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January 6, 2004

TO ALL CONSULTANTS:

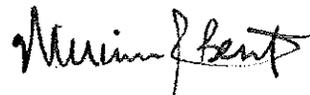
The intent of this letter is to provide information and guidance to your firm in the preparation of preliminary design documents for the Massachusetts Highway Department (MassHighway). The attached document, "Submission Guidelines – 25% Design Phase" details the process and required material needed for the completion of preliminary design plans and a Functional Design Report (FDR) for MassHighway.

Please note that these guidelines are to be used in conjunction with the "25% Highway Design Review Checklist" that was distributed to all consultants in September 2003. The guidelines present a detailed listing of the specific sections of an FDR, including a breakdown of the required data elements and analysis methods. MassHighway personnel will use these guidelines as an evaluation tool to measure completeness when reviewing preliminary design plans and report documents.

In order to provide for consistency and a smooth transition, any Department project that starts prior to April 1, 2004 may continue to submit 25% plans and FDR's based on the submission guidelines listed in the 1997 Metric Edition of the *Highway Design Manual*. Projects that fit into this category may also utilize the new procedures associated with the new guidelines. All projects beginning on or after April 1, 2004 shall use the new MassHighway approved "Submission Guidelines – 25% Design Phase". This information will be posted on the MassHighway Department web site for your reference and subsequent distribution.

If you have any questions or would like to offer comments, please feel free to contact me at (617) 973-7363, or Neil E. Boudreau, Assistant State Traffic Engineer at (617) 973-8211.

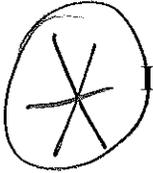
Sincerely,

William R. Bent, P.E.
State Traffic Engineer

Massachusetts Highway Department

SUBMISSION GUIDELINES - 25% DESIGN PHASE

A functional design report (FDR) is a necessary component for all Transportation and Safety Improvement Projects submitted to MassHighway, including mitigation projects developed through the Massachusetts Environmental Protection Agency (MEPA) process. However, Footprint Bridge, Roadway Resurfacing and Maintenance Projects are generally exempt from this requirement.



I. Functional Design Report

1. Existing Conditions

- A. *Study Area* – Description of the study area including geometry (i.e. lane layouts and widths, shoulder widths, traffic control, location of crosswalks, guardrail etc...), pavement conditions, posted speed limits and roadway classifications.
- B. *Existing Conditions* – Note and discuss any deficiencies or problem areas with the existing design (i.e. poor sight distance, high speeds, inefficient signal operation, lack of turn storage, etc...). Evaluate existing signage and pavement markings for potential repair or replacement. Document any field specific areas of concern or reference.
- C. *Dimensioning* – The report should address all dimensions in English Units. Values listed in the report text should correspond to the Plan Set.

2. Traffic Volumes

- A. *Traffic Count Data* – All traffic volume data older than 3 years from the date of the Project Study is unacceptable. Data less than 2 years old is preferred. However, if a low growth rate factor can be documented, the older data will be adequate for the study.
- B. *Automatic Traffic Recorder (ATR) Counts* – Taken on the mainline (both approaches) for a minimum of 48 hours. Side street approaches should also be collected for new signal installations. Note: On situations where all the approaches are equally loaded, collect the ATR volume counts for each leg.
- C. *Turn Movement Counts (TMC)* – Manual turn volume counts should be collected on all approaches and movements for a minimum of 2 hours during both the A.M. and P.M. peak hours, and recommended for 8 hours for new signal installations. The percent of Heavy Vehicles in the traffic stream should be collected as part of the TMC. If pedestrian and/or bicycle counts are relevant to the project, then a measure of these should also be included.
- D. *Development Projects* – For all private development and/or roadway reconstruction projects, new trip generation estimates should be included in the background growth. Development projects should clearly define the new trip generation and how the vehicles will be distributed throughout the study area network. A step-by-step process that documents the base traffic network, the new trip generation/distribution, the build conditions network, and the build with mitigation network should be provided for reference.

- E. *Transportation Demand Measures* – Transportation Demand Measures (TDM) present theoretical reductions in trip generation for development traffic. However, in order to provide a more conservative analysis for design purposes, use the full trip generation volumes.
- F. *Growth Rate Adjustments* – All projects should be evaluated for future year conditions based on a growth rate that is developed from documented historical data, or supplied by MassHighway or the local Regional Planning Agency. Current Massachusetts Highway Department standards call for a ten-year growth horizon, and is suggested for Private Development jobs, but not required.
- G. *Seasonal Adjustments* – Private Development jobs should consider a volume adjustment if the subject project is located in a region that experiences a notable seasonal variation, or if said development is primarily retail and encounters a peak season variation by nature.
- H. *Base Year Conditions* – Projects should use the growth and seasonal adjustments as necessary to develop base year conditions for the study. This is typically the year the design report/traffic study is completed. The base year volume data is derived from the *existing* traffic counts that are factored by the growth rate and any applicable seasonal adjustments, plus the nearby development traffic generation.

