A Dam Presentation About Hazard Creep and Ohio’s Probable Maximum Precipitation Change

Julie Lawson, PE, CFM

August 28, 2018
DAMS IN OHIO

<table>
<thead>
<tr>
<th>CLASS I</th>
<th>CLASS II</th>
<th>CLASS III</th>
<th>CLASS IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>365</td>
<td>544</td>
<td>608</td>
<td>1033</td>
</tr>
</tbody>
</table>
DAM CLASSIFICATION

Exempt/Non-Regulated:
- **Height**: ≤ 6 ft.
- **Storage**: ≤ 15 Ac-ft

Exempt/Non-Regulated:
- **Height**: < 10 ft. & **Storage**: ≤ 50 Ac-ft

POTENTIAL DOWNSTREAM HAZARD

Environmental Design Group
The community impact people.
### DAM HEIGHT AND STORAGE CAPACITY

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Class IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam Height (ft.)</td>
<td>&gt; 60</td>
<td>&gt; 40</td>
<td>&gt; 25</td>
</tr>
<tr>
<td>Storage Volume (Ac-ft.)</td>
<td>&gt; 5,000</td>
<td>&gt; 500</td>
<td>&gt; 50</td>
</tr>
</tbody>
</table>

![Diagram of dam with various components labeled](image)

- **Headwater**
- **Structural Height**
- **Hydraulic Height**
- **Dam Height**
- **Gross Head (ΔH)**
- **Tailwater**

Lowest point in the original streambed
CASE STUDY

RICHFIELD HERITAGE PRESERVE
In accordance with Ohio Revised Code Section 1521.062, the owners of dams must monitor, maintain, and operate their dams safely. Neglect of owners in fulfilling these responsibilities can lead to the development of extremely hazardous conditions to downstream residents and properties. In the event of a dam failure, owners can be subject to liability claims.

The Chief of the Division of Soil and Water Resources has the responsibility to ensure that human life, health, and property are protected from the failure of dams. Conducting periodic safety inspections and working with dam owners to maintain and improve the overall condition of Ohio dams are vital aspects of achieving this purpose.

Representatives of the Chief conducted this inspection to evaluate the condition of the dam and its appurtenances under authority of Ohio Revised Code Section 1521.062. In accordance with Ohio Administrative Code Rule 1501:21-21-03, the owners of dams must implement all remedial measures listed in the enclosed report.
POTENTIAL DOWNSTREAM HAZARD

CLASS I: PROBABLE LOSS OF LIFE

CLASS II: HEALTH HAZARD, FLOOD DAMAGE TO RESIDENTIAL, BUSINESS, OR INDUSTRIAL STRUCTURES OR TO INFRASTRUCTURE

CLASS III: DAMAGE TO LOW VALUE NON-RESIDENTIAL STRUCTURES, LOCAL ROADS, AGRICULTURAL CROPS & LIVESTOCK

CLASS IV: LOSSES RESTRICTED MAINLY TO THE DAM
DAM CLASSIFICATION

The classification of a dam is based on three factors: the dam’s height, storage capacity, and potential downstream hazard. The height of the dam is the vertical distance from the crest to the downstream toe. The storage capacity is the volume of water that the dam can impound at the top of dam (crest) elevation. The downstream hazard consists of roads, buildings, homes, and other structures that would be damaged in the event of a dam failure. Potential for loss of life is also evaluated. Various dam failure scenarios must be considered, and they include failures when the dam is at normal pool level and failures during significant flood events. Each of the three factors is evaluated, and the final classification of the dam is based on the highest individual factor. Class I is the highest and Class IV is the lowest. The classification of a dam can change based on future development along the downstream channel.

This checklist is intended to establish or verify the appropriate classification in accordance with the Ohio Administrative Code – it does not necessarily show all potential hazards or the full extent of inundation. In addition, elevations and dimensions are estimated.

**HEIGHT CLASSIFICATION**

- Dam Height = 25.10 feet
  - > 60' - Class I
  - > 40' - Class II
  - X > 25' - Class III
  - < 25' - Class IV

**STORAGE CLASSIFICATION**

- Stor. Capacity (top of dam) = 41.00 acre-feet
  - > 5000 acre-feet - Class I
  - > 500 acre-feet - Class II
  - X > 50 acre-feet - Class III
  - < 50 acre-feet - Class IV

**EXEMPT–NON-REGULATED**

- Height ≤ 6 feet
- Storage ≤ 15 acre-feet
- 6 ft. < Height < 10 ft. & Stor. ≤ 50 ac-ft

**Height Class:**
- III

**Storage Class:**
- IV

**Hazard Class (see next page):**
- II

**Final Class:**
- II

**Estimated Population at Risk:** (none)

**Class Changed:** No
“The classification of a dam can change based on future development along the downstream channel”
ODNR DAM SAFETY INSPECTION REPORT, DAM CLASSIFICATION CHECKLIST

“If downstream hazard conditions change at any time during the life of the structure, a reevaluation of the critical routing reach and modification of the critical flood may be required by the Chief.”
ORC 1501:21-13-02E
HAZARD CREEP

