SCDOT
South Carolina
Department of Transportation

September 25, 2019

HYDRAULIC DESIGN BULLETIN NO. 2019-4

SUBJECT: Updated Hydraulic Bridge Design Criteria

EFFECTIVE DATE: Immediately for projects that have not completed the Design Field Review (DFR)

SUPERSEDES: Section 1.1 Design Criteria - May 26, 2009 edition of the Requirements for Hydraulic Design Studies (RHDS)

RE: None

This bulletin provides updated design guidance for Section 1.1 of the *Requirements for Hydraulic Design Studies* (RHDS). The content of this bulletin supersedes all of Section 1.1.

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1.1 Design Criteria for New and Replacement Bridges

The following criteria shall be used in the design of bridges on new location, replacement bridges, and widening or lengthening of existing bridges. References to bridges in this manual include bridge-sized culverts unless it is obvious that a bridge structure is being addressed or the information is directed specifically to culverts. Following the guidance in FHWA's Bridge Inspector's Reference Manual (FHWA NHI 12-049), a bridge-sized culvert is defined as a single or multiple-barrel culvert with a total span greater than or equal to 20 feet as measured along the highway centerline (Figure 1).

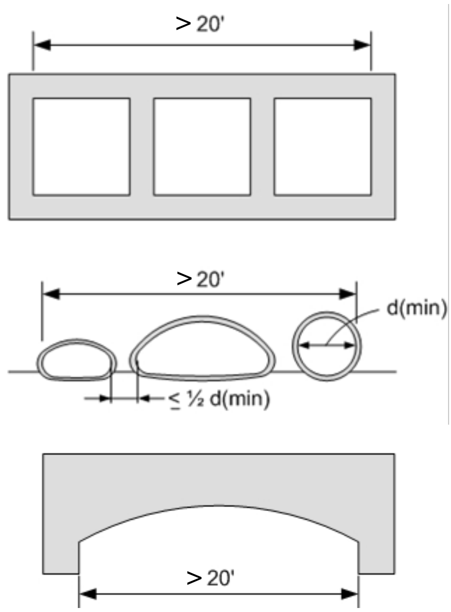

Figure 1. Sketch defining bridge-sized culverts (modified from FHWA NHI 12-049)

1.1.1 Design Flood Frequencies and Backwater

The location and geometry of all bridges will be designed to convey the design flood and base flood [1-percent annual exceedance probability (AEP) flood; also called the 100-year flood] without causing substantial damage to the highway, the stream, or other property. The design flood (Table 1) should be conveyed through the bridge opening with no road overtopping, while maintaining the required freeboard. Additionally, the 1-percent AEP (100-year) flood should be conveyed through the bridge opening with no road overtopping, while maintaining free-surface flow. The required design flood frequencies for a given road class are defined in Table 1 below.

Table 1. Design flood frequencies for bridges for selected road classes.
(AEP: annual exceedance probability]

Road Class	Design Flood Frequency
Interstate, Primary, and Evacuation Routes	2-percent AEP (50-year)
Secondary	4-percent AEP (25-year)

All bridges should be designed so that backwater for the 1-percent AEP flood is one (1) foot or less when compared to the unrestricted or natural conditions in the stream reach upstream of the proposed bridge (Figure 2). The unrestricted or natural conditions represent the modeled 1-percent AEP water-surface profile with any existing hydraulic structures and road fill removed at the stream crossing of interest. In the case of replacement bridges, the proposed bridge must meet the above stated backwater standard, but also should not create more backwater than the existing bridge. If the design policies for road overtopping, freeboard, free-surface flow, or backwater as described in Section 1.1.1 cannot be met, a request for a design variance will be required.

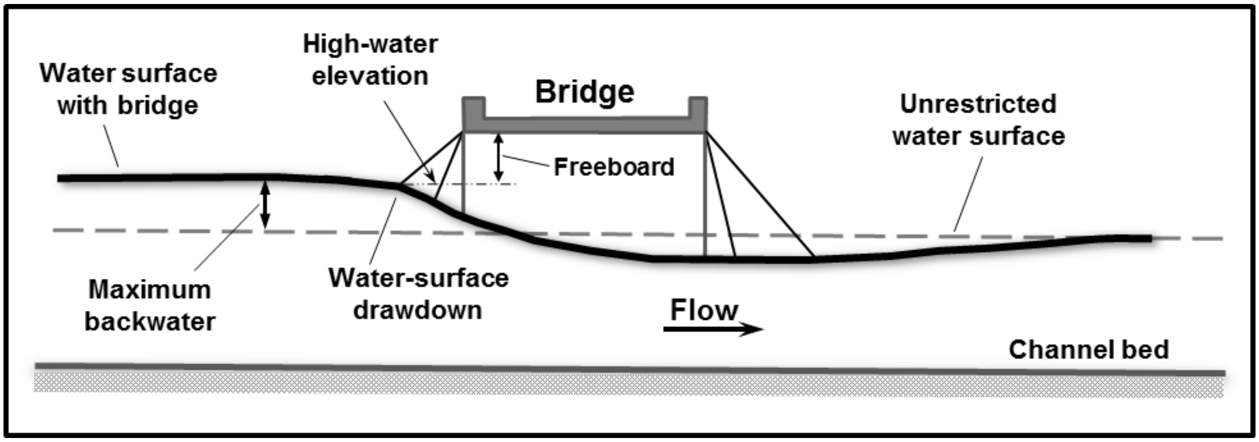

Figure 2. Illustration of bridge backwater, high-water elevation, and freeboard (The location of the backwater and high-water elevation in this figure is approximate. Engineering judgement is required to determine these values for a given bridge site.)

