OFFICE OF BRIDGE DEVELOPMENT
MANUAL ON HYDROLOGIC AND HYDRAULIC DESIGN

CHAPTER 5
PROJECT DEVELOPMENT

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5.1 Introduction

5.1.1 Background

This chapter describes the role of the Structure Hydrology and Hydraulics Unit in the project development process for projects containing structures in floodplains.

The process of locating and designing structures and their highway approaches in flood plains is becoming increasingly more complex for a number of reasons including:

- the increased sensitivity to environmental concerns and the need for additional studies and analyses to address these concerns,

- the rapid improvements in engineering and environmental methodologies requiring specialized expertise and additional resources to carry out the studies.

- the sharing of decision-making by various offices within the SHA, and

- the sharing of decision-making by various other State and Federal agencies who exercise regulatory controls affecting highway location and design.

The Office of Bridge Development has issued PPM OP-76-10G (Reference 1) which sets forth the formal review stages of projects involving structures. While this PPM serves to outline the overall process of project development, it does not describe the tasks that must be undertaken or reviewed by personnel of the Structure Hydrology and Hydraulics Unit.

The purpose of this Chapter, therefore, is to present the issues and concerns affecting the location and hydraulic design of structures, and to provide guidance and direction regarding the most effective methods of addressing these issues and concerns throughout the project development process.

5.1.2 Role of the Structure Hydrology and Hydraulics Unit

The role of Structure Hydrology and Hydraulics in the location and design phases of project development is to ensure that:

- structures over waterways and their highway approaches in flood plains are located and designed in accordance with the policies and procedures of the Office of Bridge Development as set forth in the Manual for Hydrologic and Hydraulic Design.

•conclusions and commitments in environmental study reports, location and design reports, mitigation plans, permit applications and other such documents are in consonance with the policies and procedures of the Office of Bridge Development,

•hydrology, hydraulic and scour evaluation reports are prepared and approved in a timely manner to meet the needs and the schedules of the SHA,

•apparent conflicts between recommendations arising out of the project development process and the policies and procedures of the Office of Bridge Development are recognized at an early date, referred to an appropriate level of management and resolved in a timely manner.

5.1.3 Project Development

Table 1 and Table 2 depict the milestones (or work products) for of a typical structure over a waterway for (1) location and design studies (Planning) phase and (2) the design engineering phase. The degree of complexity required for the accomplishment of the various milestones can be expected to vary from project.

The primary value of these tables is the comparison of how the tasks performed by the Structure Hydrology and Hydraulics Group (H&H) fit in with the overall project development milestones of the Office of Bridge Development and the Office of Planning.

In 2001, the Structure Hydrology and Hydraulics Group (H&H) developed a more refined project development process to assure that all significant aspects of hydrologic and hydraulic design are addressed. This process is outlined below. The reader is referred to the discussion in Chapter 3 and in the Appendix to Chapter 3 for the details involved in accomplishing these work tasks:

1) Establish design objectives and priorities.
2) Hydrologic analysis (includes bankfull discharge obtained from Step 4).
3) Existing condition hydraulics.
4) Geomorphology and Environmental Studies
5) Conceptual design for channel stability, and stream restoration and enhancement,
6) Assessment of structure/stream channel alternatives
7) Proposed condition hydraulics including bridge/culvert scour evaluations and FEMA study revisions, when required):
   - pre-TS&L for structures
   - semi-final stream channel design
8) Design plans (including temporary measures during construction)

The goal of the project development process for Structure H&H is to complete the above noted studies and tasks on a schedule that is consistent with the schedule established for the Office of Bridge Development. This approach is discussed in the following sections.

