

# QUALITY ASSURANCE HYDRO CHECKLIST FOR BRIDGE AND BRIDGE-SIZED CULVERT

**\*\*Tidal follows riverine criteria except when specifically noted\*\***

Updated 3/23/2021

QA Item	Check Box	Reference
<b>Computer Models</b>		
Acceptable numerical models used for Hydrology and Hydraulics	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS p. 74
List computer models used: _____		
<b>Hydrologic Analysis</b>		
Discharges calculated for the 50,10,4,2,1, and 0.2 % AEP (2, 10, 25, 50, 100, and 500-year storm events)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1.1 C
Discharges determined using USGS regression equations (most common)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1.1 C
Discharges determined using Log-Pearson Type III frequency distribution for gaged streams	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1.1 C
Hydrograph routing for drainage areas with significant storage volume	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1.1 C
Other method for determining discharges (explanation required)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1.1 C
<input type="checkbox"/> Explanation _____		
<b>Hydraulic Modeling</b>		
Hydraulic analysis performed using appropriate 1D or 2D method for modeling	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 2 B
Hydraulic model contains existing, natural, and proposed conditions runs	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 2 B
50,10,4,2,1, and 0.2 % AEP (2, 10, 25, 50, 100, and 500-year storm event) discharges are modeled for each condition	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 2 B
Hydraulic model geometry developed from survey data, LiDAR, and/or USGS topo maps	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 2 B
Hydraulic model contains sensitivity analysis to ensure study is modeled downstream far enough to where a +/- 3 ft starting water surface elevation does not affect water surface elevation at proposed bridge site	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 2 B
Hydraulic model extends upstream far enough to where no backwater is caused by the proposed bridge	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 2 B
Compliance to FEMA and SCDOT guidelines have been met when modeling bridges and culverts within limits of Flood Insurance Studies	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 2 C
1-D model follow HEC-RAS <i>Hydraulic Reference Manual</i> guidelines	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 2 C
2-D models follow <i>Two Dimensional Hydraulic Modeling for Highways in the River Environment</i> guidance and others mentioned in RHDS section	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 2 C
Appropriate Manning's "n" values used in model	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 2 A 2
<b>Bridge Geometric Layout</b>		
Low chord of replacement bridge not below existing bridge	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	HDB 2019-4 1.1.9; **Design Variance**
Bridge ends of replacement bridge not within limits of existing bridge	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	HDB 2019-4 1.1.9; **Design Variance**
Abutment toes of replacement bridge do not extend past abutment toe of existing bridge	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	HDB 2019-4 1.1.9; **Design Variance**
Orientation of bridge substructure determined by high flow angle	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A	RHDS 1.3.1 Step 8

Spacing of overflow bridges does not exceed 1/2 mile in wide floodplains	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	RHDS 1.3.1 Step 8
Min low chord set based on hydraulic design criteria. Check freeboard requirements. Roadway and structural requirements may dictate higher grade than hydraulic requirements.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	RHDS 1.3.1 Step 8
Fully span channels when practical	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.11
Min distance from top of channel bank for abutment setback met. Abutment toe placed 10 ft from top of bank, or at a point where the projection of the spill through slope provides a minimum 10 ft distance from any point on the channel bank or bed, whichever distance is greater	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.10 - Figure 1.3; **Design Variance**
Min distance from top of channel bank for substructure setback met. Minimum set back for piles = 5 ft setback; Pier widths <= 5ft = 10 ft setback; Pier width > 5 ft = 10 ft setback plus half the pier width beyond 5 ft	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.11 - Figure 1.4, 1.5 and Table 1.2
Bents and piers aligned to existing structure for parallel bridges	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	RHDS 1.3.1.8 Step 8 C
Piers are located away from bank toes	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HEC 9 and HEC 18
Piers are not located near the thalweg	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HEC 9 and HEC 18

### Hydraulic Model Design Criteria

1 % AEP (100-yr event) flood does not overtop roadway	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.1; **Design Variance**
Backwater < 1.0 ft for 1 % AEP (100-yr event) compared to natural conditions	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.1; **Design Variance**
Proposed bridge backwater ≤ existing bridge backwater	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.1; **Design Variance**
Design flood frequency correct for road type <input type="checkbox"/> 4 % AEP (25-year event) for secondary routes <input type="checkbox"/> 2 % AEP (50-year event) for Interstate, Primary, and Evacuation Routes	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.1
Min freeboard requirements met for design flood <input type="checkbox"/> Rivers - min 2.0 ft <input type="checkbox"/> Large rivers - min 7.0 ft <input type="checkbox"/> Lakes - min 8.0 ft	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.5; **Design Variance**
Free surface flow maintained through bridge for frequencies up to and including the 1 % AEP (100-year event)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.5.1; **Design Variance**
Bench elevation is above design high water elevation	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.6; Standard Drawing 804-105-00; **Design Variance**
Abandoned road embankments and temporary construction fill is removed and the area graded to the approximate natural ground conditions.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.9; **Design Variance**
Lifelines and Interstate are operational during the 1 % AEP (100-year event) and 0.2 % AEP (500-year event)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.1
*Tidal - Freeboard is 2 ft above the 10-year design storm plus wave height	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	RHDS 1.1.5.2

### Scour

Scour analysis performed for the 1 % AEP (100-year event) and 0.2 % AEP (500-year event) storms	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-3
Scour analysis performed using USGS bridge-scour envelope curves, where possible. Preferred alternative when site characteristics are within the limits of the data.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-3

Scour analysis performed using HEC-18 when USGS bridge-scour curves are not applicable and for comparison purposes. Used with unusual site conditions (pressure flow, overtopping, hydraulically wide piers, and complex piers).	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-3
Min Class B rip-rap for abutment protection is used	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.6; Standard Drawing 804-105-00
Rip-rap thickness 2 x D <sub>50</sub> on end fills	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.6; Standard Drawing 804-105-00
Rip-rap entrenched 2.0 ft below ground line and 2.0 ft above design year storm (or top of bench)	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.6; Standard Drawing 804-105-00
Rip-rap protection provided on all abutment end fills	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-3
Design avoids severe flow contractions	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-3
Bridge sized to minimize velocities and scour potential	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.3

### **Bridges in Floodplains**

There is no increase in the post water surface profiles compared to pre conditions. Non-compliance requires FEMA involvement.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.2
Proper model designations used in model with floodplain. The model designations are current effective, converted, corrected effective, existing conditions, revised conditions, unrestricted (or natural) conditions, as-build revised conditions.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.2.1
Finding of "No Impact" met 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.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.2.2
Finding of "No Impact" met 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.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.2.2
Finding of "No Impact" met 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.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.2.2
CLOMR or LOMR prepared for crossing where "No Impact" is not achievable	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.2.3
Procedures followed for Projects in Special Flood Hazard Areas with Floodways	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.2.4
Procedures followed for Projects in Special Flood Hazard Areas without Floodways based on Limited Detailed Studies	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.2.5
Procedures followed for Projects in Approximate Zone A	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.2.6
Procedures followed for Projects outside of Special Flood Hazard Areas	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.2.7

### **Bridge Sized Culvert (20 ft or greater) Additional Items to Review**

Culvert sized to minimize velocities and scour potential	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.3
Used in areas with low debris potential	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.8
Outlet protection design using HEC-14	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.8
Box culvert invert elevations buried 1 ft.	<input type="checkbox"/> Yes	<input type="checkbox"/> No	<input type="checkbox"/> N/A	HDB 2019-4 1.1.8