1.1.2 Regulated and Unregulated Floodplain Requirements

The SCDOT has developed requirements for roads and bridges owned by SCDOT in regulated and unregulated floodplains in accordance with the Federal Emergency Management Agency (FEMA), the Federal Highway Administration (FHWA), and the South Carolina Department of Natural Resources (SCDNR). All floodplain crossings in a designated Special Flood Hazard Area (SFHA) shall meet the requirements outlined in EO 11988, SC EO 82-19, 44 CFR 65, and this Section. At crossings not designated as a SFHA shall meet this Section and SC EO 82-19.

South Carolina as a state is a non-participating community within the NFIP under 44 CFR Part 75.14. This exempts SCDOT from the requirements of 44 CFR 60 and no SFHAs exist on SCDOT ROW. A community's floodplain requirements are not binding on SCDOT because SCDOT is an agency of the State of South Carolina. A community has no approval authority over SCDOT as related floodplain requirements.

SCDOT will consider local regulations, but it is only required to meet the above regulations and policies. SCDOT does not have to obtain a local Floodplain Development Permit. SCDOT is its own permit writer for activities in floodplains.

Existing, replacement, modified, or new crossings shall comply with the requirements in this Section (1.1.2), its subsections and not increase any of the flood profiles from the pre to post project conditions unless otherwise noted in the following subsections.

1.1.2.1 Model Designations

The hydraulic analysis for crossings in regulated and unregulated floodplains will require using multiple models to evaluate the required conditions. Following are the model designations used by SCDOT:

Current Effective: The model used by FEMA to determine floodplain and/or floodways for the effective Flood Insurance Study (FIS). The Current Effective model should be obtained from FEMA. FEMA should be contacted to determine if a Conditional Letter of Map Revision (CLOMR) or Letter of Map Revision (LOMR) has been issued for the subject stream. FEMA currently maintains a list of CLOMRs and LOMRs on their website. If a CLOMR or LOMR has been approved, this information should be obtained.

For approximate Zone A, the Hydraulic Design Engineer may contact the Hydraulic Design Support Office to coordinate with SCDNR to obtain the models used to determine the floodplain's limits for this type of flood zone.

Converted: If an outdated program was used to develop the Current Effective model, the data should be entered into a currently approved and appropriate 1-D or 2-D model. This model is then designated the Converted model. The results from the Converted model do not have to match the results from the outdated model as long as the data from the outdated model has been accurately incorporated into the approved model using the appropriate modeling techniques. In these cases, the Converted model takes the place of the Current Effective model.

Corrected Effective: This model is the Current Effective model (or Converted model when applicable) with corrections to any technical errors and incorporating topographic information with higher accuracy. In some cases, the existing bridge may have been incorrectly modeled in the Current Effective model, requiring the modifications or additional cross-section with topographic data near the existing bridge to appropriately model the bridge hydraulics. In addition, modifications to the proposed crossing can require the addition of unconstricted (or natural) cross sections near the proposed bridge location where the models can be properly compared. The Corrected Effective model will only be developed if the Current Effective (or Converted) model needs to be corrected due to situations such as those described above.

Existing Conditions: This model is the Current Effective (or Converted model if applicable) or the Corrected Effective model modified to reflect any modification within the floodplain since the date of the Current Effective model, but prior to the construction of the project.

Revised Conditions: This model is the Existing Conditions model modified to reflect the revised conditions due to the effects of the project. These revisions include the proposed crossings' geometry and embankment.

Unrestricted (or natural) Conditions: This model is the Revised Conditions model with the crossing and roadway elements removed from the model.

As-Built Revised Conditions: This model is the Revised Conditions model modified to reflect modifications made to the design plans during the construction phase that affect the results from the Revised Conditions model.

1.1.2.2 Requirements and Process for a Finding of "No Impact"

It is preferred that all structures and roadway components at crossings within a designated floodway and/or flood zone are designed to meet the requirements for a finding of "No Impact." To determine if proposed components meet the finding of "No Impact," the results from the Revised and Existing Conditions (or Unrestricted (or natural) Conditions model if applicable) models should be compared and evaluated according to the following criteria.

