OFFICE OF STRUCTURES

# MANUAL FOR HYDROLOGIC AND HYDRAULIC DESIGN

# CHAPTER 3

# PROCEDURES, DESIGN GUIDELINES, AND PERMITS

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MARYLAND DEPARTMENT OF TRANSPORTATION™

STATE HIGHWAY ADMINISTRATION

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# CHAPTER 3 PROCEDURES, DESIGN GUIDELINES, AND PERMITS

## 3.1 INTRODUCTION

Public safety, traffic service, waterway adequacy, environmental compatibility, and structural stability are important aspects of structure design and construction. Design guidelines and procedures are established to ensure that these important aspects are incorporated into the analysis and design of a structure, as well as ensure that projects comply with all applicable regulations and laws. The purpose of this chapter is to provide an overview of the Structure Hydrology and Hydraulics Division (SHHD) design guidelines and procedures related to hydrologic and hydraulic analyses completed for the design of new and replacement Maryland Department of Transportation State Highway Administration (MDOT SHA) bridges and other structures. The supporting details of SHHD analysis procedures are provided in the applicable chapters in Volume II of this manual.

This chapter also provides information regarding applicable Federal and State design guidelines. Regulatory agency approvals, which ensure compliance with regulation and policy, are obtained by MDOT SHA through the procurement of certain permits. An overview of the required permits and approvals is provided in Section 3.5 of this chapter.

Recent concern regarding climate change and sea level rise has led to interest in the development of new guidelines for design and analyses of public infrastructure. As these new guidelines are developed, MDOT SHA procedures will be revised accordingly. The need for vulnerability assessment and design resiliency may result in the need for additional project specific coordination with Federal, State, and local government agencies.

## 3.2 SHHD DESIGN GUIDELINES AND PROCEDURES

The SHHD involvement in the Office of Structures (OOS) design process includes the application of methodologies and procedures in the study areas of hydrology, hydraulics, stream morphology, scour, and bridge deck drainage. An overview of the SHHD analysis requirements are provided in the following sections for each relevant study area. Users should reference the applicable chapter(s) of Volume II for detailed SHHD design guidelines, methodologies, and procedures.

The project development process for structures shall proceed in general conformance with the procedures established by the OOS and other MDOT SHA offices to assure full consideration of the social, economic and environmental effects resulting from the construction of highways and structures in floodplains. Typical items of concern include impacts to wetlands, wetland buffers, waterways and floodplains; design of structures, particularly culverts, to minimize obstructions to passage of fish, other aquatic organisms and wildlife; maintaining the stream stability and providing opportunities for stream enhancement; and meeting State and Federal floodplain management requirements by limiting water surface elevation increases. Early and continued coordination within MDOT SHA, as well as with the Federal and State agencies involved in the project review, is essential for achieving a successful and efficient project development process. The SHHD analysis process and project milestones are provided in Chapter 4, Project Development.

In general, the detail of design studies should be commensurate with the risk associated with the structure, its approach roads, and with other economic, engineering, social, or environmental concerns. For SHHD projects, the level of design analysis required for each project is to be determined by the SHHD Team Leader, with approval from the SHHD Division Chief.

The accuracy and reliability of hydrologic, hydraulic, stream morphology, and scour studies are dependent upon the Engineer's judgment to select and apply appropriate models, equations and coefficients in a manner that is representative of the actual site conditions. Mathematical equations and computer programs selected for use should have the capability of modeling actual hydrologic and hydraulic conditions within a reasonable degree of accuracy. The Engineer is expected to be familiar with the limitations of models selected for use. The concurrence of MDOT SHA personnel should be obtained prior to the use of any methodology, if there is a question as to its ability to adequately represent the site conditions under study. In certain cases, it may be necessary to use a 2-D mathematical model, or a physical model study conducted in a hydraulic laboratory for purposes of evaluating a hydraulic design in an adequate manner. The Engineer should make every effort to obtain field measurements, historic records, or other means of verification whenever practicable to calibrate the results of model studies. Care must be exercised to validate the reliability and accuracy of any such data before it is used to calibrate a model.

### 3.2.1 Hydrologic Analysis

Hydrologic analysis is completed for OOS projects to compute various peak flow rates (i.e., flood event flows) at the structure location. The hydrologic analysis results are used to evaluate the adequacy of the proposed structure in regard to safety of the traveling public and to confirm compliance with applicable State and Federal regulations. SHHD hydrologic analysis procedures have been developed in accordance with State waterway construction regulations, including the requirement that hydrologic calculations be based on the "ultimate development of the watershed, assuming existing zoning" (COMAR 26.17.04.04, DSD, 2020).