5.2 Location and Design Studies

Table 1 presents an overview of Preliminary Engineering or Planning Projects (Phase III Projects)

TABLE 1
PRELIMINARY ENGINEERING (PHASE III) PROJECTS
MILESTONES

OFFICE OF BRIDGE DEVELOPMENT MILESTONES	INVOLVEMENT OF THE STRUCTURES H & H UNIT
Notification To Proceed	Establish Design Objectives (Refer to Section 5.2.6 for Replacement Bridges)
	Request Photogrammetry; Establish Coverage Limits
	Initiate coordination with environmental and regulatory agencies; participate in inter-agency reviews
Preliminary Engineering including Alternative Location Studies	Initiate Field Surveys
	Assess existing condition hydraulics; Initiate preliminary hydrology, geomorphology, environmental and hydraulics studies
	Assess alternative structure and channel options; develop conceptual design for channel stability, and stream restoration and enhancement where necessary.
	Identify FEMA flood plain studies
Environmental Impact Statement and Location Approval	Review SHA commitments; address concerns relative to environmental and regulatory agencies.
Design Studies Report	

The Phase III studies outlined in Table 1 apply only to projects involving the Office of Planning and Preliminary Development. Most bridge replacement designs do not involve the Office of Planning; therefore, such projects would be initiated directly as a Final

Design Phase IV Project as depicted in Table 2. Any preliminary engineering work for such projects is incorporated into the early stages of the Final Design Process.
The Final Design Phase IV process, set forth in Table 2 below, represents the next step in project development after the completion of the Design Studies Report

TABLE 2
FINAL DESIGN (PHASE IV) PROJECTS
MILESTONES

Preliminary Studies	Initiate appropriate work listed above in Table 1 if this work were not already started under a Phase 3 project.
Preliminary TS&L	Develop proposed condition hydraulics, including preliminary bridge/culvert scour evaluations
	Evaluate project effects on FEMA flood plains; submit study results through the communities to FEMA where necessary
	Develop semi-final stream channel design where necessary
	Submit Hydrology and Hydraulics Studies to MDE for approval
	Make presentations to environmental and regulatory agencies
TS&L Approval	Achieve concurrence of review agencies
	Submit permit applications
	Develop Sequence of Construction Studies
	Continue Scour Studies
	Request Soil Borings
Foundation Report	Complete Final Scour Report
	Complete Design of Scour Countermeasures
Structural Review Approval	Resolve any outstanding issues pertaining to scour and scour countermeasures
PS & E	All Permits Approved; complete design plans including temporary measures during construction.
Advertise and Award Project.	

5.2.1 Overview of the Planning (Location and Design) Phase III Studies

The location and design studies phase extends from project initiation to location approval. Location approval may differ somewhat for different types of projects.

5.2.2 Notification to Proceed

Structure Hydrology and Hydraulics should become involved at an early date in the design of all projects containing structures in flood plains, starting with the initiation of project development and the formation of the Project Management Team. Normally the Senior Project Team Leader will represent the section on the Project Management Team (See Chapter 4, Documentation, of the Manual). It is very important to establish at an early date a perspective of the scope of the work, and the relative priorities of the various aspects of design.

The request for photogrammetry should be one of the first actions taken since this work normally takes longer than other tasks to accomplish and is therefore on the critical path of project development. Use Form Number 63.3 (Revised 3/92) to request services for flying and mapping (See Chapter 4 for a copy of this form).

The area to be included in the photogrammetric survey should include all alternative alignments under consideration and the floodplains upstream and downstream of proposed floodplain crossings for suitable distances (typically 2000 feet or more).

5.2.3 Preliminary Engineering including Alternative Location Studies

This aspect of the location study phase will vary considerably from project to project. For many projects the proposed highway alignment will closely follow the existing highway alignment with limited opportunity for location on new alignment. The goal of H&H is to establish a conceptual design, taking into account the proposed project design requirements as well as the effect of the project on the stream and on any flood plain management programs (FEMA) in the project area

Preliminary study reports (Hydrology, geomorphology, environmental and hydraulics) are to be prepared as necessary to meet the objectives of the Phase III Preliminary Engineering Study. In determining the scope of such studies, attention needs to be given to the number of alternative alignments and flood plains to be addressed in the study as well as any special conditions (tidal flow, regulated flow, substantial upstream storage, etc.) that must be considered. The Project Team Leader needs to evaluate the scope of work in consultation with the Project Management Team so as to provide adequate directions to the persons conducting the study.

