CHAPTER 10, APPENDIX C

HYDRAULIC MODELING REQUIREMENTS FOR PENNDOT H&H REPORTS

This document was prepared to outline the hydraulic modeling requirements for PennDOT H&H Reports when a project is in a FEMA regulated area. FEMA regulated areas may be based on detailed or approximate studies; hydraulic models were used in detailed areas, whereas limited calculations or estimations were used to map approximate areas. FEMA regulations require a higher level of analysis and documentation when a project encroaches on a delineated FEMA floodplain or floodway; therefore, PennDOT and PA DEP also require a more thorough hydraulic analysis in detailed FEMA study areas. The guidance that follows lists the PennDOT, PA DEP, and FEMA hydraulic modeling requirements and is broken into two different sections:

- **Section 1**: Projects with flooding increases within the allowable limits
- **Section 2**: Projects with flooding increases that require a FEMA map revision

Publication 13M, Design Manual, Part 2, *Highway Design*, and the Code of Federal Regulations (CFR) are cited where appropriate. In addition, the guidance in Section 1.a is recommended for projects not located in FEMA regulated areas. The following table outlines the modeling requirements based on the location of the project and the anticipated increases in the 100-year water surface elevation.

<table>
<thead>
<tr>
<th>Location of Project</th>
<th>Increase in 100-year WSE</th>
<th>Follow Modeling Requirements in Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not in a FEMA Study Area</td>
<td>N/A</td>
<td>1.a</td>
</tr>
<tr>
<td>Approximate FEMA Study Area</td>
<td>≤ 1.00 ft</td>
<td>1.a</td>
</tr>
<tr>
<td>Approximate FEMA Study Area</td>
<td>&gt; 1.00 ft</td>
<td>2.a (CLOMR Required)</td>
</tr>
<tr>
<td>Detailed FEMA Study with no fill in the Floodway</td>
<td>≤ 1.00 ft</td>
<td>1.b</td>
</tr>
<tr>
<td>Detailed FEMA Study with fill in the Floodway</td>
<td>≤ 0.00 ft</td>
<td>1.b</td>
</tr>
<tr>
<td>Detailed FEMA Study with fill in the Floodway</td>
<td>&gt; 0.00 ft</td>
<td>2.b (CLOMR Required)</td>
</tr>
<tr>
<td>Detailed FEMA Study with no designated Floodway</td>
<td>≤ 1.00 ft</td>
<td>1.b</td>
</tr>
<tr>
<td>Detailed FEMA Study with no designated Floodway</td>
<td>&gt; 1.00 ft</td>
<td>2.b (CLOMR Required)</td>
</tr>
</tbody>
</table>

The hydrologic and hydraulic models used in FEMA studies must be evaluated according to current design guidance and current modeling practices for sizing highway waterway structures. Many FEMA studies were performed in the 1970's for the purpose of defining floodplain and floodway boundaries for the National Flood Insurance Program, whereas PennDOT usually conducts hydraulic studies to design waterway structures. Therefore, it is to be expected that different levels of detail and different methodologies are appropriate for these two types of studies.

It is common for existing water surface elevations to differ from the published elevations in the FEMA studies. The purpose of the existing model is to adequately reflect existing site conditions. If a FEMA model is used as the basis for the existing model, this will involve documenting differences and/or correcting errors in the FEMA model, adding cross sections, incorporating more detailed topographic data, and accounting for any channel/floodplain modifications since the FEMA model was published. **The existing model is required to provide an updated model to support conclusions about the actual impact of the proposed project.** When a map revision is required, the hydraulic model may need to be extended beyond the PennDOT study limits. FEMA and township (or local governing body) coordination is necessary to determine the limits of the hydraulic models to ensure that the Duplicate Effective, Corrected Effective, Existing, and Proposed Models tie into the published FEMA profiles. Additional survey may be required beyond the PennDOT study limits. Changes that have occurred since the FEMA model was created (e.g., channel geometry, buildings in floodplain, other bridges/culverts/etc.) must be surveyed and incorporated within the FEMA-required limits of the hydraulic model. If a map revision is not required, it is not necessary to incorporate/update data from the entire reach of a FEMA study. Any relevant FEMA data within the limits of the PennDOT study should be evaluated and incorporated, if appropriate. It may also be prudent to...
incorporate the nearest upstream/downstream FEMA section beyond the study limits, to enable a comparison with the published FEMA profile.