Hydrologic analysis must be completed per state regulations to obtain a Waterway Construction Permit. Documentation of the hydrologic analysis, which is submitted to the MDE Waterway Construction Division, must include the following per COMAR 26.17.04.06:

- Measurement and a map indicating the upstream drainage area to the proposed project location.
- 2, 10, and 100-year flood event peak discharges.

SHHD hydrologic analyses often include the calculation of peak discharges for the 25 and 50-year flood events, as necessary to assess whether the subject roadway crossing meets OOS Design Flood Criteria (Section 3.2.4). Hydrologic analyses must include calculation of 500-year peak discharge for use in scour evaluations and the related foundation design.

The SHHD requires that hydrologic studies be conducted in accordance with guidance in the latest version of the Maryland Hydrology Panel report, *Application of Hydrologic Methods in Maryland* (2016). This report presents an approved methodology for the analysis of flood peaks and hydrographs in Maryland, which has been jointly adopted by the MDOT SHA and the Maryland Department of the Environment. The methodology presented in the panel report typically includes

use of the latest version of GISHydro, which is a publicly available software program developed by the University of Maryland through state funding. The prescribed Maryland Hydrology Panel procedure includes development of a Natural Resources Conservation Service (NRCS) WinTR-20 model for estimation of peak discharges based on ultimate development watershed conditions. GISHydro is used to delineate the watershed and calculate and populate inputs for the WinTR-20 model. The use of other methods or models for hydrologic analysis must be approved by the SHHD Division Chief. As per state regulations, any hydrologic computations "shall use methods in the public domain which are verifiable" (COMAR 26.17.04.04, DSD, 2020).

### 3.2.2 Stream Morphology and Channel Stability

In the design of OOS structures providing stream crossing, full consideration is to be given to maintaining the stability of the stream's bed and banks, to providing opportunities for stream enhancement, and to providing favorable conditions for habitat and the passage of fish, other aquatic organisms, and wildlife. SHHD typically requires a stream morphology assessment for any project involving a structure over a waterway. If the assessment indicates a need for further analysis or it is determined that channel work is required as part of the structure design, an additional detailed stream morphology study is required.

The stream morphology assessment must include the collection of data required for the scour evaluation of the proposed structure. This includes the following:

- Anticipated scour type at the structure (live bed or clear water)
- Lateral channel movement
- Potential long-term bed degradation
- Bedload particle size distribution

Other important considerations that should be addressed in the assessment report include:

- Any anticipated channel shear stress change as a result of project
- Recommendations for AOP measures
- Factors/conditions placing MDOT infrastructure or public safety at risk
- Recommendations for additional required data or study

Stream morphology studies involve evaluation of the existing stream system, the effects that a proposed structure will have on this system, and the effect of the stream on the proposed structure. The objective of these studies is to determine if the existing stream system is stable (both vertically and laterally), and if so, how to design the structure to maintain channel stability and enhance the natural value of the stream. If the existing channel is unstable (either vertically or laterally), then the objective is to 1) determine a practical, cost-effective approach to allow the system to move towards a stable channel form in area of the proposed structure and/or 2) to make recommendations for a design that would mitigate the potential for damage to MDOT SHA assets or threats to public safety.

For culverts and smaller bridges, attention is given to the design of upstream and downstream flow transitions to avoid creating stream stability problems. Structures should be designed to maintain,

to the extent practicable, the flow pattern and distribution on the floodplain that existed prior to the initiation of the highway project.

### 3.2.3 Hydraulics Analysis

Hydraulics analysis of the existing and proposed conditions is required by the SHHD for all OOS design projects involving a waterway crossing or structure in a floodplain. The existing conditions hydraulic analysis provides base conditions for comparison and evaluation of the proposed alternatives. The analysis results are used to evaluate the adequacy of the proposed structure in regard to the safety of the traveling public, to confirm compliance with State floodplain regulations provided in COMAR (DSD, 2020), and to confirm compliance with Federal FEMA floodplain regulations (FEMA, 2019).

Hydraulics analysis to evaluate a proposed structure in regard to safety include the computations of hydraulic parameters to evaluate whether a structure meets OOS design flood criteria and the evaluation of potential roadway overtopping extent, depth, and frequency. The hydraulic analysis results are used as inputs in the scour evaluation, which is used to develop the foundation design, and thus ensure the structural integrity of the roadway crossing in extreme flood events.

Hydraulics analysis must be completed per state regulations to obtain a Waterway Construction Permit. Documentation of the hydraulic analysis, which is submitted to the MDE Waterway Construction Division, must include the following per COMAR 26.17.04.06:

- 2, 10, and 100-yr flood event water surface elevations (WSEs) for existing and proposed conditions.
- Slope, cross section and capacity of the existing channel, and average bankfull (i.e., top of bank) velocity.
- Plan (i.e., map) showing the area inundated in the 100-year flood event, the location of the proposed project, land ownership, existing and proposed contours, and buildings, roads, and drainage structures.

