

# TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE

UTAH

NATURAL RESOURCES CONSERVATION SERVICE

March 2015

ENG -210 - TECHNICAL NOTE UT210-15-06  
190-VI

SUBJECT: ENG – Procedure to determine and document the Hazard Classification of Small Dams and Ponds

Purpose: To transmit a simplified procedure and form to document the hazard classification of small dams.

Effective Date: Upon receipt.

## Contents of Technical Note:

Section 520.21 of the National Engineering Manual (NEM) and Technical Release 60 give the definitions for hazard classes of dams. The hazard classes are separated into three categories; Low, Significant, and High. Section 520.23 of the NEM outlines when in the design/construction process the hazard classification is to be made, who has the responsibility for the classification of the structure, and what documentation is required.

## **IT IS IMPORTANT THAT THIS MATERIAL IN THE NATIONAL ENGINEERING MANUAL BE READ AND UNDERSTOOD PRIOR TO CLASSIFYING A DAM.**

Hazard classification and documentation is the beginning step of the design process. The following method applies only to Low Hazard Dams with height times storage less than 3,000. Significant Hazard Dams with height times storage equal to or greater than 3,000, and High Hazard Dams shall conform to TR-60 requirements.

All structures with the potential to retain water temporarily or otherwise shall be classified during the planning and design process. The *BR* (breach ratio) equation may be used to compute the maximum breach discharge on all structures with the potential to retain water that are Low Hazard with height times storage less than 3,000. The form entitled UT-ENG-FORM UT210-15-01 *DOCUMENTATION FOR HAZARD CLASSIFICATION OF DAMS* is attached and shows the equation to be used for the computation.

Sites with houses or occupied buildings downstream of the dam shall be carefully evaluated. If the computations show breach water to be within one foot of human occupied quarters, then the site shall be breach routed. All Significant Hazard, High Hazard class dams and Low Hazard dams with height times storage greater than or equal to 3,000 shall be breach routed using TR-60 criteria. Any site where breach water may damage an important road, railroad or utility shall be breach routed. Breach routing may give a lower water surface elevation that using the procedure outlined in this Technical Note.

HEC-RAS can be used to predict flood stages downstream from a breached dam. Two site parameters required in the analysis are the depth of water in the reservoir and total volume. For simplicity, spillway discharge and local inflow from areas downstream of the dam are not considered. More rigorous breach routing methodologies are available for

more complex site conditions and where potential downstream impacts merit a more detailed investigation.

The attached Table, *NRCS Utah Dam Hazard Classification Checklist* provides guidance to determining Hazard Classification based on potential impacts to property, infrastructure, and human life.

Please contact Nathaniel Todea, State Hydraulic Engineer for assistance.

Design Aids:

Spreadsheet to aid in determining downstream water surface elevations:

[http://efotg.sc.egov.usda.gov/references/public/UT/ENG-MO-9\\_Table\\_Lookup.xls](http://efotg.sc.egov.usda.gov/references/public/UT/ENG-MO-9_Table_Lookup.xls)

Spreadsheet to aid in calculating breach flow:

<http://efotg.sc.egov.usda.gov/references/public/UT/BreachQREV.xls>

Filing Instructions: File in the Technical Notes notebook under ENG-210

Contact: Nathaniel Todea, State Hydraulic Engineer, 801-524-4582

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## PROCEDURE FOR DETERMINING THE HAZARD CLASSIFICATION OF SMALL DAMS AND PONDS

1. The use of *Technical Note UT210-15-06 Procedure to Determine and Document the Hazard Classification of Small Dams and Ponds* is only for “low hazard” dams with height times storage of less than 3,000. Dams with H x S of 3,000 or greater and “significant hazard” and high hazard” dams shall conform to TR-60 or its replacement.
2. Evaluate future growth of the area downstream of the dam. If there is a good chance that development will occur within the impact area then the dam may require a higher hazard rating.
3. The hazard classification of all “significant hazard”, “high hazard” and TR-60 dams shall be concurred in by the State Conservation Engineer or his/her representative.
4. The breach flow shall be determined using the Breach Ration equation as qualified by the upper and lower limits as determined by the following equations:

$$Q_{max} > 3.2H_{BR}^{5/2} \text{ and } Q_{max} < 65H_{BR}^{1.85}$$

The BR equation is as follows:

$$Q_{max} = 1100 * BR^{1.35}$$

$$BR = \text{BreachFactor} = \frac{V_S * H_{BR}}{A}$$

$H_{BR}$  = The depth of water at the dam may be measured from the floodplain elevation to the auxiliary spillway if the dam is long and if the cross sectional area of the stream channel is less than 50 percent of area that is available for flow in the floodplain. Floodplain elevation is defined as lowest elevation in floodplain outside of the channel. (See sketch below.)