- For SFHAs with floodways, SCDOT considers a project to meet the requirements for a finding of "No Impact" if there is no increase in the 1% AEP flood and floodway profiles and there is no increase in floodway width at published and unpublished cross sections.

- For SFHAs without floodways set with limited detail models, SCDOT considers a project to meet the requirements for a finding of "No Impact" if there is no increase in the 1% AEP flood profile for published and unpublished cross sections.

- For an approximate Zone A and areas outside of a SFHA, SCDOT considers a project to meet the requirements for a finding of "No Impact" when the hydraulic design demonstrates 1.0 foot or less of backwater above the unrestricted or natural 1% AEP flood profile and there is no increase in backwater compared to the existing conditions profile.

Changes inside the SCDOT right-of-way are considered internal to the bridge structure and only affects SCDOT's property. As long as the difference in the profiles or widths within SCDOT's property, the project is considered to meet the requirements for a finding of "No Impact."
The Hydraulic Design Engineer shall send one copy of the "No Impact" letter to the local community. Physical and electronic copies will be retained in the hydraulic engineering design files along with any pertinent information related to the finding of "No Impact." The local community may concur in writing or by not responding within 10 working days of the date on the letter. If the local community requests supporting information for the "No Impact" letter, a copy of the FEMA Compliance Study should be provided.

After the project is constructed, the as-built plans must be reviewed to determine if there is any variation from the design plans that may affect the finding of "No Impact." If the as-built plans have no variation from the design plans then no action is required. If the as-built plans have a variation from the design plans, an As-Built Revised Conditions model shall be used to verify the finding of "No Impact." If the conditions for "No Impact" are no longer met, a LOMR will need to be prepared following the guidance in Sections 1.1.2.3 through 1.1.2.6 and submitted with all appropriate forms and fees.

When the decrease in floodway width has a major economic effect on real property, the process in Section 1.2.2.3 should be followed. The hydraulic engineer can contact the Hydraulic Design Support Office for guidance on this matter.

1.1.2.3 Requirements and Process for the CLOMR/LOMR Track

When a finding of "No Impact" (see Section 1.1.2.2) is not achievable during the design phase, a CLOMR must be prepared and submitted using the appropriate forms with all fees. After the project is constructed, the as-built plans must be reviewed to determine if there is any variation from the design plans that may affect the hydraulics of the previously submitted CLOMR. If the as-built plans show no variation, a LOMR based on the original CLOMR should be prepared and submitted. The LOMR will include a certified, signed, and sealed copy of the as-built plans by the resident construction engineer, or designee, that the project was built in accordance with the design plans.

If there is a variation, an As-Built Revised Conditions model should be prepared to verify the findings of the CLOMR package. If the CLOMR is verified, a LOMR package must be prepared using the findings in the CLOMR package. When the findings in the CLOMR package are not verified, the As-Built Revised Conditions model should be used to prepare the LOMR. LOMRs must be prepared and submitted using all appropriate forms will all fees.

All property owners affected by an increase in the flood profile or floodway width must be identified and their addresses determined. Property owners maybe informed through either public notification or with letters to each of the property owners. Both will be prepared detailing the changes in the flood profile and/or width affecting the owner's property. The letters will be sent by certified mail. When the receipts for the certified letters are received, a copy of the CLOMR, payment for FEMA's review fee, and a copy of the certified mail receipts are to be submitted to FEMA. Flood easements may be obtained for properties affected by increases in the flood profiles and/or in the floodway width directly related to SCDOT's proposed design. The Hydraulic Design Engineer should work with Right Of Way Division and Project Management to obtain the flood easements. Additional notification must be sent via certified mail to owners of affected property due to modifications in the hydraulic analysis in the LOMR submittal.

Instructions for preparing and submitting CLOMRs and LOMRs can be found in the FEMA MT-2 form (see FEMA's web page), and this guidance should be followed when preparing these documents. Originals of all signed documents, supporting documentation, and other information pertinent to the CLOMR and LOMR shall be kept in the physical and electronic hydraulic engineering design files for the project.

1.1.2.4 Requirements for Projects in Special Flood Hazard Areas with Floodways

When a project is within a SFHA with a floodway the following procedures shall be applied. If conditions for a finding of "No Impact" are met, the hydraulic design engineer shall prepare a "No Impact" letter and follow the process in Section 1.1.2.2. SCDOT will proceed with construction after contacting the local community though the "No Impact" process.

If the conditions for a finding of "No Impact" are not met, the hydraulic engineer shall prepare and submit a CLOMR package prior to construction following the guidance related to CLOMRs in Section 1.1.2.3. SCDOT will proceed with construction after receipt of technical approval of the CLOMR package.

After construction, the construction and the as-built plans will be compared to determine if any variations that could affect the findings in the previously submitted CLOMR. Next, instructions in Section 1.1.2.3 must be used to determine if the project has significate effects on the floodway. Based on these two comparisons, a LOMR package will be prepared following the instructions for LOMRs in Section 1.1.2.3.