3. Safety Analysis

- A. *Crash Data* - Review of the accident history (latest 3 years minimum) with documentation of trends, probable causes, geometric shortfalls, and potential remedial action as appropriate. Stopping sight distance should be reviewed when applicable.
- B. *Crash Rate Worksheets* – Analysis of the existing data and calculation of the intersection crash rates using the Standard MassHighway Worksheet. If sufficient data is available, the crash rates for Roadway Segments should be provided. Crash Rate Data is available on the MassHighway website.
- C. *Collision Diagrams* – If the intersection averages more than 10 accidents per year, or if it appears on the latest Top 1000 crash locations list, collision diagrams should be provided to examine patterns and determine where improvements are necessary.

4. MUTCD Signal Warrants

- A. *Traffic Data* – The traffic volume data, including the appropriate side street approaches, should be analyzed for a minimum of 8 hours and put into tabular form for review.
- B. *Warrant Analysis* – The MUTCD Warrants should be reviewed based on the prevailing geometric conditions to determine if signal installation is justified (or for intersection reconstruction, if signals remain warranted). Note: MassHighway prefers that an “Eight-Hour Vehicular Volume Warrants” be met in order to satisfy signal warrants.

5. Intersection Analysis

- A. *Peak Hour Factor (PHF)* – All intersection approaches should be evaluated based on the peak 15 minutes of data collected during the peak hour. Thus, when determining the peak hour of volume, isolate the peak 15-minute period to calculate the PHF. This should be done on an approach-by-approach basis.

- B. *Heavy Vehicles* – The traffic volume data should be evaluated to determine the percent of heavy vehicles in the traffic stream. This may be done on an approach-by-approach basis, or by lane group as necessary. All analyses performed should reflect the actual field collected data.
- C. *Capacity Analysis* - all approaches, including a determination of level of service and vehicle delays using the current approved software packages by MassHighway. Where appropriate, short lane segments that operate effectively in the field as turning pockets without being striped or signed as such, should be included in the capacity analyses. Engineering judgment should be used in taking this credit, and all assumptions should be documented in the report text.

The following cases should be reviewed:

- 1) Existing Traffic Volumes w/Existing Geometry (No Build)
 - 2) Future Traffic Volumes w/Existing Geometry (No Build)
 - 3) Future Traffic Volumes w/Proposed Geometry (Build)
 - 4) Private Development Projects* - *Future Build-Out traffic volumes should be analyzed on mitigated geometry.*
- D. *Systems Analysis* – For closely spaced and/or coordinated signal systems, an approved software program should be used. The systems analysis can be either arterial or network format, and should present optimization options. Electronic file copies of these analyses should be made available to MassHighway for review.
 - E. *Queue Length Analysis* – Both average and 95th Percentile Back of Queue calculation results should be provided for the existing and future build conditions. The current approved software packages provide vehicle queue lengths as part of the analysis and should be used for all situations. However, queues calculated as part of a coordinated systems analysis are preferred over the isolated intersection results. If queue lengths are not provided with an approved software, MassHighway has a separate spreadsheet application that can be used. A standard vehicle length of 25 feet should be used unless data can be provided to support an alternate length.
 - F. *Basic Signal Strategy* – The capacity analyses evaluated should accurately reflect both the existing conditions and the proposed geometry, including signal housing locations, lane & pavement markings, and proposed phasing.
 - G. *Roundabouts* – When a new or existing roundabout or rotary is analyzed as part of the project, it is necessary to evaluate the capacity and delays for the approach lanes. A number of software packages provide roundabout capacity analysis methods. These programs should comply with the latest version of the Highway Capacity Manual. Refer to the Federal Highway Administration publication, “Roundabouts: An Informational Guide” for direction on operational analysis.

6. Proposed Geometry

- A. *Modified Geometry* – Discussion of the proposed geometric changes and/or alternative designs considered. List out the strengths and weaknesses of each and how a preferred alternative was derived.

- B. *Proposed Traffic Control Modifications* – Discuss how the proposed design will alter the traffic control conditions. Be specific with the layout and intended operation of any new equipment.
- C. *Roundabouts* – When a roundabout intersection is proposed for a project, we recommend reviewing the Federal Highway Administration’s publication, “Roundabouts: An Informational Guide” for design assistance. Design criteria are explained in depth with detailed explanations of the characteristics of the modern roundabout vs. the traditional rotary that is common in Massachusetts.
- D. *Mitigation Requirements* – For all Private Development projects the proposed mitigation requirements (Section 61, if applicable) should be clearly defined. This includes all phased work up to full build-out (mitigation phases based on occupancy, trip generation or other means). The schedule for improvements should be clearly defined in the document.
- E. *Traffic Calming* – All projects submitted to MassHighway for review that include any form of traffic calming should follow the “Traffic Calming Guidelines” as developed by the New England Section of the Institute of Transportation Engineers on behalf of MassHighway. Traffic Calming is primarily intended for functionally classified local roads.
- F. *Utility Poles* – In conjunction with FHWA, MassHighway gives special emphasis to the reduction of crashes with utility poles. The location of utility poles should be reviewed on all projects, and every effort to minimize crashes should be explored. This may include the relocation of utility poles away from the edge of the roadway and/or to the inside of the curve.
- G. *Roadway Departures* – Particular attention should be placed on the evaluation of Roadway Departures. Crash data should be examined for trends in run-off-roadway collision conditions. Corrective measures to prevent roadway departure hazards should be incorporated into the project design where appropriate.
- H. *Work by Others* – The project should document the “work to be done by others” and how the schedule for this work impacts the proposed development mitigation. Lapses in construction sequencing should be addressed with temporary improvements as necessary. Generally this should be worked out in advance with the MassHighway Public/Private Development Unit.