$V_s$  = Reservoir storage to auxiliary spillway crest elevation at the time of failure, acre-feet.

$A$  = Cross sectional area of the dam above floodplain elevation, square feet.

The attached spreadsheet, *BreachQRev.xls*, has been created to aid in the calculation of the breach flow.

5. The downstream water surface elevations can be estimated using the *ENG-MO-09\_Table\_Lookup.xls*
  - a. Inputs for the spreadsheet are:
    - i) Valley Roughness, n
      - (1) The “n” values (Hydraulic Roughness) may be estimated as shown in NEH Part 630, Hydrology, Chapter 6. Additional guidance may be given by the State Hydraulic Engineer.
    - ii) Valley Slope, s in ft/ft
      - (1) Valley slope may be estimated from USGS Topographic Map or by survey data.
    - iii) Valley width, W in ft.
      - (1) For valley widths larger than 300 feet use data for 300 foot width as a conservative answer or breach route.
      - (2) Consideration may be given to size of valley at point in question if valley width changes more than 25 percent. The design may be based on average valley width

if approved by responsible engineer.

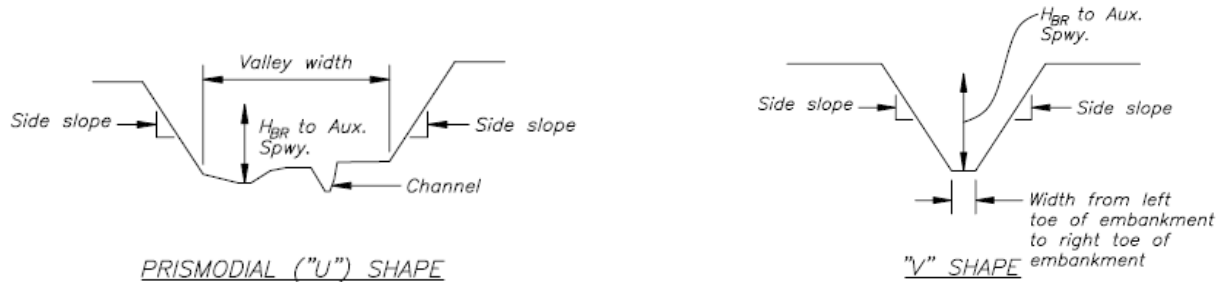
iv) Peak Breach Flow, Peak in cfs

- (1) Using conservative answers is also permitted. For example when  $Q_{max} = 750$  cfs using the table for 1,000 cfs is permitted which gives a conservative answer.
- (2) For  $Q_{max}$  values less than 200 cfs, the value for 200 cfs may be used.
- (3) For most small dams  $Q_{max}$  will be less than 2,500 cfs.
- (4) For  $Q_{max}$  values more than 5,000 cfs, breach routing of the structure may be considered.

v) Reservoir Volume, V in acft.

b. Interpolation of the values is permitted.

c. Most valleys are prismoidal "U" shaped or "V" shaped. Most "V" shapes are located in loess soil.



6. Using the water surface elevations determined in the previous step, evaluate the downstream impacts using the *NRCS Utah Dam Hazard Classification Checklist*. Circle or mark the selected classification for each category and include notes and data that justify the selection.
7. The *NRCS Utah Dam Hazard Classification Checklist* has been developed to give guidance in determining the hazard classification based on downstream impacts and permissible damage. This is only intended to aid your judgment in determining the hazard classification of a structure. Other factors to consider for downstream road hazards are:
  - a. Are there alternative routes for people to travel on?
  - b. Is the road a school bus route?
  - c. Extent of damage expected. If low point is near the floodplain elevation, then the likelihood of road flooding is greater, but road damage is normally minimal.
  - d. Length of time needed to repair the expected damage.
  - e. Does floodwater overtop the road on a regular basis? If drivers are used to having water over the road, then the hazard is less.
  - f. What is the traffic count on the road? A low traffic count is considered less than 300 vehicles per day. Traffic count information can be obtained on the UDOT Web site.
  - g. The skill level of drivers using the road and the type of vehicles should be considered when evaluating road hazard. Water over a road near a high concentration of people such as a school or subdivision is a bigger hazard than water over a road used primarily for farm use.
  - h. All pertinent factors shall be considered in assigning a hazard classification
8. If the results of the investigation using this simplified process indicate that the hazard classification may be "significant" or "high" hazard a more detailed look will be required including a more detailed breach routing of the flows. This may require a more detailed

survey of channel and floodplain below the structure and the use of tools not covered in this technical note. Assistance shall be requested from the State Hydraulic Engineer who will provide guidance in additional steps that are required and additional data that must be collected.