Studies regarding environmental considerations such as opportunities for stream restoration and enhancement should be prepared using the guidance in Chapter 3.
Hydraulic Study Reports are described in detail in Chapter 3, Policy, Chapter 10, Bridges, And Chapter 9, Channels; however, preliminary studies generally would not go into the detail presented in these references. Preliminary studies should include identification of FEMA (National Flood Insurance) Projects.

After approval of the Environmental Document/ Location Approval, the Office of Bridge Development prepares a Design Studies Report to complete its work with regard to Phase 3 Projects.

5.3 Final Design Phase IV Projects (Table 2)

5.3.1 Overview of Phase IV (Table 2)

Table 2 presents the detailed studies and steps to be accomplished during final design. For projects initiated by the Office of Bridge Development, certain aspects of the work described in Table 1 would be accomplished in Phase IV as preliminary studies. Detailed guidance regarding these studies is presented in Chapter 3.

5.3.2 National Flood Insurance Program

When a proposed structure is to be constructed on a flood plain regulated under the National Flood Insurance Program by the Federal Emergency Management Agency (FEMA), it is the responsibility of the Project Team Leader to see that the bridge is constructed in accordance with the national flood plain management requirements. The SHA procedures for coordinating design of hydraulic structures with local communities (and through them with FEMA) are set forth in Appendix 5B.

In some instances, as may be the case of an in-kind replacement of a bridge superstructure on an existing foundation, the effect of the proposed construction on the floodplain will be negligible. The Project Team Leader may recommend that such projects be developed without a hydraulic review of the FEMA model used to develop water surface profiles for the site.

In other instances, as may be the case for a bridge on new location, it may be necessary to obtain the model used by FEMA to establish floodwater elevations and to rerun the model with the changed conditions created by the proposed bridge.

In either of the cases noted above, coordination with FEMA through the local community should begin at an early stage of project development. Procedures for obtaining existing FEMA models are described in Appendix 5B of this chapter.

5.3.3 Field Surveys

Upon receipt of the photogrammetric data from planning, the Project Team Leader needs to determine the scope of field surveys required for development of the hydraulic report. The Survey Request Form is available as FILE D:\SURVEY.REQ. (See Chapter 4 for a copy of this form).

This step in project development merits prompt and careful attention:

•This step is on the critical path of project development since accurate and representative cross-sections of a stream and its flood plain are necessary for preparing water surface profiles.

•A hydraulics engineer should work with the survey party to designate cross-section locations and to determine Manning roughness (n) values.

5.3.4 Hydraulic Studies

There are two types of hydraulic studies used in Maryland as discussed below:

5.3.4.1 Detailed Hydraulic Studies Using the Final Design Process (Table 2)

Typically, detailed studies using the Final Design Process (Table 2) are prepared for a structure over water to evaluate the hydrology, geomorphology and hydraulics of the watershed, and to prepare water surface profiles for the reach of the stream that is of interest in the design of the bridge or culvert under consideration. The overview of this type of study has been discussed on the preceding pages of this chapter. Details and guidelines regarding specific hydraulic design guidelines and considerations are presented in Chapters 3, 9 and 10. A detailed hydraulic analysis is always required for a structure on new location.

5.3.4.2 Replacement-in kind of an Existing Bridge

Under certain conditions, a simplified hydraulic study may be acceptable for replacement of an existing structure. The evaluation process for a replacement-in-kind is described below and in Appendix C of this chapter:

1. Upon initiation of a project to replace an existing structure over a waterway, it should be assigned to a Project Team Leader in the Structure Hydrology and Hydraulics Unit.