1.1.2.5 Requirements for Projects in Special Flood Hazard Areas without Floodways Based on Limited Detail Studies

When a project is within a SFHA without a floodway where the base flood elevations have been developed based on a limited detail study, the following process shall be applied. If conditions for a finding of "No Impact" are met, the Hydraulic Design Engineer shall prepare a "No Impact" letter and following the process in Section 1.1.2.2. SCDOT will proceed with construction after contacting the local community though the "No Impact" process.

If the conditions for a finding of "No Impact" are not met and there is an increase less than or equal to 1.0 foot, flood easements must be obtained following the guidance in Section 1.1.2.3.

After construction, the construction and the as-built plans will be compared to determine if any variations affect the flood easements. Based on this comparison, the easements may need to be modified.

If the conditions for a finding of "No Impact" are not met and there is a rise in the flood profile greater than 1.0 foot between the Existing and the Revised Conditions models, the hydraulic engineer shall prepare and submit a CLOMR package prior to construction following the guidance related to CLOMRs in Section 1.1.2.3. SCDOT will proceed with construction after receipt of technical approval of the CLOMR package.

After construction, the construction and the as-built plans will be compared to determine if any variations that could affect the findings in the previously submitted CLOMR. Based on this comparison, a LOMR package will be prepared following the instructions for LOMRs in Section 1.1.2.3.

1.1.2.6 Requirements for Projects in Approximate Zone A

When a project is within a floodplain with the classification of an approximate Zone A, the following process shall be applied. If conditions for a finding of "No Impact" are met, the Hydraulic Design Engineer shall prepare a "No Impact" letter and following the process in Section 1.1.2.2. SCDOT will proceed with construction after contacting the local community though the "No Impact" process.

If the conditions for a finding of "No Impact" are not met, the hydraulic engineer shall prepare and submit a CLOMR package prior to construction following the guidance related to CLOMRs in Section 1.1.2.3.

After construction, the construction and the as-built plans will be compared to determine if any variations that could affect the findings in the previously submitted CLOMR. Based on this comparison, a LOMR package will be prepared following the instructions for LOMRs in Section 1.1.2.3.

1.1.2.7 Requirements for Projects Outside of Special Flood Hazard Areas

When a project is within a floodplain that is outside of a SFHA, the following process shall be applied. If conditions for a finding of "No Impact" are met, the Hydraulic Design Engineer shall prepare a "No Impact" letter. The letter shall be placed in the project file.

If the conditions for a finding of "No Impact" are not met, flood easements must be obtained following the guidance in Section 1.1.2.3.

After construction, the construction and the as-built plans will be compared to determine if any variations that could affect the flood easements. Based on this comparison, easements could be modified following the instructions in Section 1.1.2.3.

1.1.3 Flow Velocities.

Flow velocities within the bridge opening should be limited so there will be minimum scour in the overbank portion of the opening. In addition, design flow velocities should not substantially damage the highway facility or substantially increase damage to adjacent properties. Evaluating acceptable stream channel and overbank velocities for a given site requires judgment. A comparison of the natural velocities and existing bridge velocities, along with any scour problems, or lack thereof, at the existing structure can be useful. The type of soil at the site (highly erodible or not) should be considered. Bridge-sized box culverts should be sized with acceptable flow velocities to minimize potential scour.

1.1.4 Bridge Scour for Riverine

A scour analysis shall be performed for all bridges following the guidance in Section 1.3.1 for riverine bridges. A summary of the scour analysis shall be transmitted to the Geotechnical and Structural Design Sections and the scour lines for the 1- and 0.2-percent floods shall be plotted on the bridge plan and profile sheet. With the exception of riprap protection for abutment end fills, new bridge foundations will be designed to withstand the design scour without the aid of bridge-scour countermeasures. A copy of all scour studies and determination for Item 113 must be sent to the Hydraulic Design Support Office for inclusion in Bridge Maintenance's Bridge Files. The as-built plans should be reviewed to check the rated for Item 113. All designed bridges shall be designed to resist and survive scour.

1.1.5 Design Freeboard

All bridges will be designed with a clearance called the freeboard, which is defined as the vertical clearance between the bridge superstructure at its lowest point, and a specified high-water elevation created by the proposed bridge (Figure 2). The freeboard has multiple purposes: to protect the structure from damage from debris, to protect the bearings and beam seats from the corrosive effects of water, and to reduce the possibility of pressure flow, which tends to produce more severe scour. (Note: Larger freeboard clearances than those specified in this section may be required to meet other State or Federal regulations.)

1.1.5.1 Freeboard for Riverine Bridges

It is SCDOT's policy to provide a minimum freeboard of 2.0 feet above the high-water elevation for the design flood (Table 1) for all riverine bridges. For interstates, primary, evacuation routes, and secondary roads, free-surface flow should be maintained through the bridge for frequencies up to and including the 1-percent AEP flood (see Section 1.1.1 for additional information), which on occasion may require a freeboard greater than the minimum 2.0 foot freeboard.

