studies in applying CSS and flexibility in design, Mn/DOT has not yet adopted specific flexibility in design objectives, criteria, or guidelines and does not yet consistently consider and apply sufficient innovation and flexibility in planning, design, and operations to balance competing objectives and optimize return on investments for the majority of the Department's projects.

Project Examples

Representative examples of Minnesota projects (there are other examples in all districts), which have used design flexibility in a variety of ways, are described below. All of these projects had unique circumstances or special situations that influenced the chosen solutions and required a more creative approach to design than is usually employed in the typical project delivery process. All of these projects encountered significant procedural and design challenges which had to be overcome in order to implement flexible design solutions. The design flexibility used in these projects has shown staff that it is possible to effectively balance competing objectives by using a more flexible approach to design. However, staff is also aware that there are currently major process hurdles to access design flexibility on typical projects. The purpose of this design forum is to identify the hurdles that designers encounter when proposing flexible approaches to problem solving so that creative solutions can be more easily implemented where they are appropriate.

Reconstruction Projects

The following are examples of reconstruction projects where design flexibility was used to resolve competing objectives.

Minnesota TH 61 (North Shore Scenic Highway All-American Road) – This roadway design and reconstruction approach was cited as one of nine case studies featured in the 2002 National Cooperative Highway Research Program (NCHRP) Report 480 "A Guide to Best Practices for Achieving Context Sensitive Solutions". Selection of a lower design speed (55 mph rather than 70 mph) and maintaining an upgraded two-lane facility, appropriate to the unique circumstances, allowed maximum flexibility to find the best roadway alignment to balance the competing safety, mobility, social, economic and environmental needs while saving costs and optimizing return on investments. Forensic post-reconstruction analysis later documented that annual crash rates had also been reduced by 45% to more than 70% in the various segments.

MN TH 38 (Edge of the Wilderness National Scenic Byway) – This roadway design and reconstruction project was cited as the best CSS project in the inaugural 2005 AASHTO national Best Practices in CSS competition. Reconstruction of TH 38 segments utilized the lowest appropriate design speeds (50-55 mph), and appropriate design exceptions, to maximize flexibility in design to balance unique competing needs and objectives while trying to maximize return on investments and value-added. The substandard highway was reconstructed as a 10-ton road maintaining much of the existing two-lane horizontal and vertical alignments balanced with strategic spot and intersection improvements where accidents were documented as frequent. The typical reconstruction cross-section includes two 12' lanes with 4' paved shoulders and 2' of additional reinforced gravel shoulder and rumble stripes to mitigate for substandard alignment and the use of steeper back slopes and variable ditch cross-sections to minimize adverse environmental impacts. Forensic post-reconstruction analysis documented typical cost savings of more than 40% and annual crash reductions exceeding 55%.

TH 23 Spicer from TH 71 to CSAH 31 (through Spicer and New London) – The reconstruction and expansion of this 2 lane roadway to a divided 4 lane highway passes through the environmentally sensitive Green Lake Watershed. To reduce runoff impacts, 39 ponds of various configurations (single, double, multi cell & grit chamber) were constructed to capture and treat roadway runoff before entering Nest & Green Lakes. In addition, the impervious roadway surface was reduced by designing 6 foot shoulders throughout the raised median urban section. A number of retaining walls were constructed to minimize impacts to vegetated slopes and to also minimize the surface areas of urban ponds and ditches within right of way constraints. The architectural details for the retaining walls and bridge abutments utilized a multi-colored concrete field stone pattern to reflect the historical and prominent use of natural stone construction found throughout the community of Spicer.