## DOCUMENTATION FOR HAZARD CLASSIFICATION OF DAMS

Name or Number of Site \_\_\_\_\_

Program (Check One):      Watershed;      RC&D;      CO-01 (CTA, EQUIP, WRP,  
Etc.) Location: (See attached map or photo)

North \_\_\_\_\_, Easting \_\_\_\_\_ UTM NAD83 (ft. / m)

County \_\_\_\_\_ Section No. \_\_\_\_\_ T \_\_\_\_\_ R \_\_\_\_\_

Dam in Series:      Yes      No      Explain: \_\_\_\_\_

### Preliminary Structure Data

\_\_\_\_\_ Assumed Hazard Class

Drainage Area: \_\_\_\_\_ Acres

A. Pond Bottom Elevation at Centerline \_\_\_\_\_ F. Storage Volume (Vs) : \_\_\_\_\_ Ac-Ft.

B. Elevation at Downstream Toe \_\_\_\_\_ G. Effective Height:  $\underline{E} - \underline{A} =$  \_\_\_\_\_C. Floodplain Elevation at Centerline \_\_\_\_\_ H. Overall Height:  $\underline{D} - \underline{B} =$  \_\_\_\_\_D. Settled Top of Dam Elevation \_\_\_\_\_ I. Height x Storage (HxS)  $\underline{G} \times \underline{E} =$  \_\_\_\_\_

\*\*HxS must be &lt; 3,000 for low hazard

E. Auxiliary Spillway Crest Elevation \_\_\_\_\_ Conduit Diameter: \_\_\_\_\_ inches

Additional Notes: \_\_\_\_\_

### Downstream Conditions

1. Valley Conditions Downstream from Structure:      Convergent      Divergent      Parallel

Floodplain Elevation \_\_\_\_\_ Valley Slope in Downstream Direction \_\_\_\_\_

2. Stream Channel Size: Depth \_\_\_\_\_ Width \_\_\_\_\_ Valley: Width \_\_\_\_\_ Shape \_\_\_\_\_

3. Valley Roughness or Retardance (composite): "n" \_\_\_\_\_

4. First Downstream Hazard (See Page 2 of 2) \_\_\_\_\_ Distance \_\_\_\_\_

5. Distance Downstream to Junction of Significantly Larger Tributary \_\_\_\_\_

Rationale for Determining Hazard Class \_\_\_\_\_

ATTACHED:      Breach Routings      Yes      No

Map(s)

Other pertinent supporting documents

Describe Potential Downstream Development: \_\_\_\_\_

Potential impact area due to sudden failure of dam: N/A or See Below (circle one)

Describe Type of Utilities, Distance Downstream and Distance Above Floodplain Elevation	Approximate Distance Downstream From Dam	Approximate Distance Above Floodplain Elevation	Location in Potential Impact Area (Yes or No)
Building (houses etc.) and Utilities:			
Roads and Railroads:			
Bridges:			

**Minimum Breach Discharge:** Unless a refined analysis is performed using principals of erosion and sediment transport, the minimum breach discharge is:

$$H_{BR} = \text{Auxiliary Spillway Elevation} - \text{Floodplain elevation}$$

$$= \frac{\text{E}}{\text{C}} - \frac{\text{C}}{\text{C}} = \text{_____} \text{ ft.}$$

$$A = \text{Cross sectional area of dam above flood plane} = \text{_____} \text{ sq. ft.}$$

$$V_S = F = \text{_____} \text{ ac. ft.}$$

$$BR = \frac{V_S * H_{BR}}{A} = \frac{\text{_____} * \text{_____}}{\text{_____}} = \text{_____} \text{ ac.}$$

$$Q_{max} = 1100 BR^{1.35} = \text{_____} \text{ cfs. Use } \text{_____} \text{ cfs}$$

Except that  $Q_{max}$  is not to be less than  $Q_{max} = 3.2H_{BR}^{5/2} = \text{_____}$

However,  $Q_{max}$  not need exceed  $Q_{max} = 65H_{BR}^{1.85} = \text{_____}$

Distance Downstream (ft.)	0	500	1,000	1,500	2,000	2,500	3,000	5,000	7,500	10,000	15,000
Water Depth (ft.)	$H_{BR}$										
Average Velocity (fps)											
Q (cfs)	$Q_{max}$										

**DAM HAZARD CLASSIFICATION**

Low    Significant    High

**ENGINEERING APPROVAL CLASSIFICATION**

I    II    III    IV    V    VI    VII    VIII

- **Low Hazard**--Dams in rural or agricultural areas where failure may damage farm buildings, agricultural land, or township and country roads.
- **Significant Hazard**--Dams in predominantly rural or agricultural areas where failure may damage isolated homes, main highways, or minor railroads or interrupt service of relatively important public utilities.
- **High Hazard**--Dams where failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways, or railroads.

