

Low-head Dams

(a.k.a. Drowning Machines)



What are Low-head Dams?

- Small Overflow Structures
- Various Functions
- Located Everywhere
- Attractive Nuisance
- Non-Jurisdictional



Low-head Dams: Structures

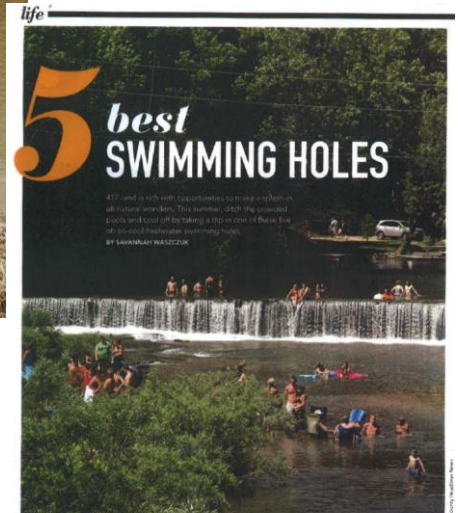
- Masonry, Concrete
- Crest
- Wing Walls
- Foundation



Low-head dams: Function

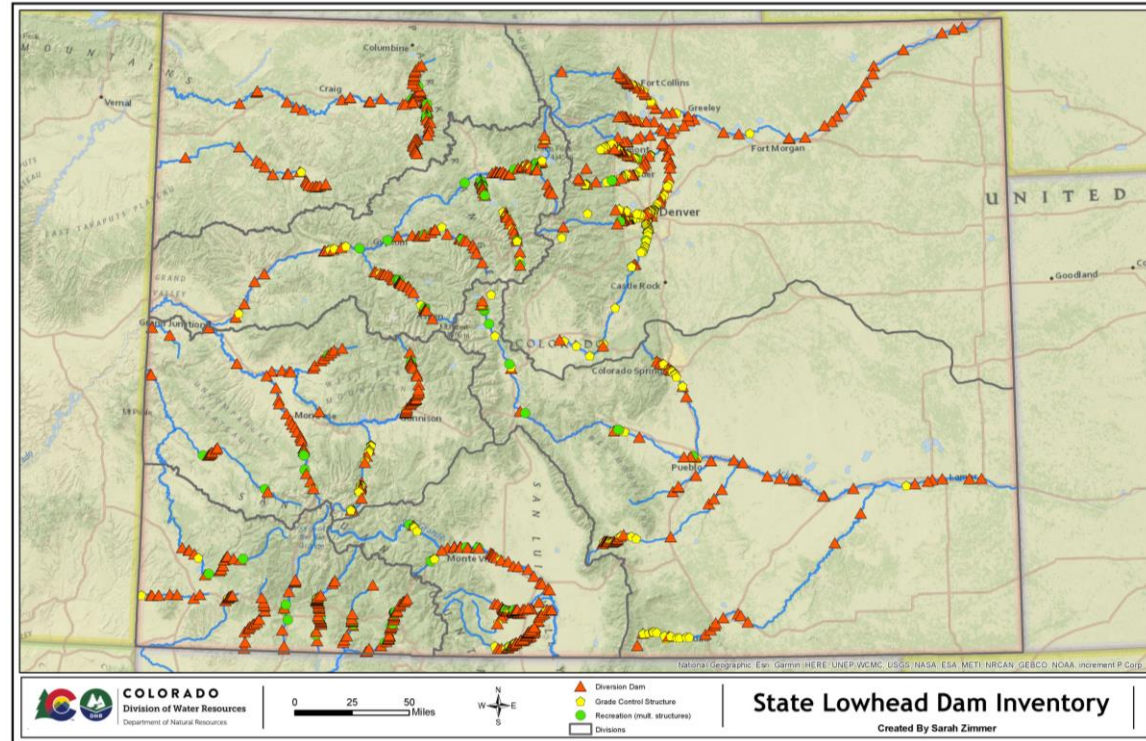
To create a reliable upstream water surface elevation for:

- Power
 - Mill Dams
 - Hydroelectric Facilities
- Diversion
 - Irrigation
 - Municipal Water Supply
- Channel Grade Control
- Aesthetics/Recreation



Low-head Dams: Location




The location of many low-head dams is unknown. Some states are working to identify these hazards.