TH 1 Near Ely – TH 1 connects the North Shore of Lake Superior with the community of Ely in the northeast corner of the state while traversing wild and remote woodlands. The highway also serves as one of the gateways into the vast and famous Boundary Waters Canoe Area (BWCA) wilderness. The 15-mile section between Lake County Highway 2 and the Kawishiwi River Bridge was an experience loved by residents and tourists alike for its winding alignment and trees right up to - and even growing in - the roadway shoulder. In reconstructing this segment and striking a balance between modernizing the highway and preserving its character, charm and historical integrity were challenging concerns and a difficult and sensitive undertaking. Selection of the design speed was the key decision to enable a flexible and context sensitive design. After several trial investigations, the design speed was set at 40 mph - a design exception 10 mph below the standard range and 10 mph below the existing posted speed. Additionally, design exceptions for horizontal alignment below 40 mph were used in a few sensitive and constrained areas. This flexibility allowed the vast majority of the highway's length to fall within a few feet of the alignment of the original road - itself designated as a historic property. The highway's other elements were designed using Minnesota's Natural Preservation Route standards as borrowed from the Minnesota State Aid Rules. The successful application of CSS vision and flexible design execution produced a project that gained public acceptance during development and has received very positive feedback upon completion.

TH 10 Access Management through Detroit Lakes - The realignment and reconstruction of Highway 10 through the heart of the City of Detroit Lakes, MN improved safety and mobility along this segment of an important interregional corridor while improving access and mobility for local traffic as well. Collaborative solutions were identified during public input and included reducing crossings with the railroad and providing an opportunity for urban redevelopment in

Detroit Lakes. The design addressed many factors including railroad needs, coordination with local business and civic groups, historic buildings and properties, impacts to adjacent property owners, water quality, and staging criteria controlled by fish migrations. The project's staging plan was considered a critical input in the early stages of design. Traffic impacts were reduced and the construction contract used several innovative contracting methods. A + B bidding was used and the successful bidder took a three year project and built it in two years. A locked incentive date was used within the project for timely completion of work on an important bridge. The contractor not only achieved the date but completed the bridge work in one construction season rather than two. Detour rentals were utilized throughout the project to reduce the length of time in which important city streets were detoured. The above, coupled with effective use of a communication and public relations expert (pay item), resulted in a very successful and cost-effective project that was delivered quickly and with well informed and engaged public and business stakeholders.

CSAH 3 Excelsior Boulevard (St. Louis Park) – This roadway design and reconstruction approach was cited as one of five case studies in the Institute of Transportation Engineer's 2006 proposed recommended practice publication *Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities*. Design speed was reduced and flexibility in design was applied to reallocate cross-section space to balance competing stakeholder needs and objectives while also improving safety for all modes. Community needs, in this built urban environment, were addressed along this roadway by using a design speed of 35 mph (consistent with desired operating speed) and 11 foot travel lanes, adding landscaped medians, eliminating shoulders, adding off-street parking facilities, adding on-street parking lanes that incorporated reaction distances, adding protected but shortened left turn lanes and tapers, adding access controls and consolidations, adding near-side and far-side transit stops, providing for convenient off-route bicycle mode accommodation (parallel streets), widening sidewalks, adding streetscape elements and a hierarchy of roadway and pedestrian level lighting that all combined to support a "complete street" and revitalized suburban town center. Forensic post-reconstruction analysis documented more than a 60% annual crash reduction in the first reconstruction segment.

CSAH 13 (Radio Drive) Safety & Mobility Project - The County and City worked with the public to develop a safety and mobility project that was consistent with the community's vision. The project included critical technical improvements such as expansion into a four-lane divided roadway with turn lanes; multi-use paths on both sides of the roadway; signalization; and a multilane roundabout. The Radio Drive/Bailey Road roundabout was one of the first full multilane roundabouts in the state and the first full multilane roundabout on a high-speed arterial roadway. It currently carries over 20,000 ADT and is expandable to carry over 60,000 ADT in the future. Preliminary construction cost estimates for this three mile long project were up to $14 million. A value engineering approach was used during final design and it led to a context-sensitive design solution and construction cost of $9.6 million. Cost savings were realized through use of a full closure during construction, profile adjustments to minimize earthwork and adverse project impacts, minimization of right of way acquisition, and use of MSE walls. The staging eliminated a full year of construction and allowed the project to open on schedule after a yearlong delay due to lack of funding.

Retrofit Projects

The following projects are examples of projects where design flexibility was used to resolve an existing problem without complete reconstruction. In some cases, actions were taken to

address emergency situations; in other cases, actions were taken to gain benefits early by providing immediate solutions to existing problems.