If the OOS project includes proposed installation of a culvert, the documentation must also indicate that the invert of at least one cell of the culvert will be placed 1-ft below the invert of the stream (COMAR 26.17.04.06), except for culverts with a rise lesser than 5-ft where the invert should be depressed by 20% of the proposed structure rise, per current MDE policy. If the length of the culvert exceeds 150-ft, SHHD must be demonstrate through study that any adverse impacts will be mitigated (COMAR 26.17.04.06).

If additional to the minimum regulatory requirement of calculations for the 2, 10, and 100-year floods, SHHD hydraulic analyses generally include calculations for the 25 and 50-year flood events, as necessary to assess whether the subject crossing meets OOS Design Flood Criteria (Section 3.2.4). Hydraulic analyses must include calculations for the 500-year flood for use in the scour evaluation and the related foundation design. The hydraulic analysis and model are also used to determine the incipient overtopping flood (i.e., the maximum flood accommodated by the bridge without overtopping of the bridge, its approach roads, or other drainage divide) for use in the scour evaluation.

State regulations do not allow the construction of a proposed structure if it will increase the risk of flooding to other property owners (COMAR 26.17.04.11). MDE policy requires that if any change proposed by the OOS would result in increases to WSEs of 0.1-ft or greater, SHHD must request concurrence from any property owners impacted by this increase, purchase the property, or place the property in a designated flood easement.

For OOS projects located in FEMA regulated floodplains, hydraulic analysis must be completed to evaluate project impacts. The Maryland Hydraulics Panel, which is a panel of experts comprised of state, federal, consultant, and university personnel with special expertise in the field of hydraulics, has developed recommendations for hydraulic analyses of MDOT SHA design projects located in FEMA Special Flood Hazard Areas (SFHA), as presented in *Recommendations for Hydraulic Analyses in FEMA Special Flood Hazard Areas in Maryland* (2018). If a project is located with a FEMA SFHA, the hydraulic analyses should be conducting according to these recommendations.

The following publicly available models are approved by the SHHD for analysis of OOS projects: the US Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS) model and the Federal Highway Administration's HY-8 Culvert Hydraulic Analysis Program. HEC-RAS is typically used for the hydraulic analysis of structure replacement projects. For simplified analyses or small structure projects, SHHD may determine that an HY-8 analysis is sufficient. For some projects, analysis using a two-dimensional (2D) hydraulic model may be required. Preferably, this analysis will be completed using SRH-2D or HEC-RAS 2D. Other models, such as TUFLOW, may be use with SHHD approval. The SHHD Team Leader, with approval from the SHHD Division Chief, will determine the specific requirements on a per project basis. Only models approved by the Office of Structures are to be used in hydraulics studies. Any proposal to conduct analysis using a different methodology or model must be approved by the SHHD Division Chief. As per state regulations, any hydraulic computations "shall use methods in the public domain which are verifiable" (COMAR 26.17.04.04, DSD, 2020).

SHHD typically requires that some level of field survey data, including cross-sections and topographic data, are used in development of SHHD hydraulic models and analyses. The field collected data can be supplemented with topographic data based on LiDAR, photogrammetry, or other technology, especially for development of overbank cross-section areas. The Engineer conducting the study should be prepared to demonstrate that input data and output results have been carefully examined and determined to be representative of the site conditions. High water marks, previous hydraulic studies performed by the MDOT SHA or others, or other similar types of information or measurements should be carefully evaluated for accuracy and reliability prior to their use in calibrating a model.

### 3.2.4 Design Flood Criteria

The hydrologic and hydraulic analysis results are used to determine if the existing and proposed structures meet OOS design flood criteria. The required design flood return period (i.e., flood frequency) is determined based on the functional classification of the highway on which the structure is located (Table 3-1). The magnitude of the design flood is typically determined from SHHD hydrologic analyses. In some cases, such as in-kind replacement projects, the flood magnitude may be determined from previous hydrology studies conducted by MDOT SHA,

FEMA, or other agencies. The hydraulic analysis results are used to assess whether the design flood criteria are met in the existing and proposed conditions.

**Table 3-1 Recurrence Interval for Design Flood**

| Highway Classification (see MDOT SHA Highway Location Reference) | Design Flood Recurrence Interval (years) |
|---|---|
| Interstate, other Freeways and Expressways, and Rural, Urban and Other Principal Arterials | 100 |
| Intermediate and Minor Arterials | 50 |
| Major and Minor Collectors | 25 |
| Local Streets | 10 |

### 3.2.5 Scour Evaluation

A primary responsibility of the SHHD is to provide for the public safety, such that structures are designed to be stable and to resist damage from scour and hydraulic forces during extreme flood events. Structures should be located and designed, to the extent practicable, to minimize flood flow obstruction and resultant scour potential. Either a scour evaluation or a scour assessment is required for all OOS bridges and bottomless structures providing waterway crossing. A scour evaluation is typically required, unless it is determined that the structure is rated as low risk for scour. The SHHD team leader will determine which study type is appropriate, with approval from the SHHD Division Chief.