Another reason for differences between existing and published flood elevations is usually due to the differences in modeling software. There are significant differences between the current HEC-RAS program, which FEMA strongly supports, and the other programs (e.g., HEC-2, WSPRO, E431, J635, etc.) that were accepted at the time of the original FEMA study. For instance, HEC-RAS uses none of the same computational routines as its predecessor, HEC-2. Appendix C of the HEC-RAS Reference Manual describes all of the major computational differences between HEC-RAS and HEC-2.

There are a number of frequently encountered situations that do not require a FEMA map revision or Conditional Letter of Map Revision (CLOMR), but do require additional documentation in the H&H Report.

- There are differences between current survey data and FEMA geometric data (e.g., channel data, stream alignment, structure geometry, etc.).
- The existing and/or proposed water surface elevations differ from the published elevations in the FEMA Flood Insurance Study.
- The hydrologic analysis using current methods produces different peak flow values than the published FEMA flows.
- An existing bridge crossing that was originally mapped is proposed for removal, or a new structure crossing is proposed for construction.

**FEMA will require a CLOMR when there is an increase in the 100-year flood elevation between the existing and proposed models in excess of the allowable limits. A CLOMR will be required when the proposed project is in:**

- an Approximate FEMA area with 100-year increases > 1.00 ft, per Chapter 10, Appendix A, Procedures for Coordinating Highway Encroachments on Floodplains with FEMA;
- a Detailed FEMA area without a floodway and 100-year increases > 1.00 ft, per 44 CFR 60.3(c)(10);
- the floodway fringe of a Detailed FEMA area and 100-year increases > 1.00 ft, per 44 CFR 60.3(c)(10); or
- the floodway of a Detailed FEMA area and 100-year increases > 0.00 ft, per 44 CFR 60.3(d)(3).
SECTION 1: Projects with flooding increases within the allowable limits

1. Increases in 100-year water surface elevation between existing and proposed within the allowable limits

   a. Approximate FEMA Study (100-year increases ≤ 1.00 ft) or No FEMA Study

      • Calculate hydrology with PennDOT accepted method(s), per Chapter 10, Section 10.6.C
      • Model the PennDOT design, Chapter 105-classified flood, 100-, and 500-year (if applicable) events, per Chapter 10, Section 10.6.E
      • Hydraulic model output and electronic files for:
        o Existing model
        o Proposed model
        o Temporary model (if applicable)

   b. Detailed FEMA Study with no fill in floodway (100-year increases ≤ 1.00 ft), or Detailed FEMA Study with fill in floodway (100-year increases ≤ 0.00 ft), or Detailed FEMA Study with no designated floodway (100-year increases ≤ 1.00 ft)

      • Calculate hydrology with PennDOT accepted method(s), per Chapter 10, Section 10.6.C
      • Compare FEMA published flows with calculated flows and justify use of flows, per Chapter 10, Section 10.6.C.2
      • Model the PennDOT design, Chapter 105-classified flood, 100-, and 500-year (if applicable) events, per Chapter 10, Section 10.6.E
      • If the use of the calculated flows is justified over the FEMA flows, modeler must run the FEMA published 100-year flow in addition to the calculated 100-year flow, per Chapter 10, Section 10.7.C.9
      • Hydraulic model output and electronic files for:
        o Existing model*
        o Proposed model
        o Temporary model (if applicable)
      • Compare the existing model water surface elevations to the published regulatory base flood elevations (Note: Adjustment may be necessary between FEMA datum and survey datum.)
        o Include copies of floodway tables, flood profiles, and other pertinent data from the Flood Insurance Study, per Chapter 10, Section 10.7.C.7
        o Document and justify any differences, per Chapter 10, Section 10.7.C.9.

* The original FEMA hydraulic data should be utilized to the maximum extent as deemed appropriate, per Chapter 10, Section 10.7.C.3. (Note: Adjustment may be necessary between FEMA datum and survey datum.)

   o Request the model data from FEMA (Note: If the original data is not available, include the letter from FEMA in the H&H Report as proof.)
   o Review the information
   o Evaluate differences in FEMA data and current survey data
   o Incorporate FEMA data within the PennDOT study limits where appropriate
SECTION 2: Projects with flooding increases that require a FEMA map revision