TH 65 in Columbia Heights – This is a four-lane divided roadway in an urban environment with many driveways, median openings, cross-streets and signalized intersections. The numerous access points resulted in one-way and do not enter signs being installed in the median over many years which resulted in a "sea of posts and signing". Mn/DOT and the city systematically evaluated access points to determine which, if any, were "over-signed". Using the flexibility allowed in the MUTCD, many signs were removed. The reduction in signs resulted in improved aesthetics for the city, lower maintenance cost for Mn/DOT and a safer and less distracting environment for the traveling public.

TH 61 through Hastings – This roadway was a four-lane undivided roadway with a very high crash rate and a high frequency of rear end, left turn crashes. Every other city street would have had to be closed to meet Mn/DOT standards for left turn lanes and tapers, which was unacceptable to the city. Shorter turn lanes and shorter tapers were proposed so that all public street intersections could remain open. The project became acceptable to community stakeholders once flexibility in design was offered and reconstruction resulted in a 44% annual reduction in crashes.

TH 7 from Hutchinson to St. Bonifacius - Roundabouts and passing lanes were constructed on the eastern portion of this project to handle safety issues and projected traffic volumes instead of the more typical rural divided highway with interchanges and stoplights. Retaining walls in Hutchinson were constructed to minimize right-of-way takings and reduce cost. Controlled access management in certain areas was implemented to establish proper placement of entrances to the highway.

TH 100 from 36th Street to I-394, St. Louis Park – This is a four-lane segment of freeway between two six-lane segments. It was built in 1937 and has substandard ramps. The Metro District narrowed the existing shoulders and lanes on this road segment to add a third lane in each direction. Congestion has decreased, throughput has increased, and speed has increased. There has been a marked reduction in crashes and the benefit-cost ratio is 13:1 based on congestion savings over a 7-year service life.

TH 100 northbound from France Avenue to I-694 – This project was undertaken to relieve congestion caused by the I-35W bridge collapse. The shoulders of this ramp segment were converted to provide a two lane entry on to I-694. Traffic throughput increased, congestion decreased, and speed increased. There has been a modest reduction in crashes and the benefit-cost ratio is 17:1 based on congestion savings over a 20-year service life.

I-94 from I-35W to Hwy 280 – This project was undertaken to relieve congestion caused by the I-35W bridge collapse. The Metro District narrowed the existing shoulders and lanes to provide four lanes of capacity. Access to Hwy 280 was improved by having the southbound Hwy 280 to westbound I-94 ramp start a new lane (instead of merging in on the left) and converting the eastbound I-94 exit (to northbound Hwy 280) to a two lane exit. The improvements resulted in a 24 hour increase in traffic volumes and decreases in both a.m. and p.m. peak period congestion.

Key Questions

Some of the key questions (and no doubt there are many others) that need to be addressed during the forum (*Flexible Design for 21st Century Challenges: Balancing Competing Objectives and Optimizing Return on Investments*) include:

- What changes need to be made in Mn/DOT's philosophy and approaches to allow greater understanding and broader flexibility in planning, scoping, design development, operations and decision-making overall?
- What institutional roadblocks need to be addressed?
- How should links between funding and design approaches and standards be changed?
- How can data and assumptions be re-examined to frame different and better solutions?
- How should we evaluate return on investments and points of diminishing returns?
- What changes need to be made in Mn/DOT's planning, scoping, design and operational approaches and guidelines? Should we recommend value ranges or specifically gradated values in our flexibility guidance?
- Should we change our design exception and variance philosophy and processes?
- Should we change our criteria for level of service, capacity/congestion, and functional classifications?
- How can we advance broader and more balanced multimodal considerations and solutions with more flexibility in our approaches and guidance?
- Should design speed be the same as targeted operating speed?
- How do we introduce greater flexibility without compromising safety?
- Are there liability and risk management issues that need to be addressed?
- What training, research, and innovation is needed?
- What performance measures or indicators of success are needed?