

**COUNTY OF PRINCE EDWARD, VIRGINIA**  
**RFP #10-02**  
**ATTACHMENT I**

**SCOPE OF SERVICES**  
**DAM BREAK INUNDATION ZONE MAPPING**

**Introduction**

A dam break inundation zone map shall be developed that meets all of the requirements of the Dam Safety Act and the Impounding Structure Regulations for regulated dams with a High, Significant or Low Hazard Potential. The Dam Safety Act requires an owner of a regulated High, Significant or Low Hazard Potential dam to prepare a map of the dam break inundation zone that meets the requirements set out in 4VAC50-20-40 (Hazard Potential Classification of Impounding Structures). The Impounding Structure Regulations utilize dam break inundation zone maps to comply with the requirements of 4VAC50-20-175 (Emergency Action Plan for High and Significant Potential Hazard Impounding Structures) and 4VAC50-20-177 (Emergency Preparedness Plan for Low Hazard Potential Impounding Structures). All dam break inundation zone maps shall be signed and sealed by a professional engineer licensed in the Commonwealth of Virginia.

**Field Investigation**

The consultant will visit the site along with DCR and Prince Edward County representatives to ascertain the location of the dam as it relates to upstream and downstream hydrology. All primary and secondary roads, bridges downstream of the dam will be investigated. Any residence that may be in an inundation zone directly below the dam will be noted for later investigation.

**Field Survey**

The consultant will provide field survey as required to supplement available mapping. Based upon review of the site and review of the modeling requirements, the following dam information and x-sections will be required:

1. Dam profiles from natural ground to natural ground
2. Dam x-sections at the widest point from water surface to toe of dam
3. Emergency spillway profiles from water surface to top of discharge point
4. Invert of outlet pipes and toe drains
5. As many x-sections downstream as necessary to develop break models

X-sections at road crossings to include:

100' +/- upstream of roadway

Toe of slope upstream and downstream of roadway

High side or centerline profile of traveled surface

A minimum of three x-sections and sketches of downstream bridges and culverts

Up to two x-sections at habitable structures at or near the inundation zone

### **Dam Inundation Zone Data Collection**

In addition to initial field investigation the consultant will conduct a survey of the dam and downstream structures that are critical in determining the hazard classification of each dam. The consultant will conduct a watershed assessment of the upstream and downstream drainage areas and collect field data required for hydraulic analysis and flood routing. The information obtained from field assessment will be used to:

1. Determine field survey locations
2. Verify drainage areas and flow paths
3. Verify the presence or absence of structures that may be located within the inundation zones.

This data will be used in conjunction with mapping obtained from various sources such as USGS Topographic quad maps and GIS mapping provided by the Virginia Geographic Information Network.

### **Hydrologic and Hydraulic Analysis**

A dam break analysis using an approved hydrologic/hydraulic computer model shall be conducted. The modeling effort must conform to the intended use of the chosen computer model. Mixing the criteria of one procedure, listed in 4VAC50-20-320 (Acceptable design procedures and references) with criteria from another procedure, unless otherwise mentioned, is prohibited. Some computer models that are acceptable include HEC-1, HEC-HMS, HEC-RAS and the NWS Dambreak. Other computer models may be used if approved by the Division of Dam Safety and Floodplain Management prior to submitting the results to the DCR Regional Engineer. Present and planned land-use in the dam break inundation zones for which a development plan has been officially approved by the locality shall be considered when conducting the dam break analysis.

The consultant will develop a hydrologic model for the contributing watershed to the dam. The discharges generated from these watershed models will be routed through existing outlet structures to evaluate non-breach discharges and the associated water surface elevations within the impoundment. The hydrologic model will also include an analysis for each watershed that contributes flow within the inundation zone and for any watershed that contributes flow to the downstream channel that may affect upstream water surface elevations.

### **Breach Analysis**

Based on survey and field data, breach model parameter values will be developed in order to generate breach discharges and create inflow hydrographs for downstream routing. Specific breach parameter values, such as failure time, will be optimized. Once these parameters are established, breach analysis will be performed as per Dam Safety Regulations:

As a minimum, the following shall be reflected using an approved hydrologic/hydraulic computer model:

1. Sunny day dam break with the starting water surface elevation at the normal or typical water surface elevation of the impounding structure.

2. Dam failure during the required spillway design flood. An overtopping failure shall be modeled if the emergency spillway is unable to pass the spillway design flood without overtopping the crest of the dam. A piping failure shall be modeled if the emergency spillway has enough capacity to pass the required spillway design flood without overtopping the crest of the dam.
3. Routing the spillway design flood through the dam without any failure.
4. Dam failure during the Probable Maximum Flood.