The latest version of the OOS software program, ABSCOUR, is to be used for SHHD scour evaluations. This model incorporates a number of the scour evaluation methods documented in the FHWA manual HEC-18, with MDOT SHA specific methods applied for the evaluation of contraction and abutment scour. Analysis using other models or methodologies must be approved prior to use by the SHHD Team Leader or SHHD Division Chief.

The final scour evaluation study is completed subsequent to the hydrology, hydraulics, and stream morphology studies, using the data from these studies once the results are reviewed and approved by the SHHD Team Leader and SHHD Division Chief. Data from subsurface soil investigations and borings are used in the scour evaluation. The SHHD requires evaluation of potential scour depths for the design flood (lesser magnitude flow of either incipient overtopping flood or 100-year event) and the check flood (lesser magnitude flow of either incipient overtopping flood or 500-year event). It is recommended that all cases be evaluated to determine the worst-case condition.

The geotechnical study results and scour evaluation results are used to develop the Foundation Report. This report specifies foundation design details for piers and abutments. Bridges and bottomless arch culverts are to be designed to withstand scour from extreme events in accordance with OOS procedures. Smaller culvert inlets and outlets need to be evaluated and protected with riprap or other measures when necessary to limit the extent of scour and erosion. Consideration

should be given to the potential for long term bed degradation, lateral channel migration, bend scour, and any other channel instabilities as determined in the stream morphology assessment.

### 3.2.6 Bridge Deck Drainage

Bridge deck drainage systems must be designed to provide safe and efficient conveyance of surface runoff from the traveled way in a manner that minimizes damage to the bridge and adjacent terrain and maximizes the safety of passing vehicles. Drainages systems should be designed to limit the spread of gutter flow into the travel lanes. For all OOS bridges with a shoulder width greater than 6-ft, based on a rainfall intensity of 6 inches/hour, the spread should be limited to the shoulder. If the shoulder is 6-ft wide or less, the spread limit is 6-ft. For OOS bridges located in a sag (sump location), additional criteria must be met for a rainfall intensity of 8.7 inches/hour, which include a spread limit of 10-ft (shoulder width greater than 6-ft) or 7-ft (shoulder width of 6-ft or less). For OOS projects, bridge deck drainage analysis should typically be conducted using the MDOT SHA Maryland Pavement and Deck Design (MPADD) software program. Design analysis using other methods or models must be approved by the SHHD Division Chief.

## 3.3 FEDERAL GUIDELINES

### 3.3.1 Highways in the River Environment (HEC-17)

The Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 17 (HEC-17), *Highways in the River Environment - Floodplains, Extreme Events, Risk, and Resilience*, provides "technical guidance and methods for assessing the nexus of riverine and transportation as it relates to floods, floodplain policies, extreme events, climate change, risks, and resilience" (FHWA, 2016). Specifically, this federal document provides technical guidance and methods for assessing the vulnerability of transportation facilities to extreme events and climate change in riverine environments. The publication provides an overview of federal floodplain policy, including FHWA and FEMA guidelines. HEC-17 includes hydrologic procedures and the associated uncertainty associated with projecting flood flows, as well as an overview of deterministic and statistical models used for hydrologic analysis. The document is available online on the FHWA's publication website (FHWA, 2016).

### 3.3.2 Evaluating Scour at Bridges (HEC-18)

The Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 18 (HEC-18), *Evaluating Scour at Bridges*, presents "the state of knowledge and practice for the design, evaluation and inspection of bridges for scour" (FHWA, 2012a). HEC-18 was issued by the FHWA as part of a set of HECs that includes HEC-20 and HEC-23 to provide guidance for bridge scour and stream stability analyses. The purpose of the publication is to provide guidelines for designing new and replacement bridges to resist scour, evaluating existing bridges for vulnerability to scour, inspecting bridges for scour, and improving the state-of-practice of estimating scour at bridges. The document is available online on the FHWA's publication website (FHWA, 2012a).

### 3.3.3 Stream Stability at Highway Structures (HEC-20)

The Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 20 (HEC-20), *Stream Stability at Highway Structures*, provides "guidelines for identifying stream instability problems at highway stream crossings" (FHWA, 2012b). The publication lists "geomorphic and hydraulic factors that affect stream stability and provides a step-by-step analysis procedure for evaluation of stream stability problems." The document includes techniques for stream reconnaissance and classification, as well as techniques for stability analysis and restoration concepts. The document is available online on the FHWA's publication website (FHWA, 2012b).