2. Increases in 100-year water surface elevation between existing and proposed and a CLOMR is required

   a. Approximate FEMA Study (100-year increases > 1.00 ft)
      - Same modeling requirements as Section 1.a of this document
      - Map of existing and proposed 100-year floodplain boundaries, per CFR Title 44, Part 65.6.a.11
      - Submit with appropriate FEMA CLOMR MT-2 Forms
        www.fema.gov/plan/prevent/fhm/dl_mt-2.shtm

   b. Detailed FEMA Study with no designated floodway (100-year increases > 1.00 ft) or
      Detailed FEMA Study with fill in floodway (100-year increases > 0.00 ft)
      - Calculate hydrology with PennDOT accepted method(s), per Chapter 10, Section 10.6.C
      - Compare FEMA published flows with calculated flows, per Chapter 10, Section 10.6.C
      - In order to use the calculated flows, the change between published and calculated flows must be statistically significant, per CFR Title 44, Part 65.6.a.5. FEMA defines "statistically significant" as determined by a confidence limits analysis of the new discharge estimates.
      - Hydraulic model input, output, and electronic files, per CFR Title 44, Part 65.6.a.8 and FEMA MT-2 Form Instructions:
        - Effective FEMA Model - Original FEMA hydraulic model used to develop the published base flood elevations.
        - Duplicate Effective Model - Obtain and reproduce the original Effective FEMA Model in HEC-RAS to produce the Duplicate Effective Model. Compare HEC-RAS Duplicate Effective Model water surface elevations to published FEMA profile (should be within 6 inches). FEMA coordination will be necessary to determine the limits of the hydraulic model to ensure that they tie into the published FEMA profiles.
        - Corrected Effective Model - Correct any errors in the Duplicate Effective Model (e.g., bridge data, modeling methods, errors in data) and add any additional cross sections or detailed topographic data. The Corrected Effective Model must not add any man-made changes since the Effective FEMA Model.
        - Existing (Pre-project) Model - Update the Corrected Effective Model with any man-made changes that have occurred since the development of the Effective FEMA Model. (Note: If there are no man-made changes to the model then the Corrected Effective Model will become the Existing Model.)
        - Proposed (Revised or Post-Project) Model - Add the proposed bridge/roadway geometry to the Existing Model.
        - Existing Floodway Model (if FEMA-delineated floodway is present) - Perform a floodway run using the Existing Model. This model must force the floodway widths to match the effective published floodway.
        - Proposed Floodway Model (if FEMA delineated floodway is present) - Using the Proposed Model, perform a floodway run and force increases to be 1.00 foot or less. This model will show the proposed 100-year floodway widths and elevations.
      - Map of effective, existing, and proposed 100-year floodplain boundaries, per CFR Title 44, Part 65.6.a.11, and effective and proposed floodway boundaries (if applicable), per CFR 65.7.b.5
      - Submit with appropriate FEMA CLOMR MT-2 Forms
        www.fema.gov/plan/prevent/fhm/dl_mt-2.shtm
DATE: June 17, 2008

SUBJECT: Hydraulic Modeling Guidance

TO: PennDOT District Executives and PADEP Regional Chiefs

FROM: Brian Thompson, PE Director
       John Hines, Executive Director
       PennDOT Bureau of Design PA DEP

The Pennsylvania Department of Transportation (PennDOT) and The Department of Environmental Protection (PA DEP) have worked jointly to develop Hydraulic Modeling Requirements for PennDOT H&H Reports. The guidance document has been developed by a joint taskforce of PennDOT and PA DEP representatives from PennDOT Bureau of Design and District Offices and PA DEP Central Office and Regional Offices.

This document was prepared to outline the hydraulic modeling requirements for PennDOT H&H Reports when a project is located in a Federal Emergency Management Agency (FEMA) regulated floodplain. The guidance is based on PennDOT’s Design Manual 2 (DM-2) requirements, the Federal Code of Regulations (CFR) requirements related to FEMA study areas, and DEP Chapter 105 and 106. In addition, the guidance in Section 1.a is recommended for PennDOT projects not located in FEMA regulated areas.

Attached is a copy of the Joint Guidance document dated June 17, 2008. This guidance document should clarify the hydraulic requirements for projects located in FEMA study areas. For PennDOT the Hydraulic Modeling Guidance will become part of Design Manual Part 2, Chapter 10 – Appendix C. For PA DEP this document will be available online in the Chapter 105 Online Guidance Manual and should be part of PA DEP’s desk manual for review of permit applications.

If you have any questions please contact Harold Rogers at PennDOT at 717-787-3767 or Jeff Means at PADEP at 717-772-5643.

Attachment
cc: Richard H. Hogg, PE Reading File
    Highway Administration Bureau Directors
    PennDOT District ADE’s Design
    PennDOT District Bridge Engineers
    PennDOT District H&H and Permit Coordinators
    Kelly Heffner, PA DEP
    Jeffrey Means, PA DEP
    PA DEP T-21 Staff