“A term used to describe urban growth and development occurring downstream of a dam that was not originally designed to protect persons and their property"

NEW MEXICO OFFICE OF THE STATE ENGINEER DAM SAFETY BUREAU

Impacts

- Reclassification of existing dams
- Increased requirements of dam owners
- Higher cost to improve/maintain dams
- Increased risk to public

https://www.youtube.com/watch?v=5CcVSVhAYvA
HAZARD CREEP

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CLASS IV: LOSSES RESTRICTED MAINLY TO THE DAM

Environmental Design Group
The community impact people.
Probable Maximum Precipitation (PMP)
The greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location. *World Meteorological Organization*

Probable Maximum Flood (PMF)
The largest flood that could conceivably occur at a particular location, estimated from the probable maximum precipitation.
DESIGN FLOOD

CLASS I DAMS
100% PMF

CLASS II DAMS
50% PMF

CLASS III DAMS
25% PMF
Application of Probable Maximum Precipitation Estimates – United States East of the 105th Meridian
Prepared by NOAA, 1982
Case Study

Upper Lake

Flood Routing Summary

A dam must be able to safely pass severe flood events. A dam uses a combination of spillway discharge capacity and reservoir storage capacity, known as discharge/storage capacity, to prevent floodwater from overtopping the embankment crest and destabilizing the dam. When a dam has inadequate discharge/storage capacity, floodwater will overtop and erode the embankment. This can cause severe damage and dam failure.

As part of this inspection, the Division of Soil and Water Resources did not thoroughly investigate this dam’s discharge/storage capacity or its ability to safely pass the required design flood. In 1995 J&L Engineering performed hydrologic and hydraulic calculations to estimate the size of the design flood and the discharge/storage capacity of the dam. These calculations were used in the flood routings to determine the maximum water surface elevation in the reservoir for various flood events.

Camp Hilaka Lake Dam is a Class II dam; therefore, in accordance with OAC Rule 1501:21-13-02, the required design flood is 50% of the Probable Maximum Flood (PMF) or the critical flood. This dam and its spillway system must safely pass the design flood without overtopping the embankment crest and destabilizing the dam. Flood routing calculations indicate that the dam can pass approximately 100% of the PMF; Camp Hilaka Lake Dam appears to be able to safely pass the design flood.
Flood Routing Summary

A dam must be able to safely pass severe flood events. A dam uses a combination of spillway discharge capacity and reservoir storage capacity, known as discharge/storage capacity, to prevent floodwater from overtopping the embankment crest and destabilizing the dam. When a dam has inadequate discharge/storage capacity, floodwater will overtop and erode the embankment. This can cause severe damage and dam failure.

As part of this inspection, the Division of Soil & Water Resources did not thoroughly investigate this dam’s discharge/storage capacity or its ability to safely pass the required design flood. In 2002 the Division of Soil and Water Resources performed hydrologic and hydraulic calculations to estimate the size of the design flood and the discharge/storage capacity of the dam. These calculations were used in the flood routings to determine the maximum water surface elevation in the reservoir for various flood events.

Camp Julia Crowell Lake Dam is a Class II dam; therefore, in accordance with OAC Rule 1501:21-13-02, the required design flood is 50% of the Probable Maximum Flood (PMF) or the critical flood. This dam and its spillway system must safely pass the design flood without overtopping the embankment crest and destabilizing the dam. Flood routing calculations indicate that the dam can pass approximately 18% of the PMF; Camp Julia Crowell Lake Dam does not appear to be able to safely pass the design flood.
Case Study

Lower Lake

1. The dam’s discharge/storage capacity must be sufficient to safely pass the required design flood. Perform a hydrologic and hydraulic study to determine the adequacy of the dam’s discharge/storage capacity to safely pass the required design flood. Prepare plans and specifications as necessary to increase the discharge/storage capacity to pass the required design flood. In accordance with OAC Rule 1501:21-13-02, the minimum design flood for Class II dams is 50 percent of the Probable Maximum Flood or the critical flood. See the Flood Routing Summary section of this report for additional information.
Probable Maximum Precipitation Study for the State of Ohio
Prepared for ODNR, 2013
PMP Study for the State of Ohio
Case Study
Richfield Heritage Preserve

6-Hour Storm Duration with dimensionless design storm distribution

18.1 in.
Case Study
Richfield Heritage Preserve

24-Hour Storm Duration with SCS Type II distribution at 1.5 hour time step

24.8 IN.
Case Study
Richfield Heritage Preserve

MEAN ANNUAL PRECIPITATION: 39.7 inches
Case Study
Richfield Heritage Preserve

HYDROLOGIC SOILS GROUP

STRUCTURES BUILT
Case Study
Richfield Heritage Preserve

**UPPER LAKE**

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
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<tbody>
<tr>
<td>Precipitation</td>
<td>24.8 IN</td>
</tr>
<tr>
<td>Runoff</td>
<td>21.87 IN</td>
</tr>
<tr>
<td>Peak Runoff (PMF)</td>
<td>4,494 CFS</td>
</tr>
<tr>
<td>Peak Outflow</td>
<td>4,531 CFS</td>
</tr>
<tr>
<td>Max Outflow</td>
<td>6,249 CFS</td>
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<tr>
<td>Attenuation</td>
<td>15 MIN</td>
</tr>
<tr>
<td>Peak Storage</td>
<td>56.7 AC-FT</td>
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<tr>
<td>Max Storage</td>
<td>134.4 AC-FT</td>
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<tr>
<td>Peak Elevation</td>
<td>1157.2</td>
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<tr>
<td>Top of Dam</td>
<td>1158.0</td>
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</table>