### 3.3.4 Design of Bridge Deck Drainage (HEC-21)

The Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 21 (HEC-21), *Design of Bridge Deck Drainage*, provides "guidelines and procedures for designing bridge deck drainage systems" (FHWA, 1993). The publication is a compilation of bridge drainage design guidance, including design theory and design procedures. In the document, drainage system design is considered from the viewpoint of hydraulic capacity, traffic safety, structural integrity, practical maintenance, and architectural aesthetics. Design guidance related to gutter spread and flood frequency, as well as existing computer models for use in computations are discussed. The document is as available online on the FHWA's publication website (FHWA, 1993).

### 3.3.5 Bridge Scour and Stream Instability Countermeasures (HEC-23)

The Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 23 (HEC-23), *Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance*, presents "design guidelines for bridge scour and stream instability countermeasures that have been implemented by various State departments of transportation" (FHWA, 2009). The intent of the publication is to provide a comprehensive analysis of scour and stream instability problems and solutions, based on a consolidation of design guidance from other FHWA publications. Design guidance in HEC-23 includes countermeasures to protect bridge piers and abutments from scour; riprap design criteria, specifications, and quality control; and environmentally sensitive channel and bank protection measures. The document is available online on the FHWA's publication website (FHWA, 2009).

### 3.3.6 Highways in the Coastal Environment (HEC-25)

The Federal Highway Administration (FHWA) Hydraulic Engineering Circular No. 25 (HEC-25), *Highways in the Coastal Environment*, provides "guidance for the analysis, planning, design and operation of highways in the coastal environment" (FHWA, 2008). The report is intended to integrate coastal engineering principles with the design of coastal highway systems. HEC-25 includes a summary of coastal science concepts and modeling tools, as well as bridge planning and design applications that are unique to the coastal environment. This includes a chapter on tides and storm surge related modeling approaches and a chapter on coastal bridge scour with information on policy, guidance, and research. The publication is intended for use by engineers and others involved with planning, designing, or constructing transportation infrastructure in coastal environments. The document is available online on the FHWA's publication website (FHWA, 2008).

### 3.3.7 Risk MAP Program

The Policy for Flood Risk Analysis and Mapping comprises the standards for practitioners of FEMA's Risk Mapping, Assessment and Planning (Risk MAP) Program. The standards define the specific implementation of the statutory and regulatory requirements for the National Flood Insurance Program (NFIP) flood risk analysis and mapping and address the performance of flood risk projects, processing of Letter of Map Changes (LOMC), and related Risk MAP activities. Standards are published separately from guidance as standalone statements that outline the required elements of the Risk MAP Program.

FEMA has many guidance documents that provide vetted recommended approaches for FEMA's Risk MAP Program. These guidance documents support current FEMA standards and facilitate effective, efficient implementation of the program. All guidance documents were written to support FEMA standards and align with current regulations but are not mandatory. Alternate approaches that comply with standards and support program objectives are acceptable.

## 3.4 STATE GUIDELINES

### 3.4.1 Waterway Construction Guidelines

Design plans should include temporary measures used during construction for any required stream diversions, as per state regulations (COMAR 26.17.04.06, DSD, 2020). The accommodation of stream flow during construction is of particular concern for public safety, especially when temporary structures or flow diversions are inadequate. This can result in flooding on adjacent developed properties and overtopping of roads carrying highway traffic, and thus ensuing risks to vehicular traffic. Stream diversion plans should be developed using the results of the SHHD hydrologic and hydraulic analyses and based on the Maryland Department of the Environment (MDE) guidelines provided in *Maryland's Waterway Construction Guidelines* (2000). The MDE guidelines advise that "temporary measures for dewatering and diverting flows from a reach for construction purposes should have sufficient capacity to convey 2-year flows for existing development conditions" (MDE, 2000). Any proposed modification to the stream diversion plans before or during construction should be reviewed by SHHD to ensure adequate safety provisions.

### 3.4.2 Soil Erosion and Sediment Control

The temporary measures used during construction for erosion and sediment control should be designed according to Maryland Department of the Environment standards, as provided in the 2011 Standards and Specifications for Soil Erosion and Sediment Control. This publication provides guidance for engineers and project designers to develop construction site control measures to prevent erosion and sediment laden runoff, as required per state regulations (COMAR 26.17.01, DSD, 2020). The document consists of an introduction, a planning and design section, and seven sections of erosion and sediment control practices. The publication can be obtained online from the MDE website (MDE, 2011).

## 3.5 REGULATORY PERMITS AND APPROVALS

Certain permits and agency approvals are required prior to the construction of a proposed new or replacement structure. A summary description of the permits and approvals which may be required for an OOS project is provided in this section.