Actual Hazard Class \_\_\_\_\_ Analyzed by \_\_\_\_\_ Date \_\_\_\_\_

Reviewed by \_\_\_\_\_ Date \_\_\_\_\_

Approved by \_\_\_\_\_ Date \_\_\_\_\_

Note: The table below is only a guide. Good engineering judgement is required in evaluating potential impacts.

<b>NRCS Utah Dam Hazard Classification Checklist</b> (Estimate of Downstream Potential Impacts from a Dam Breach Failure Event)			
Potential Hazards	Hazard Classification		
	Low	Significant	High
<b>LANDUSE</b> for WATERSHED SURROUNDING THE DAM (ABOVE AND BELOW). Must also consider future changes in Landuse and evaluate for most limiting conditions.	Rural or agricultural--Areas of mostly farming or ranching. Urban housing developments do not exist and none are expected during the structure's design life.	Predominantly rural or agricultural	Developing or urban
<b>ROADS</b>			
Dirt and Gravel--All rural area roads without concrete or bituminous surfacing	May Damage--(DV < 10) and/or (VPD < 100)	May Damage--(DV < 10) and/or (100 < VPD < 500) and/or (Visibility < 500')	May Damage--(DV < 10) and/or (VPD < 500) and/or (Visibility < 200')
Paved--Any concrete or bituminous surfaced township, county, or state road which is used for public transportation	May Damage--(Depth < 1') and/or (Velocity < 5 fps) and/or (VPD < 100)	May Damage--(DV < 10) and/or (100 < VPD < 500) and/or (Visibility < 500')	May Damage--(DV < 10) and/or (VPD < 500) and/or (Visibility < 200')
Main Highways--U.S., Interstate, and turnpike highways, and any concrete or bituminous surfaced township, county, or state road that serves as the only access to a community.	No Damage	May Damage--(DV < 10) and/or (100 < VPD < 500) and/or (Visibility < 500')	May Damage--(DV < 10) and/or (VPD < 500) and/or (Visibility < 200')
<b>RAILROADS</b>			
Minor--Infrequently used railroad. Disruption of service would not adversely affect local economy, safety, or general well-being of area.	No Damage	May Damage--Interruption of service for a day or more	Serious Damage--Interruption of service for a day or more
Main--Intrastate or interstate railroads that have frequent use. Disruption of service would adversely affect local economy, safety, or general well-being of area.	No Damage	No Damage	Serious Damage--Interruption of service for a day or more
<b>BUILDINGS</b>			
Farm Buildings--Non-Occupancy on-farm buildings such as barns and sheds.	May Damage--Flood depth on main floor, 3 feet, and (DV < 10)	Serious Damage or loss.	Serious Damage or loss.
Isolated Homes--Single Family residences on farms and ranches. Not a developing area.	No Damage	May Damage--Flood depth in living area < 3 feet, and (DV < 10)	Serious Damage or loss.
Homes--Single Family residences, apartments, motels, and hotels.	No Damage	May Damage--Flood depth in living area < 3 feet, and (DV < 10)	Serious Damage or loss.
Industrial/Commercial	No Damage	No Damage	Serious Damage or loss. Type of building, construction, and contents of building must be evaluated. General serious damage can occur at flood depths of 3 ft or less and/or velocity of 5 ft/sec or less.
Public--Schools, Churches, Libraries, Nursing Homes, Hospitals, etc.	No Damage	No Damage	Serious Damage or loss. Type of building, construction, and contents of building must be evaluated. General serious damage can occur at flood depths of 3 ft or less and/or velocity of 5 ft/sec or less.
<b>PUBLIC USE AREAS</b>			
Parks, Playgrounds, Ball Fields, Cemetery, Golf Courses, etc.	DV < 5	DV < 10	Serious Damage or loss.
Airports	No Damage		Serious Damage or loss
<b>UTILITIES</b>			
Local power, power substations, phone lines, water lines, cable tv, cellular towers, and any other important local utility. Interstate and Intrastate power and communication lines serving towns, communities, and significant military or commercial facilities. Disruption of power and communications would adversely affect the economy, safety, and general well-being of the area.	No Damage	May Damage--Damage may occur when buried lines are exposed by erosion or when towers, poles, and above ground lines are damaged by undermining or by debris flow.	Serious Damage or loss--Interruption of service for more than 1 day.
<b>LOSS OF LIFE</b>			
Potential for Loss of Life--Generally associated with people exposure to the downstream breach wave where flow depth and velocity may cause a hazardous situation.	Low Potential--Depth < 1', Velocity < 3 fps, and DV < 3	Moderate Potential--Depth < 2', Velocity < 6 fps, and DV < 10	High Potential--Depth > 2' and/or Velocity > 6 fps and/or DV > 10

DV = Depth (ft) times Velocity (ft/sec)

VPD = Vehicles per Day