

# FLOOD MONITORING FOR SCOUR CRITICAL BRIDGES

## INTRODUCTION

Flood events can compromise the safety of bridges susceptible to scour. Scour is the erosion of the streambed material caused by flowing water. Scour caused by floodwaters can remove large amounts of foundation material from under the footings of a bridge and cause the bridge to become unstable. Bridge owners are required by the National Bridge Inspection Standards (NBIS) to monitor scour critical bridges during flood events. The purpose is to document obvious signs of distress on bridges and/or approach roadways which are overtopped, or nearly overtopped, with flood waters and to coordinate necessary bridge closures. See photographs for examples of flooding and its effects at the end of this document

## SCOUR CRITICAL CATEGORIES

A scour critical bridge requires a written scour plan of action (POA) which includes monitoring when triggered by flooding events. In Pennsylvania, scour critical bridges are categorized based on the bridges vulnerability to scour. Category A is more susceptible to scour while Categories B & C, respectively, have decreasing vulnerability to scour. Many bridges are not classified scour critical and therefore do NOT need to be monitored during floods. However, nearly all bridges which cross waterways have some vulnerability to scour damage or washout caused by flood waters.

After the start of monitoring, the minimum frequency for monitoring for bridges according to category is:

- Category A – once every 4 hours
- Category B – once every 12 hours
- Category C – once every 24 hours

Note that each scour critical bridge being monitored requires a minimum of 2 visits to verify whether water is rising or receding. Use the monitoring log to record visible distress by circling either Yes (Y) or No (N) to identify whether conditions for closure exist at the bridge. Bridge closure should be strongly considered whenever a Y is circled on the monitoring log. Detailed descriptions of bridge closure conditions and the bridge closure plan and are provided on the front of the monitoring log.

## FLOOD ALERTS & NOTIFICATIONS

The National Weather Service (NWS) Flood Alerts inform the public of potential hazardous conditions at three levels:

- **Flood Advisory – serious**  
Conditions are less certain than a watch
- **Flood Watch – more serious**  
A threat of flooding, but the occurrence is neither certain nor imminent
- **Flood Warning – most serious.**  
High flows or overflows which includes a serious threat to life or property is in progress, imminent, or highly likely

Weather warnings for specified areas are broadcast on local television stations, over local radio stations, and on the internet at <http://alerts.weather.gov/cap/pa.php?x=3> and then clicking on the desired county.

## BRIDGE MONITORING VISITS

Determine if a bridge is scour critical by going to the PennDOT website located at: <https://padotgis.maps.arcgis.com/apps/webappviewer/index.html?id=0f62b3249c12447082f5b3151eadfeaf>.

The website provides a Local Scour Critical Bridge Map to assist bridge owners to identify, locate and determine ownership of scour critical bridges.

During flood events the owner of a scour critical bridge is required to monitor their scour critical bridges. The PennDOT

website linked above also provides a bridge-specific Scour Critical Bridge Monitoring Log that can be downloaded, printed, and then filled out for each monitoring visit. Completed monitoring logs for each scour critical bridge must be kept in the bridge file which the owner maintains.

The monitoring process occurs in distinct stages of a flood event described as Before, During, Closing and After.

#### **Before a Flood Event:**

- Identify individuals who will monitor bridges.
- Individuals responsible to monitor bridges need to be familiar with monitoring procedures.
- Identify bridges within the municipality or county which are scour critical and require monitoring by using the PennDOT website.
- Determine bridge closure methods.
- Pre-plan bridge monitoring assignments and create a plan to communicate bridge closures that may occur during flooding events.

#### **During a flood event:**

- **SAFETY FIRST**
  - **Do not endanger yourself or others while monitoring bridges.**
  - **Do not enter flood waters.**
  - **Flood waters include both standing and flowing water.**
- When stream waters rise, begin monitoring visits for Category A bridge(s).
- A **Flood Warning** issued by the National Weather Service should trigger bridge monitoring (Flood Warnings are often preceded by Flood Advisories or Flood Watches).
- As flood conditions worsen, or continue over a long period of time, then begin monitoring Category B and Category C bridges.