The SHHD is not responsible for directly obtaining any permits. Rather the required permits are applied for and obtained by other MDOT SHA Divisions, with supporting data provided via the studies and analyses completed by SHHD. Wetland and waterway permits, as well as Critical Area approvals, are obtained by the Office of Environmental Design (OED), Environmental Programs Division (EPD). SHHD submits supporting data to the Maryland Department of the Environment (MDE) in the form of the hydrology and hydraulic analysis reports for review and approval in support of EPD permit applications. Other approvals, such as those related to the National Environmental Policy Act (NEPA), the Maryland Environmental Policy Act (MEPA), and the Maryland Historical Trust (MHT), are obtained by the Environmental Planning Division (EPLD), Office of Planning and Preliminary Engineering.

The SHHD is responsible for obtaining the necessary Federal Emergency Management Agency (FEMA) approvals for projects located in National Flood Insurance Program (NFIP) regulated floodplains. This includes the preparation and submittal of an application for a Letter of Map Change (LOMC), which is the FEMA procedure for change or correction of a flood insurance rate map (FIRM).

### 3.5.1 Waterway and Wetland Permits

Any proposed construction activity in a nontidal waterway, nontidal floodplain, nontidal wetland, or tidal wetland requires regulatory approval via a state waterway construction permit or wetland license, which is based on project review and approval by MDE and the U.S. Army Corps of Engineers (USACE). Approval is required to "assure that activities in a waterway or its floodplain do not create flooding on upstream or downstream property, maintain fish habitat and migration, and protect waterways from erosion" (MDE, 2020). Per state regulations, authorization is required for construction or repair of bridge and culverts (COMAR 26.17.04, DSD, 2020). The regulatory agencies jointly responsible for review and issuance of the applicable permit type include the MDE Water and Science Administration (WSA) Nontidal Wetlands Division, and the MDE WSA Waterway Construction Division, the MDE WSA Tidal Wetlands Division, and USACE.

Nontidal Wetlands and Waterways Permits and Tidal Licenses are obtained by the MDOT SHA Office of Environment, Environmental Programs Division. The hydrologic and hydraulic analyses reports developed by the SHHD are typically submitted to MDE for review and acceptance prior to submission of the permit application. MDE state reviewers or designated consultant review teams issue a letter accepting the results of the hydrology study, then the corresponding resultant hydraulic study. Due to the complexity and long-term timeframe of structure replacement projects, MDE and MDOT SHA have developed this preliminary submission approach, which provides for greater efficiency and cost effectiveness on state projects.

#### 3.5.1.1 Joint Permit Application

The MDE and the USACE have developed a Joint Permit Application (JPA) process for activities in, along, and across waters (and wetlands) of the State. Authorizations from both agencies are obtained through submittal of a *Joint Federal/State Application for the Alteration of Any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland*. The JPA is submitted to the MDE Regulatory Services Coordination Office (RSC). The RSC office will provide a copy of the application to the USACE, as well as to the appropriate divisions of the MDE Water and Science Administration.

The USACE issues permits for any structures or work that impact the course, capacity, or condition of a navigable water of the United States under Section 10 of the Rivers and Harbors Act of 1899 (33 USC 403). The USACE exercises jurisdiction over waters (navigable and otherwise) of the United States under the authority of Section 404 of the Clean Water Act of 1972 (33 USC 1344). Based on the JPA submission, the USACE will confirm applicability of a general permit or requirement to obtain an individual permit. USACE also determines under which general permit type a project should be permitted. The types include:

- Nationwide Permit
- Regional General Permit
- Programmatic General Permit

The majority of OOS projects are permitted under the Maryland State Programmatic General Permit. This permit is implemented jointly by USACE and MDE. There are two categories within this permit (A and B). For category A, MDE issues the permit on behalf of USACE (USACE does not review the project). For category B, both MDE and USACE review and jointly issue the permit. OOS projects which include channel stabilization are typically permitted under category B. Projects larger in scope, or which include stream restoration and/or wetland mitigation, are typically permitted under the Nationwide Permit or as an Individual Permit by the USACE.

#### 3.5.1.2 Nontidal Waterways

Nontidal waterways are regulated by the Waterway Construction Division of the MDE Water and Science Administration and the USACE. The waterway construction regulations are designed to govern construction, reconstruction, repair, or alteration of a dam, reservoir, or waterway obstruction or any change of the course, current, or cross section of a stream or body of water within the State including any changes within the 100-year frequency floodplain of free-flowing waters. The regulations governing work in nontidal waterways are provided in COMAR 26.23 (DSD, 2020). Work is permitted through submission of a "Joint Federal/State Application for the Alteration of any Floodplain, Waterway, Tidal or Nontidal Wetland in Maryland" (MDE, 2020).