Larger rivers, such as the Congaree, Great Pee Dee, Santee, and Wateree, will tend to have bigger sizes of debris, requiring an increase in the freeboard. In such cases, the minimum freeboard should be increased to 7.0 feet across the main channel. Beyond the channel, the bridge grade may be tapered down to a 2.0 foot freeboard, if deemed appropriate.

The freeboard is based on the potential size of drift and debris on the stream during the design flood. The hydraulic design engineer should evaluate the debris load potential and history of debris accumulation. Using judgment, the hydraulic design engineer should select the appropriate freeboard to allow debris to safely pass under the bridge superstructure without collecting on the bridge. If the minimum freeboard for a riverine bridge as described in Section 1.1.5.1 cannot be met, a request for a design variance will be required.

1.1.5.2 Freeboard for Bridges over Lakes and Reservoirs

If the bridge is over one of the major lakes or reservoirs where there is boat traffic, the grade should be set so that there is a minimum of 8.0 feet of freeboard above the maximum operating pool, and satisfies any requirements concerning boat traffic in the area, and other State or Federal regulations. If the minimum freeboard for a bridge crossing a lake or reservoirs as described in Section 1.1.5.3 cannot be met, a request for a design variance will be required.

1.1.5.3 Determination of the Design High-Water Elevation for Evaluating Freeboard

The design high-water elevation for evaluating freeboard and determining the minimum low chord elevation should represent the highest water-surface upstream of the bridge before it begins to drawdown through the bridge (Figure 2). The location of the drawdown can be determined by examining the water surface profile produced by a 1-D or 2-D model. In the case of a HEC-RAS 1-D model, the point of drawdown generally occurs at the first cross section upstream of the bridge, which is typically located along the upstream toe-of-fill. Based on the design high-water elevation, and consultation with the structural design engineer, the minimum finished grade for the bridge should be determined and supplied to the road designer for use in determining an appropriate finished grade elevation.

1.1.6 Bridge Abutment Protection

Riprap, or equivalent, shall be placed on all bridge end fills per SCDOT standard drawing number 804-105-00. The size of the riprap should be determined following the guidance in the FHWA HEC-23, *Bridge Scour and Stream Instability Countermeasures*, using the 1-percent AEP flood for the design. Class B riprap shall be the minimum size that is used on bridge end fills. The minimum riprap thickness on the end fills will be calculated as two (2) times the design D50. The riprap should be entrenched a minimum of 2.0 feet below the ground line and should extend to 2.0 feet above the design high-water level. On occasion, the bench elevation at the top of the end fill will be less than 2 ft above the high-water elevation and therefore, the riprap can only be extended to the top of the bench. To prevent erosion of the end fill, the bench elevation should not be placed at or below the design high-water elevation. If the bench cannot be kept above the design high-water elevation, a request for a design variance will be required.

1.1.7 Guide Banks

In wide floodplains where the approach flow outside the bridge is significant, guide banks (spur dikes) will be considered. The two-dimensional computer program SRH-2D, or other approved SCDOT model, should be used to evaluate the need for guide banks per HEC-23.

1.1.8 Bridge-Sized Culverts

A bridge-sized culvert should be used only when debris potential is considered low at the site of interest. The outlet velocity for bridge-sized culverts (see Figure 1) should be evaluated to determine if the velocity will cause scour of the channel bed or banks. If scour is predicted, outlet protection should be used. The scour protection should be designed using FHWA's HEC-14. Bridge-sized culverts should be designed to meet the bridge hydraulic design criteria. The flow line of box culverts should be set 1.0 foot below the channel bottom.

1.1.9 Bridge Replacements

The low chord of a replacement bridge should not be below the low chord of the existing bridge, and the bridge ends should not be within the limits of the existing bridge. Additionally, the abutment toe of the replacement bridge should not extend past the abutment toe of the existing bridge. Abandoned road embankments for the existing bridge or temporary construction fill that may adversely affect the replacement-bridge hydraulics, or prevent compliance with FEMA floodplain regulations, should be removed, so as to approximate natural ground conditions. The hydraulic design engineer should provide Road Design with the stations for removal of the abandoned embankment. If the design policies for replacement bridges regarding low chords, bridge ends, abutment toes, and abandoned road embankments as described in Section 1.1.9 cannot be met, a request for a design variance will be required.

1.1.10 Abutment Setbacks

To provide a small buffer between the stream bank and the bridge abutment, the abutment toe should be placed a minimum of 10 feet from the top of bank, or at a point where the projection of the spill through slope provides a minimum 10-foot distance from any point on the channel bank or bed, which ever distance is greater (Figures 3 and 4). This minimum setback distance should be maintained at all locations along the abutment toe. There are other hydraulic and scour design considerations that may dictate a larger abutment setback distance than the specified minimum setback. For example, larger setback distances may be required to reduce backwater, velocity, and (or) scour. Additionally, channel instabilities such as channel migration or widening that may threaten bridge stability, may necessitate larger setbacks to minimize those potential threats. There will be some cases where the natural ground topography at the bridge (such as a steep rise in the ground near the channel bank) precludes the ability to meet the minimum setback distance (Figure 3). In such cases, a variance for the minimum setback is not required. The abutment-setback design standard generally is not applicable to floodplain relief bridges since typically there is no defined channel on the floodplain. However, engineering judgment should be used at relief bridges to determine if there is a defined channel that may require the setbacks. If the design policies for abutment setbacks as described in Section 1.1.10 cannot be met, a request for a design variance will be required.