II. Preliminary Construction Plans

1. Basic Construction Plan Set

- A. *Format* – The plan set should follow the guidelines specified in the current Massachusetts Highway Department Highway Design Manual. Refer to the “25% Highway Design Review Checklist” released in September 2003 for step-by-step procedures. Where possible, “cut sheets” are preferred for Traffic Signal and Sign & Pavement Marking plans rather than being included on “roll plans”.
- B. *Dimensions* – All projects, including private developments, public-private partnerships and MassHighway funded work, must be designed in English Units.

- C. *Roadway Cross-Section* – The typical cross-section for the roadway segments included in the project should meet the current MassHighway design standards. This includes, but is not limited to the provision for bicycle accommodation. Right-of-Way constraints and Historic District restrictions may prevent the desired cross-section from being obtained, however, the appropriate waivers will need to be requested.
- D. *Additional Plans* – It is recommended to supply additional details on the preliminary plans, such as: lane and shoulder pavement markings, sign locations, crosswalk and wheelchair ramp placements, and location of sidewalk facilities. All construction projects should adhere to the guidelines specified in the Massachusetts Statewide Bicycle Transportation Plan and be in compliance with the regulations of the Architectural Access Board (AAB) and the Americans with Disabilities Act (ADA).

2. Traffic Signal Plans

- A. *Signal Head Placement* – All existing and proposed traffic signal heads should be identified on the plans and positioned at their intended angle of sight. Heads should be located within the cone of vision as specified by the MUTCD and at least 40 feet but not more than 150 feet from the stop line.
- B. *Pavement Markings* – The pavement markings necessary to the operation of the traffic signals (i.e. lane layouts, stop lines, dedicated turn lanes...) should be displayed on the intersection plans.
- C. *Signal Head Data* – The plans should label the type and quantity of each signal head used at an intersection according to MUTCD guidelines. The proposed signal head arrangement should coordinate with the phasing scheme that is being used and with the capacity analyses supplied in the design report.
- D. *Sequence and Timing Chart* – Each signalized location should have the appropriate sequence and timing chart included with the plan set. This information is not required at the 25% design stage, although it will be effective in expediting the review process for the next level.
- E. *Phasing Diagram* – The phasing diagram for the signal installation should be shown on the plans and indicate any concurrent or actuated pedestrian phases. If emergency vehicle preemption is supplied, the phasing diagram should include this information as well. The plans should match what is used in the capacity analysis.
- F. *Coordinated System* – For a coordinated traffic signal system, a breakdown of the components should be listed on the plans. A Time-Space Diagram for the interconnected signals is recommended at the 25% submission, although not required until the 75% stage.
- G. *Signal Detectors* – Although this is not a requirement at the 25% design stage, it is recommended that traffic signal detector information be included in the signal plans. Location and detector type information is more important than specifics on hardwiring and geometrics. Bicycle accommodation is now required at all signal installations, except on approaches to and from limited access highways.

3. Traffic Management Plans

- A. *Basic Traffic Management Plans* – While it is not a requirement at the 25% design level, it is recommended that some preliminary traffic management plans (TMP) be

provided at that stage. TMPs are an intricate part of every construction project and the importance of these plans cannot be understated.

- B. *Typical Layouts* – Each project should, at a minimum, include a typical TMP layout as provided in the MUTCD. However, seeing as each location is unique in its design, modifications are usually necessary. Preparation of TMPs at the 25% design stage will allow the Department review staff an early opportunity to make suggestions that could save time in the next submission.
- C. *Detour Routes* – All proposed detour routes should be clearly marked out and be “user friendly” to the general public. Confusing detour routes end up causing more problems than the detour itself. Avoid excessive signage with detours, only providing signs where a change of direction occurs or a new roadway enters the route.
- D. *Pedestrian & Bicycle Accommodations* – All TMPs must address pedestrian & bicycle issues. If bike or pedestrian facilities are temporarily closed due to construction then alternative routes must be provided and clearly marked. All temporary facilities must be handicap accessible as directed by the Architectural Access Board (AAB) and the Americans with Disabilities Act (ADA). Refer to current MassHighway policies