#### 3.5.1.3 Nontidal Wetlands

The Maryland Nontidal Wetlands Protection Act of 1991 requires a state nontidal wetlands permit, or letter of authorization, from the Nontidal Wetlands Division of the MDE Water and Science Administration for activities in a nontidal wetland, or within a 25-foot nontidal wetland buffer or 100-foot nontidal wetland expanded buffer. Approval is granted if a project meets all Maryland and USACE regulations and permit requirements. Per COMAR 26.23, the Nontidal Wetlands

Division is mandated to protect nontidal wetland resources through regulations of activities which include grading and filling, excavating or dredging, change existing drainage patterns, disturbing the water level or water table, and destroying or removing vegetation.

#### 3.5.1.4 Tidal Wetlands and Waterways

Activities that may change tidal wetlands require a tidal wetland permit or license from the Tidal Wetlands division of the MDE Water and Science Administration. The Tidal Wetlands Division regulates projects that are conducted in, on, over, under, or through State or private tidal wetlands. Tidal wetlands include all lands beneath tidal waters and tidal waters up to the mean high-water line, and vegetated wetlands, such as marshes, that abut those waters and are subject to periodic tides within Maryland. The Tidal Wetlands Division may issue a license for any project that includes the construction of structures, dredging, or filling of State tidal wetlands. Approval is granted if a project meets all Maryland and USACE regulations and permit requirements.

Per COMAR 26.24.02.01, some activities are exempted from the requirement to obtain a license or permit. This includes "routine maintenance, repair, or replacement of a highway structure, pier, boathouse, a structure on a pier, bulkhead, revetment, tidal impoundment dike, water control structure, aboveground transmission facility, agricultural drainage ditch, or highway drainage ditch when the existing structure is functional and there is no increase in the original length, width, height, or channelward encroachment." MDE considers a structure to be functional if it is performing at least 85% of the action that the structure was originally intended to perform.

The waterway permitting requirements for projects in tidal areas are different from the requirements for projects in non-tidal areas. For projects within a tidal boundary area as defined by MDE, it is generally not required to submit the completed hydrologic and hydraulic analysis reports to MDE (i.e., MDE approvals of SHHD analyses are not required to obtain the necessary permits). The SHHD Team Leader should coordinate with the EPD to confirm whether a project waterway is categorized as tidal and to determine any site-specific analysis requirements.

### 3.5.2 NEPA/MEPA Approvals

For projects that utilize federal funding and/or require any other federal actions or permits MDOT SHA is required to obtain National Environmental Policy Act (NEPA) approval from the FHWA. The Office of Planning and Preliminary Engineering's Environmental Planning Division (EPLD) is the lead for obtaining these approvals. MDOT SHA projects using only state funds are reviewed and approved by EPLD under the Maryland Environmental Policy Act (MEPA).

NEPA establishes a national environmental policy and provides a framework for environmental planning and decision-making by federal agencies. NEPA directs federal agencies, when planning projects or issuing permits, to conduct environmental reviews and solicit public involvement when considering the potential impacts on the environment by their proposed actions.

While NEPA provided the basic framework for integrating environmental considerations into Federal decision-making, it did not provide the details of the process for which it would be accomplished. As a result, FHWA developed procedural guidelines and regulations (23 CFR 771) directing how NEPA should be interpreted and implemented for their actions and by state agencies such as MDOT SHA who utilize federal funds on their behalf. These procedures require

interdisciplinary review and coordination with other federal, state, and local agencies help to ensure that the damage that any federal action may have on environmental resources is weighed against the economic and technical benefits of a project and that avoidance and minimization of impacts is considered. Should project design change after NEPA approval, a reevaluation of the original NEPA approval may be required. MEPA is the Maryland state companion environmental legislation to NEPA for state funded actions that do not utilize federal funds.

#### 3.5.2.1 Section 4(f) Approval

Similar to NEPA, MDOT SHA is also required to obtain Section 4(f) approval from the FHWA for projects that impact any resources that qualify for protection. Section 4(f) of the US DOT Act of 1966 (23 CFR 774, OFR, 2020) requires that FHWA cannot approve the use of land from publicly owned parks, recreational areas, wildlife and waterfowl refuges, or significant public and private historical sites unless the following conditions apply:

- There is no feasible and prudent avoidance alternative to the use of land; and
- The action includes all possible planning to minimize harm to the property resulting from such use; OR
- The Administration determines that the use of the property will have a de minimis impact.

EPLD is also the lead for obtaining Section 4(f) approvals.

### 3.5.3 FEMA Approval

Review and approvals by the Federal Emergency Management Agency (FEMA) may be required on OOS projects for compliance with federal regulations as mandated in the Code of Federal Regulations, Title 44 (OFR, 2020). OOS projects located in FEMA designated Special Flood Hazard Areas (SFHA) require FEMA coordination. The OOS proposed replacement design may affect the hydrologic or hydraulic characteristics of a flooding source. This may result in necessary modifications of the effective regulatory floodway, Base Flood Elevations (BFEs), and/or Special Flood Hazard Area (SFHA), all of which are provided on the FEMA effective Flood Insurance Rate Map (FIRM).