1.1.11 Channel Spans and Substructure Locations

Debris accumulation on substructures (piers and bents) can cause significant flow blockage and increased scour, possibly leading to failure of the substructure or road approaches. To minimize this threat, the stream channel should be fully spanned when practical, so as to keep piers out of the channel. When substructures must be placed in the channel, consideration should be given to their location, so as to minimize the potential for debris and scour problems, following the guidance in the FHWA HEC-9 and HEC-18 manuals. If the proposed bridge will be located next to an existing bridge, the piers of the proposed bridge should be aligned with the piers of the existing bridge, if practical, to minimize the potential for debris collection.

To minimize damage to the channel banks during construction, the substructure should be set back a sufficient distance away from the top of the channel banks using the guidance in Figures 4 and 5, and Table 2. There are other design considerations that may dictate a larger pier or pile bent setback distance than the specified minimum setback. For example, channel instabilities such as channel migration or widening that may threaten bridge stability, may necessitate larger setbacks to minimize those potential threats.

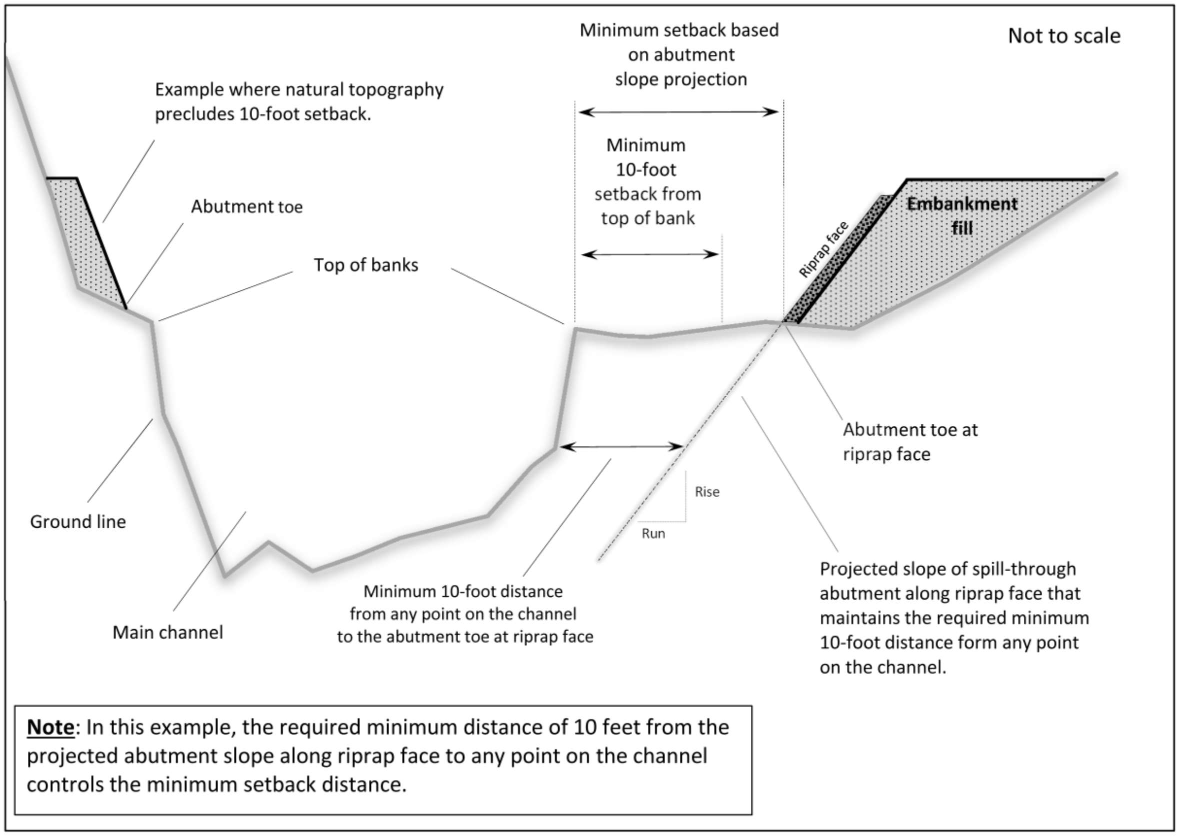

Figure 3. Illustration showing minimum abutment setback distances in reference to (1) the channel bank and (2) the projection of the spill-through abutment slope that provides a minimum 10-foot distance from any point on the channel bank or bed.