### **Mapping and Inundation Limits**

Topographic information that show at a minimum ten-foot contour elevations shall be used to develop the hydrologic/hydraulic computer model downstream of the dam, including cross sections at potential damage locations (homes, businesses, roads, utilities, etc.) downstream of the dam. The consultant engineer must develop reliable cross sections to input into the computer model. If adequate topographic information is not available, the dam owner must provide an alternative method for identifying potential damage locations that must be approved by the DCR Regional Engineer, prior to initiating the evaluation. Topography may be a component of the submitted inundation map; however, map clutter must be avoided. If the topography is not submitted on the inundation map, a copy of the topographical information used shall be submitted with the engineering analysis and paper copies of all hydrologic and hydraulic computer model runs to the Regional Engineer.

The consultant engineer shall use sanctioned engineering criteria and sound professional judgment for the worst case storm conditions in the selection of:

- a. Dam failure parameters
- b. Rainfall distributions
- c. Flood routing procedures and coefficients
- d. Use of available topography and supporting field surveys
- e. Development of SCS Curve Numbers
- f. Development of spillway rating curves and area-capacity curves
- g. Determination of the Time of Concentration and/or lag time
- h. Other steps used during the modeling and analysis of flood conditions in the watershed and downstream of the impounding structure.

The judgments and the engineering criteria used by the dam owner's engineer shall be reviewed and approved by the DCR Regional Engineer for appropriateness. The DCR Regional Engineer will provide specific guidance and/or recommendations via written correspondence to the dam owner should the judgments or the use of the engineering criteria be determined to be inappropriate.

The computer model shall be extended to a point downstream of the impounding structure where the water surface elevations of the spillway design flood with and without dam failure converge to within one foot of each other or to a point at which the Probable Maximum Flood with a dam failure creates a possible damage to a structure, whichever is the farthest downstream.

The following shall be clearly marked at each potential damage location on each map:

- a. Cross Section number and distance downstream from the dam to the nearest tenth of a mile
- b. Relative time of travel, in minutes, of the first flood waters associated with a dam failure to reach the impact location
- c. Relative time of travel, in minutes, of the peak flood level associated with a dam failure to reach the impact location
- d. Maximum depth of water with a dam failure at each impact location in feet (depth of water on the structure)

The map lines delineating the inundation areas shall be drawn in such thickness (solid, dashed or dotted lines in black) to identify the inundation limits as the main feature of the map. The lines shall not obliterate the location of houses or features which are shown as being inundated. Identify the appropriate scale and show the north arrow on each map sheet.

Inundation maps may have color in the background and shall be at a scale where impacted structures downstream may be clearly seen. Avoid color-coding of the inundation lines since the maps will often be copied on black and white reproduction equipment. If the inundation area is too large to be shown on one map, an index map shall be included which shows the full extent of the inundation area and the outline of the detailed maps with an identifier for each map sheet. Impacted structures (homes, businesses, roads, utilities, etc) shall be clearly shown and if cross-hatching is used it must not obscure the structures. The physical addresses and contact persons may be located on a separate attachment to avoid clutter. This information will be used to aid emergency responders in quickly locating impacted structures and conducting evacuations. Inundation maps shall not be produced in a size larger than 11" by 17" and the final size must be folded to a size of 8" by 11". The inundation maps shall be submitted to the DCR Regional Engineer electronically in a Windows compatible image format and as a set of paper maps. Acceptable digital image formats consist of JPEG, TIF, BMP, GIF, PNG, or EMF files. Adobe software constructed PDFs are also acceptable. Image resolution should be sufficient to view and read the necessary information noted above.

A narrative describing the accuracy and limitation of the information supplied on the inundation maps shall be provided to the DCR Regional Engineer. Since local officials are likely to use the maps for evacuation purposes, the following note shall be attached to each map: "Mapping of flooded areas and flood wave travel times are approximate. Timing and extent of actual inundation may differ from the information presented on this map."

### **Hazard Classification**

The consultant will develop the Hazard Classification for each impounding structure from the results of the Hydrologic and Hydraulic Analysis and field survey information. This classification will establish the required Spillway Design Flood (SDF) for each dam in Table 1 of the Regulations. The determination/verification of the hazard classification

is the key factor in determining the complexity of the Breach analysis, Incremental Damage Assessment (IDA) and the limits of inundation mapping  
The hazard potential classification shall be proposed by the dam owner and shall be subject to reclassification by the Virginia Soil and Water Conservation Board, upon review of the information submitted by the dam owner and the owner's engineer and any pertinent information regarding potential impacts downstream of the dam caused by a failure of the dam.

### **Incremental Damage Analysis**

The consultant will perform an Incremental Damage Analysis (IDA) to possibly reduce the required Spillway Design Flood (SDF) based on the results of the Hazard Classification and the Breach Analysis. The analysis will determine if the required SDF can be reduced. If the IDA reduces the required SDF then the Breach Analysis task will be repeated with the new SDF value. The results from this analysis will be documented and included in a separate report.

### **Inundation Report**

The consultant will provide one original and two copies of the written report providing a summary of the findings. The report will be presented in a three-ring binder complete with inundation mapping and selective supporting calculations. The report will include the results of the breach analysis and all of the parameters discussed above. A CD of the report, complete with reproducible inundation maps, and a GIS Layer shape file of the inundation areas shall be submitted with each report.

###