FEMA approval for changes to the FIRM associated with a proposed structure design is obtained via a Conditional Letter of Map Revision (CLOMR). A CLOMR is "FEMA's comment on a proposed project that would, upon construction, affect the hydrologic or hydraulic characteristics of a flooding source and thus result in the modification of the existing regulatory floodway, the effective Base Flood Elevations (BFEs), or the Special Flood Hazard Area (SFHA)" (FEMA, 2019). If it is determined that a CLOMR is required, SHHD must complete the required hydraulic analysis and submit the CLOMR application to FEMA for approval. MDOT SHA must seek community concurrence before submitting the CLOMR application. A CLOMR is required in the following scenarios:

- When a regulatory floodway has been adopted and proposed encroachments within the floodway boundary result in any increase (proposed versus existing conditions).

- When base flood elevations have been established, but a regulatory floodway has not been adopted, and proposed encroachments within the floodplain boundary result in increases above 1.00 feet (proposed versus existing conditions), when combined with all existing and planned development.
- When required by the community, as communities may have floodplain management ordinances that are stricter than the deferral minimum standards. For example, a community can enforce more restrictive standards. The following Maryland Counties currently enforce a standard of no increase to the 1% annual change water surface elevation (proposed versus existing conditions) for all encroachments within the floodplain boundary: Carroll County, Howard County, Montgomery County, and Prince George's County.

The SHHD may be required to make revisions to the effective FEMA Flood Insurance Rate Map (FIRM) through an application to FEMA for a letter of map revision (LOMR). A LOMR is the official letter from FEMA revising the effective FIRM. Community coordination is a required as part of the LOMR application. If the proposed OOS project impacts flood hazard mapping and water surface elevations, a LOMR is required after the proposed project is constructed. Some communities may also require a LOMR even when the proposed OOS project does not result in necessary FIRM revisions. This may be the case if the hydraulic analysis, which includes updates and improvements to the effective analysis to reflect existing (pre-project) conditions indicates necessary FIRM revisions. This requirement is determined by the individual FEMA communities.

### 3.5.4 SWM and ESC Approvals

Proposed construction projects are required to include an MDE approved erosion and sediment control (ESC) and stormwater management (SWM) plan. These approvals are obtained by the OOS; the SHHD is not typically involved in plan development or approval. The governing regulations are provided in Title 26 of COMAR. Specifically, ESC regulations are provided in subtitle 26.17.01 and SWM regulations are provided in subtitle 26.17.02.

MDE has granted MDOT SHA delegated authority for plan review and approval responsibility. The MDOT SHA Plan Review Division (PRD) reviews construction plans and supporting analysis for consistency with SWM and ESC regulations. Projects with grading that disturbs less than 5000-$ft^2$ of land area and less than 100 $yd^3$ of earth are exempted from ESC plan approval. Projects with grading that disturbs less than 5000-$ft^2$ of land area are exempted from SWM plan approval.

### 3.5.5 Critical Area Commission Approval

The Chesapeake Bay Critical Area Commission (CAC) must review and approve plans for any construction activity within 1,000-ft of the Chesapeake Bay or its tidal tributaries. The governing regulations are provided in COMAR Title 27. The commission was enacted in 1984 to safeguard the Bay from the negative impacts of intense development and to control future land use development in the Bay watershed. It was determined that protection of land within 1,000 ft of the Bay's tidal influence is critical to the health of the Bay. The CAC review and approval are coordinated by EPD.

### 3.5.6 Coast Guard Permit

A Coast Guard bridge permit is required to construct or modify a bridge or causeway across a navigable waterway of the United States. Per the Code of Federal Regulations, Title 33, navigable waterways are defined as:

- Territorial seas of the United States;
- Internal waters of the United States subject to tidal influence; and
- Internal waters of the United States not subject to tidal influence that:

**1.** Are or have been used, or are or have been susceptible for use, by themselves for in connection with other waters, as highways for substantial interstate or foreign commerce, notwithstanding natural or man-made obstructions that require portage, or

**2.** A governmental or non-governmental body, having expertise in waterway improvement, determines to be capable of improvement at a reasonable cost (a favorable balance between cost and need) to provide, by themselves or in connection with other waters, as highways for substantial interstate or foreign commerce.

Factors considered in review and approval of a permit include the vertical and horizontal clearances of the navigation channel, how the structure will affect water traffic, whether there are any channels to be dredged for construction equipment, and proper lighting of the structure for navigation. If it is determined that an Office of Structures project requires a Coast Guard Permit, the MDOT SHA OOS Division will apply for and acquire the permit.

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