CIVIL ENGINEERING / LANDSCAPE ARCHITECTURE / PLANNING / SURVEYING / ENVIRONMENTAL SERVICES / CONSTRUCTION MANAGEMENT
Case Study
Richfield Heritage Preserve

LOWER LAKE

PRECIPITATION: 24.8 IN
RUNOFF: 21.87 IN
PEAK RUNOFF: 3,510 CFS
UPPER LAKE: 4,531 CFS
PEAK INFLOW (PMF): 7,760 CFS
MAX OUTFLOW: 1,160 CFS
MAX STORAGE: 41 AC-FT
TOP OF DAM: 1072.8
Case Study
Richfield Heritage Preserve
Case Study
Richfield Heritage Preserve
# Dam Information

## Dam Inventory Sheet

**Name:** CAMP JULIA CROWELL LAKE DAM  
**File No.:** 1115-003  
**National #:** OH-000770  
**Permit No.:** N/A  
**Owner:** Girl Scouts of North East Ohio  
**Owner Type:** Private  
**Multi-Dams:** Yes, 3. Class I/0  
**Address:** One Girl Scout Way  
**City:** Macedonia  
**State:** OH  
**Zip:** 44065  
**Contact:** Jim Kanaden  
**Phone No.:** 330/864-6933

**County:** Summit  
**Latitude Deg.:** 41 Min.: 14 Sec.: 30  
**Longitude Deg.:** 81 Min.: 40 Sec.: 36  
**Township:** Richfield  
**Stream:** Tributary To East Branch Rocky River  
**Nearest Affected Community:** Echo Lake Glen  
**Community's Distance from Dam (miles):** 2.3  
**USGS Quad.:** West Richfield  
**USGS Basin No.:** 04110001

**Designed By:** Kirby  
**Completed:** 1929  
**Plan Available:** Yes At: CDNR, DIVISION OF WATER

**Purpose:** Recreation, Private  
**Type of Impound.:** Dam And Spillway  
**Type of Structure:** Earthfill  
**Drainage Area (sq. miles):** 1.78 or (acres): 1139

**Embankment Data**  
**Length (ft.):** 140  
**Height (ft.):** 25.1  
**Top Width (ft.):** 1  
**Upstream Slope:** 2H:1V  
**Downstream Slope:** 2H:1V

**Spillway Outlet Works Data**  
**Lake Drain:** 8-IN VALVE LOCATED THROUGH SPILLWAY  
**Principal:** CONCRETE WEIR BUTTRESS 22-FT HIGH, 60-FT LONG  
**Emergency:** 30-FT WIDE EARTNEH CHANNEL

**Maximum Spillway Discharge (cfs):** 1100  
**Design Flood:** 0.50  
**Flood Capacity:** 0.18

**Dam Reservoir Data**  
**Elevation (f-t-MSL):**  
| Top of Dam | 1072.8 | 6.5 | 41 |  
| Emergency Spillway | 1070.9 | 5.5 | 29.7 |  
| Principal Spillway | 1070 | 5 | 25 |  
| Streambed | 1047.7 |  |  |  

*Elevations are not necessarily related to a USGS benchmark

**Foundation:**

**Inspection History:**  
**Phase I:** Other Visits:  
**Inspection Year:** B

**Operation Information/Remarks**  
Embarkment crest width is 10-ft. The width of 1.0-ft is a concrete parapet wall that extends across the embankment.

**Emergency Action Plan:** Not Approved  
**Format:** No Plan  
**OMI:** No  
**Last Entry:** 4/24/2014
This dam must have an operation, maintenance, and inspection manual (OMI) and an up-to-date emergency action plan (EAP). Prepare an OMI and update the EAP and submit for approval. Guidelines for the preparation of these documents are included with this report.

**Ohio Department of Natural Resources**

**Division of Soil and Water Resources**

**Fact Sheet**

**Fact Sheet 96–39**

**Dam Safety: Annual Fee**

Under the compliant dam discount program, the Chief may reduce the amount of the annual fee that an owner of a dam is required to pay if the owner is in compliance with section 1521.062 of the Revised Code and has developed an emergency action plan pursuant to standards established in rules adopted under this section.
CONCLUSIONS

Address hazard creep
- Educate – Private dam owners
- Mitigate – Avoid development
- Modernize – Improve dam spillways
- Prepare – Have contingency plans
- Respond – Emergency services
- Recover – Remove or rebuild

Understand how current land use and the 2013 Ohio PMP impact your dam

Create and maintain EAP & OMI
ANY DAM QUESTIONS?

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jlawson@envdesigngroup.com
Akron | Cleveland | Columbus

https://damsafety.org/

http://water.ohiodnr.gov/safety/dam-safety