2. A preliminary decision is made as to whether the structure is to be designed under the final design process (Table 2) or as a replacement in kind. If the final design process is to be used, the Table 2 process is used. If the bridge is to be a replacement-in-kind, then the following steps should be followed to progress the work.

3. Preliminary hydrology and hydraulics studies should be initiated by the Project Team Leader in order to decide whether the waterway opening of the existing structure meets current SHA design criteria:

4. The return period of the design discharge should be determined from the functional classification of the highway on which the structure is located in accordance with the criteria set forth in Chapters 3, 8 and 10. The magnitude of the design discharge may be determined from previous hydrology or hydraulics studies conducted by SHA, FEMA, or other agencies; or from preliminary hydrologic analyses using the procedures set forth in Chapter 8, Hydrology.

5. The water surface profile for the design discharge may be derived from previous hydraulic studies as discussed above, or determined on the basis of a preliminary hydraulic analysis using procedures acceptable to the Senior Project Team Leader. The Project Team Leader shall prepare a brief report on the results of the study of the structure's waterway adequacy for the Senior Project Team Leader's review.

6. If the structure does not meet SHA design criteria, the Senior Project Team Leader will need to decide whether to follow the normal procedure for a replacement bridge (Table 2) or to pursue a design exception in order to use the replacement-in-kind procedure. Factors to consider in weighing the merits of a design exception should include:

- Frequency of overtopping and resulting safety hazards and delays to traffic. This should include a determination of present and anticipated future ADT, and the type of service provided by the highway (school bus route, emergency evacuation route, etc.). It should also include consideration of the availability of alternative routes for detouring of traffic in the event the structure or highway is closed to traffic.

- Location and extent of the overtopping section(s) and whether it is practical and environmentally acceptable to upgrade the structure and the roadway approaches to meet the design criteria.

- Environmental impacts associated with designing the structure and its roadway approaches to meet current design criteria.

The Project Team Leader should submit his recommendations for approval of a design exception to the Director, Office of Bridge Development. If the design exception is not approved, the project development process will continue to follow the steps for normal project development, including detailed hydrologic and hydraulic studies, as set forth in Table 2.

If the structure meets the SHA criteria for waterway adequacy, or if a design exception is approved by the Director, Office of Bridge Development, the project development process should proceed as discussed below.

7. The next milestone to consider is whether the proposed replacement structure can meet the criteria established by the Department of Natural Resources for in-kind replacement of Bridges and Culverts. The complete criteria for in-kind replacement are presented in Appendix 5 C of this chapter. There are three categories that are recognized as in-kind replacement:

(1) Exact Replacement

(2)Structurally In-Kind Replacement

(3)Hydraulically In-Kind Replacement

All other replacements are defined as either Structurally or Hydraulically Out-of-Kind Replacements, and are to be considered as new bridges and culverts. As noted earlier, the Final Design Process (Table 2) is to be used for structures in this category

The Project Team Leader will need to determine the appropriate category on the basis of the preliminary studies. In addition, he or she will need to make a preliminary scour study for the purpose of evaluating the stability of the structure to resist damage from scour.

If it is decided to continue with the in-kind replacement schedule, the structure should be evaluated for vulnerability to damage from scour using the procedures described in Chapter 11.
The Hydraulics Report and preliminary scour studies should be completed prior to the scheduled date of the TS&L for replacement projects.

5.3.5 Structure Alternatives for the Final Design Process

Ongoing coordination between hydraulic and structural design engineers should be a routine part of the final design process in order to arrive at a practical, cost-effective design. As a part of this review process, the recommended design should be presented to

the Interagency Review Group in order to discuss and resolve concerns about environmental impacts that may affect the bridge location and/or design.

5.3.6 Hydraulic Report and Preliminary Scour Report

The hydrology, geotechnical, hydraulic and scour reports should address the particular engineering and environmental impacts that may affect the selection of the location and design of the proposed structure as explained in Chapter 3.