- Monitor Category A, B, and C bridges for signs of distress and record observations on scour critical bridge flood monitoring log during each visit.
- Continue to make monitoring visits while water level is rising.
- Monitor bridges a minimum of two times. This is necessary to determine if the water level is receding.
- Once it is confirmed that the water level is receding, monitoring may be discontinued.
- **SAFETY FIRST**
  - **Do not endanger yourself or others while monitoring bridges.**
  - **Do not enter flood waters.**
  - **Flood waters include both standing and flowing water**

#### **Closing a Bridge (when necessary)**

- Close the bridge when necessary to ensure public safety. Follow the directions on the scour critical bridge flood monitoring log to determine if conditions at the bridge make this step necessary (refer to photos - pages 4 & 5).
  - Bridge
    - Pressure flow
    - Water overtopping the bridge
    - Misalignment, settlement or tilt damage
  - Approach Roadway
    - Settlement damage
    - Embankment erosion damage
  - Waterway Channel
    - Significant debris build-up
- **In order to re-route emergency response vehicles after a bridge has been closed, immediately notify appropriate law enforcement, local emergency responders, and county emergency communications center using a non-emergency phone number or pre-established alternate communications.**
- **Avoid directly calling 911 unless there is an actual emergency.**

- Notify PennDOT Municipal Services or PennDOT bridge inspection personnel of bridge closures whenever possible.

#### After the flood event:

- Completed monitoring logs for each bridge that was monitored are to be placed in the bridge file maintained by the owner.
- These records may be subject to audit at a later date as required by FHWA.
- Bridges that have been closed undergo a post-flood damage inspection performed by a certified bridge safety inspector.
- **All closed Category A bridges must be inspected PRIOR to re-opening.**
- **All flood-damaged bridges (including settlement, tilt, misalignment, erosion or bridge washout) must remain closed until inspected.**
- Depending on the severity of the storm, some or all Category A, B, C or D bridges may require a post-flood damage inspection after water recedes to normal levels; this may include bridges that were not closed during monitoring.
- Post-flood inspections are conducted by a certified bridge safety inspector.
- This determination will be made by PennDOT. PennDOT bridge personnel will coordinate with local bridge inspection engineers.

#### INTERNET RESOURCES

##### PennDOT

<https://www.penndot.pa.gov/>

- Then click on the 511 link from the home page
- Then click on the Travel Conditions link in the upper left and select Weather Alerts on the pull down menu
- Then select a county to view

<https://www.penndot.pa.gov/Doing-Business/LocalGovernment/MunicipalServicesRepresentatives/Pages/default.aspx>

- Bureau of Municipal Services

<https://www.penndot.pa.gov/ProjectAndPrograms/Bridges/Pages/default.aspx>

- Bridge Information

##### National Weather Service

<http://alerts.weather.gov/cap/pa.php?x=1>

- Listing of all Pennsylvania alerts statewide.

<http://alerts.weather.gov/cap/pa.php?x=3>

- Select a specific Pennsylvania county

<http://water.weather.gov/ahps2/index.php?wfo=ctp>

- Provides river observations and river forecasts of a number of rivers and other waterways
- Click on the desired river or waterway icon
- The river flood and action stages will be shown

##### Commonwealth of PA Alert System

<https://public.coderedweb.com/CNE/en-US/BF5CCF5B2AB3>

- Provides direct severe weather updates
- The updates are sent by either e-mail or cell phone via text/SMS messages.
- These updates can be received by visiting the AlertPA's website and registering as a new user
- After registering the user has full control over what alerts to receive and how to receive them

##### Federal Highway Administration

<http://www.fhwa.dot.gov/federal-aidessentials/catmod.cfm?id=87>

- Provides an informative video on the National Bridge Inspection Standards (NBIS)
- Provides Federal-Aid Essentials for Local Public Agencies





**Pressure flow – water is flowing against or the bridge superstructure. Water levels may continue to rise and flow over the bridge; this is called “overtopping”.**



**Extreme settlement damage in the abutment**



**Settlement damage in the roadway due to settlement and tilt of the bridge abutment in the picture to the right**



**Settlement damage of the bridge causing tilt and roadway settlement damage in the picture to the left**



**Settlement damage in the abutment due to scour underneath the bridge abutment**



**Settlement damage effect on the roadway due to scour underneath the bridge abutment in the picture to the left**





**Settlement damage in the stone masonry pier and some collapsing in the arch**



**Embankment erosion damage and part of bridge has collapsed into the stream channel**



**Settlement damage in the approach fill behind the abutments as viewed from the roadway above the bridge.**



**Embankment erosion damage under the adjacent roadway. The roadway shoulder has fallen away**



**Extreme settlement damage in the roadway, causing a hole in the roadway behind the bridge abutments**



**Severe debris buildup of tree branches, caught against the bridge blocking more than 25% of the span opening**