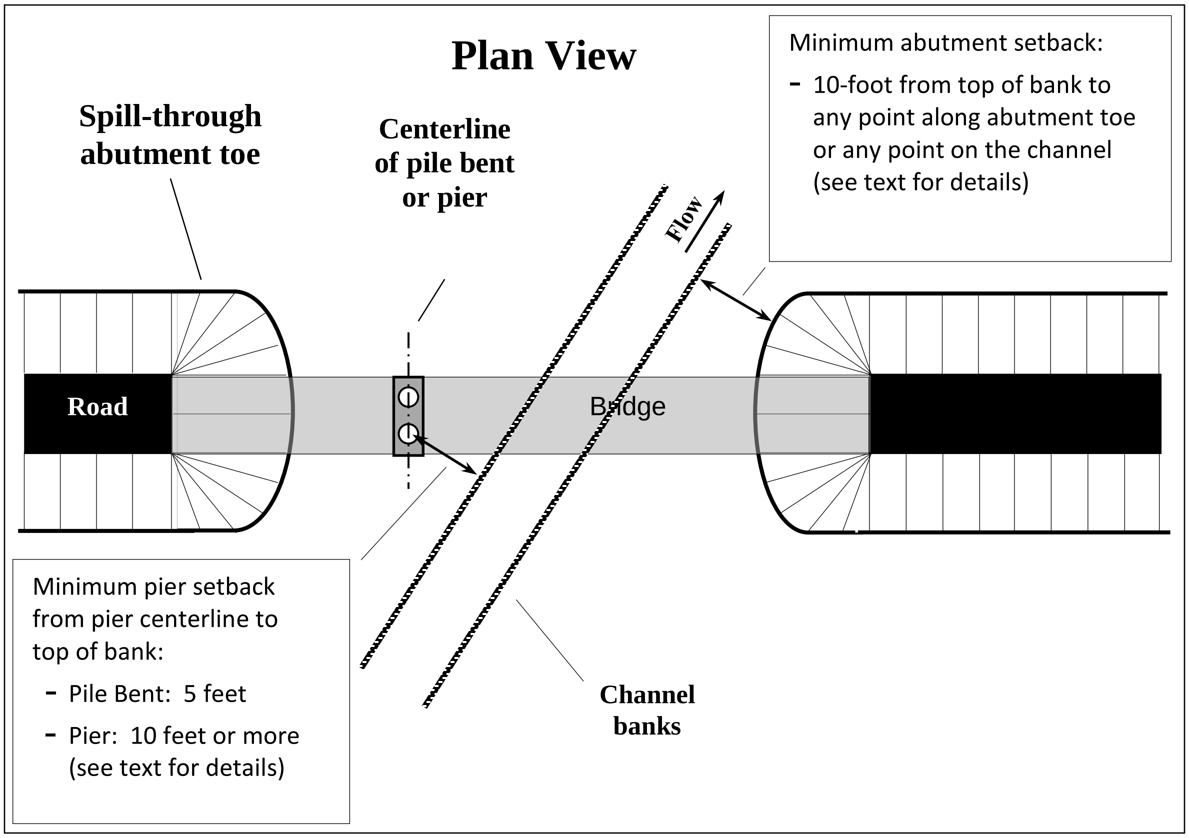

Figure 4. Illustration showing plan view for minimum setback distances in reference to the channel bank for spill-through abutments and floodplain piers.