5.3.7 Permits for Non-tidal Waterways

Various permits and approvals may be required during project development. For Phase III Studies conducted by the Office of Planning (PPD), authorization may be required from the Department of Natural Resources (DNR), the U.S. Fish and Wildlife Service and/or the Maryland Historic Trust and the Corps of Engineers. These authorizations address environmental issues. Structures H&H personnel are not normally involved with these authorizations, although they may be asked to assist in the development of information for such authorizations. In addition to PPD authorizations, other permits may be required based on the scope of the project.

Permits are of three basic types:

1. General Waterway Construction Permit,
2. Regional Letter of Authorization (RLOA), and
3. Joint Permit Application (JPA) for both the Corps of Engineers and the MDE.

For most bridge projects, (Phase IV Projects) Bridge Division personnel prepare the permit applications and submit them to the Environmental Programs Division (EPD) for review and processing. EPD then coordinates and processes permit reviews and approvals with all appropriate agencies.

The Structures H&H Team Leader should be involved in this process. At an early stage of project development, studies need to be made to determine if the project is located within the limits of the 100-year flood and/or if wetlands or waterways will be affected. The Bridge Division should obtain the flood plain determination from Structures H&H, and a request for a wetlands review should be submitted to the Environmental Programs Division.

At a later stage of project development, the Team Leader should review the plans and permit application to assure the adequacy of (1) proposed scour countermeasures at bridges and (2) project elements dealing with stream stability and stream restoration. The impacts listed in the application due to construction of the structure, stream relocations during construction and installation of scour countermeasures should be calculated on the

basis of the most conservative assumptions (greatest impacts) regarding the effect of the construction.

5.3.8 Permits for Tidal Waterways

Permits are required for highway crossings of tidal waterways. A construction permit application is to be sent to the Maryland Department of the Environment (MDE), Tidal Wetlands Division, for SHA projects affecting tidal waterways. The application is normally prepared by the OBD Project Engineer or OHD Project Engineer (depending on which office has the lead in project development. The application is then submitted to the Environmental Programs Division (EPD) for coordination and processing with the reviewing agencies.

In general, OBD does not conduct a detailed H&H study for tidal crossings. This is because floodwater impacts due to tidal storm surges for the 100-year flood are large in comparison to increases in floodwater elevations caused by the highway on adjacent properties. However, OBD should evaluate the tide conditions for the possibility that backwater conditions from riverine flow due to the proposed project may exceed the elevation of the 100-year storm tide elevation on developed properties. OBD does prepare a scour evaluation for each tidal waterway crossing, using the guidance set forth in Chapter 10 of this manual.

Other impacts to tidal waters, such as impacts to tidal wetlands, are addressed by the Environmental Programs Division. OBD assists in this evaluation by providing detailed information of the wetland areas affected by the highway and the extent of impacts, if any, due to in-stream work at structures.

5.3.9 Foundation and Final Scour Reports

The information obtained from the foundation report should be used to verify any assumptions made in the preliminary scour report regarding subsurface conditions, the nature and extent of the soils and the occurrence of rock. If the foundation report reveals information significantly different from that used in the preliminary study, the scour report should be revised to reflect the consequences of the new information with regard to the computed scour and the recommendations for the design of the structure foundations and/or the scour countermeasures. Where necessary (due to changes in structural designs or scour countermeasure installations), amend the Permit Application to reflect final design conditions.

At this point, the Hydrologic and Hydraulic Data Sheet (See Appendix 4A of Chapter 4) should be filled out in final form and submitted for approval.

5.3.10 PS&E Submission

The Project Team Leader needs to remain involved in the project development process up through PS&E approval in order to respond to any issues which may arise in his or her area of responsibility that could delay progress of the work.

5.4 References

1. PPM OP-76-10 (G), Formal Review Stages of Projects, Office of Bridge Development, Revised 10/8/86.
2. Office of Bridge Development Manual for Hydrologic and Hydraulic Design, 2006
3. Department of Natural Resources, Water Management Administration, Operational Policy 93-1 dated July 1, 1993.