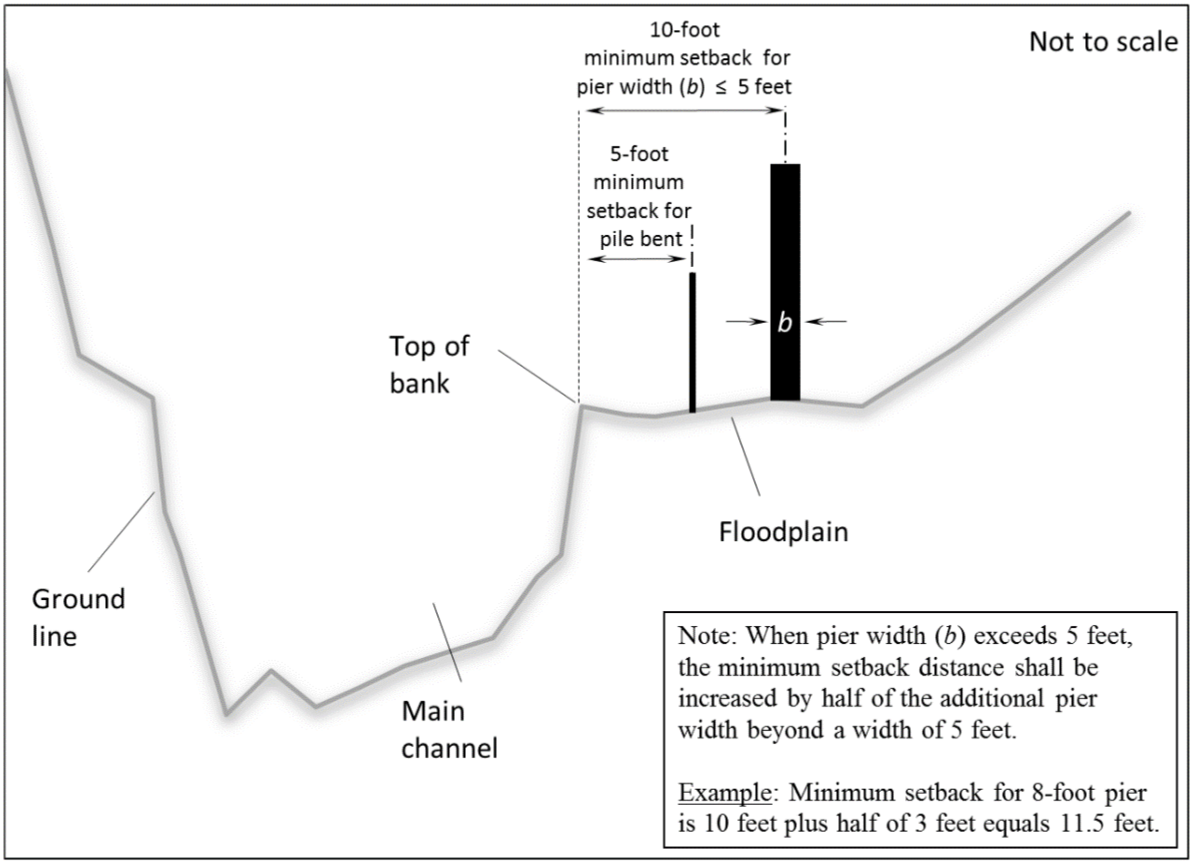

Figure 5. Illustration showing minimum setback distances for pile bents and piers located on the floodplain in reference to the channel bank.

Table 2. Minimum substructure setback distance from the top of the channel banks for substructures located on the floodplain (Figure 5).

Substructure Type	Substructure Width (*b*) Above Ground (feet)	Substructure Location	Setback Distance from Top-of-Bank to Centerline of Substructure (feet)
Piers, such as drilled shafts or piers requiring excavation	$b \leq 5$	Floodplain	10
Piers, such as drilled shafts or piers requiring excavation	$b > 5$	Floodplain	[a]10 feet, plus half of the pier width beyond 5 feet
Pile bent	$b \leq 2$	Floodplain	5

[a] Example: Minimum setback for 8-foot pier is 10 feet plus half of 3 feet, equals 11.5 feet.

1.1.12 Tidal Bridges

Bridges in the tidally controlled areas should meet the design criteria in Section 1.1 unless it is modified in this subsection.

1.1.12.1 Freeboard for Tidal Bridges

Bridges on tidal streams will be designed to protect the bridge structure itself. Most of the surrounding land and the approach roadways will be inundated by relatively frequent (10- to 25- year) tidal storm surges. The recommended design freeboard for bridges in these areas is 2.0 feet above the 10-percent AEP (10-year) high-water elevation plus the wave height. It is also recommended to have the bottom of all interior bent cap elevations above the extreme high tide. The finished grade of the bridge will be set by considering this recommendation, navigation clearances, the approach roadways, topography, and practical engineering judgment.

1.1.12.2 Bridge Scour for Tidal Bridges

A scour analysis shall be performed for all bridges following the guidance 2.3.4 for tidal bridges. A summary of the scour analysis shall be transmitted to the Geotechnical and Structural Design Sections and the scour lines for the 1- and 0.2-percent floods shall be plotted on the bridge plan and profile sheet. With the exception of riprap protection for abutment end fills, new bridge foundations will be designed to withstand the design scour without the aid of bridge-scour countermeasures. A copy of all scour studies and determination for Item 113 must be sent to the Hydraulic Design Support Office for inclusion in Bridge Maintenance's Bridge Files.

1.1.12.3 Bridge Scour for Tidal Bridges

Riprap, or equivalent, shall be placed on all bridge end fills per SCDOT standard drawing number 804-105-00. The size of the riprap should be determined following the guidance in the FHWA HEC-23, Bridge Scour and Stream Instability Countermeasures, using the 1-percent AEP flood for the design. Class B riprap shall be the minimum size that is used on bridge end fills. The minimum riprap thickness on the end fills will be calculated as two (2) times the design D50. The riprap should be entrenched a minimum of 2.0 feet below the ground line and should extend to 2.0 feet above the design high-water level plus the wave height. On occasion, the bench elevation at the top of the end fill will be less than 2 ft above the high-water elevation and therefore, the riprap can only be extended to the top of the bench. To prevent erosion of the end fill, the bench elevation should not be placed at or below the design high-water elevation. If the bench cannot be kept above the design high-water elevation, a request for a design variance will be required.