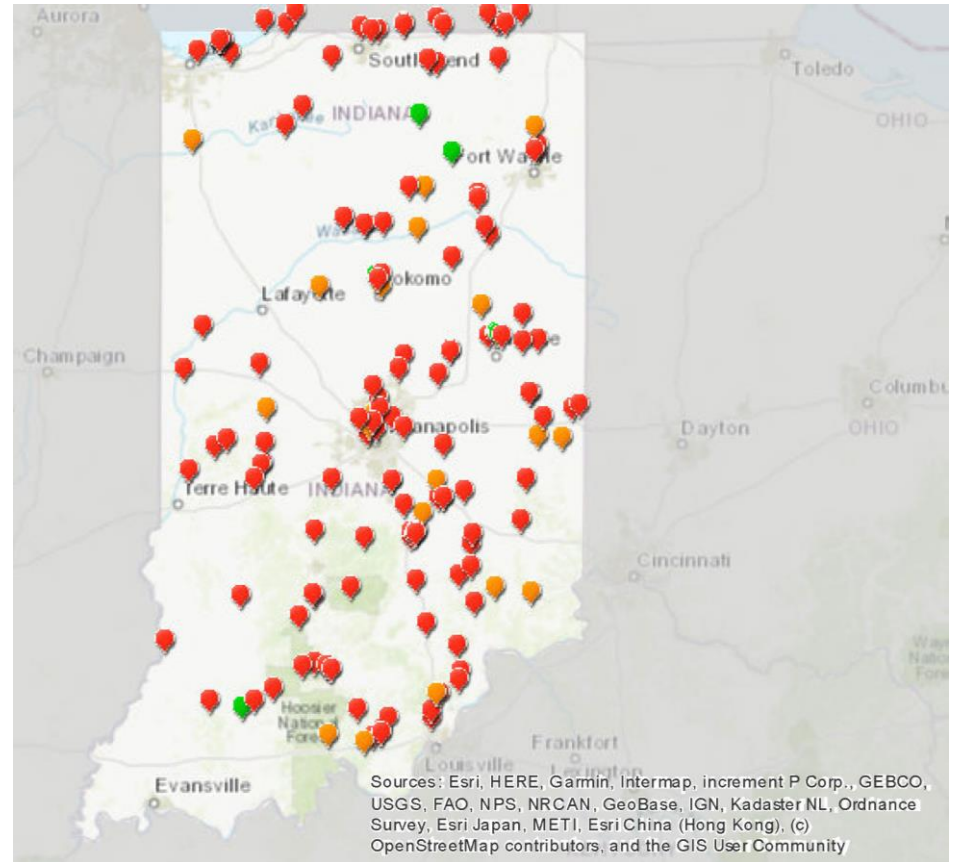


Colorado Department of Natural Resources Low-head Dam Safety Initiative

Low-head Dams: Location

Low-Head Dams

-  Intact
-  Partial
-  Removed (residual material may remain)



Indiana Department of Natural Resources Low-head Dam Awareness

Low-head Dams: An Attractive Nuisance

- Appears Innocuous
- Enticing Challenge for Kayakers, Canoeists, & Tubers
- Unpredictable
- Rescue Nearly Impossible



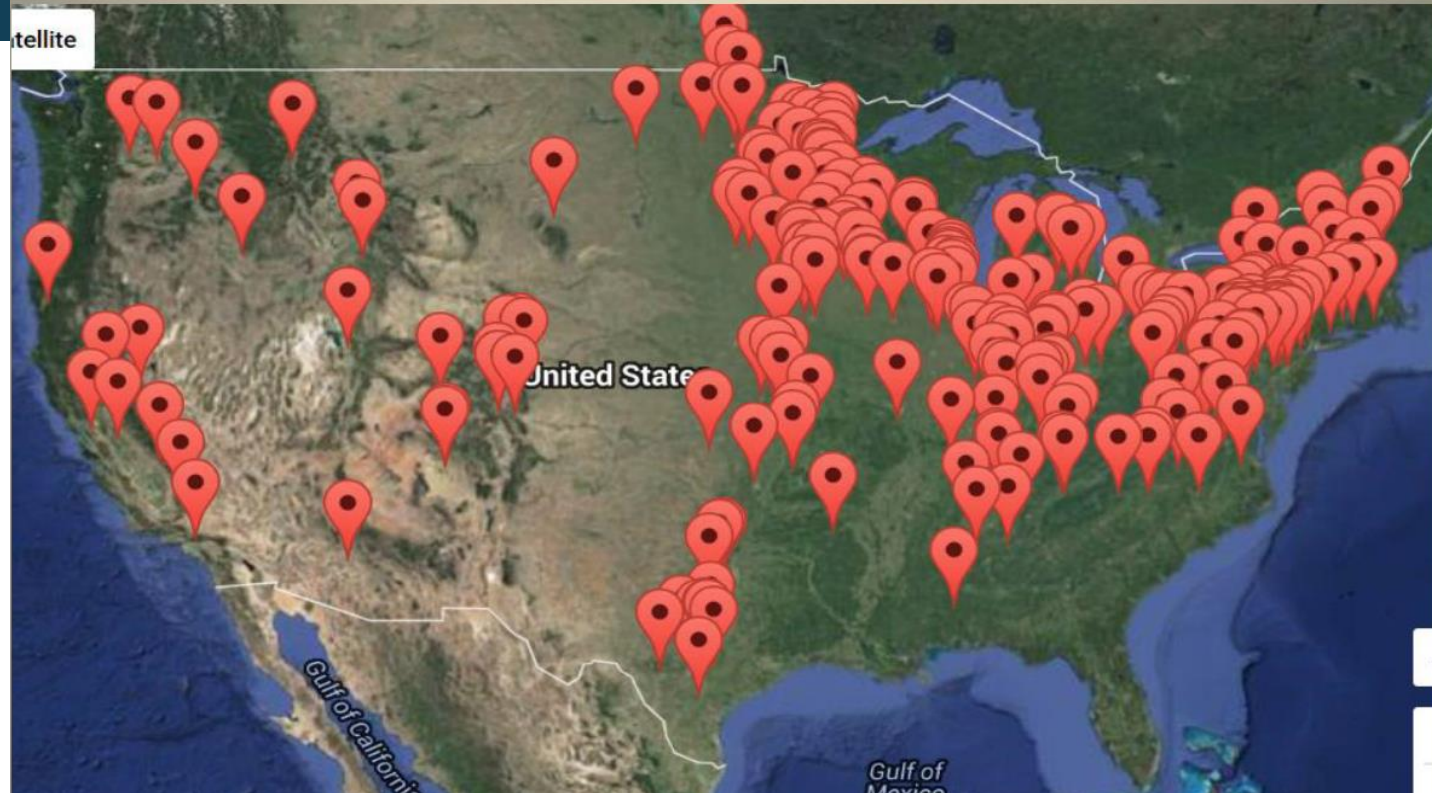
Video Clip – Binghamton, NY - 1975



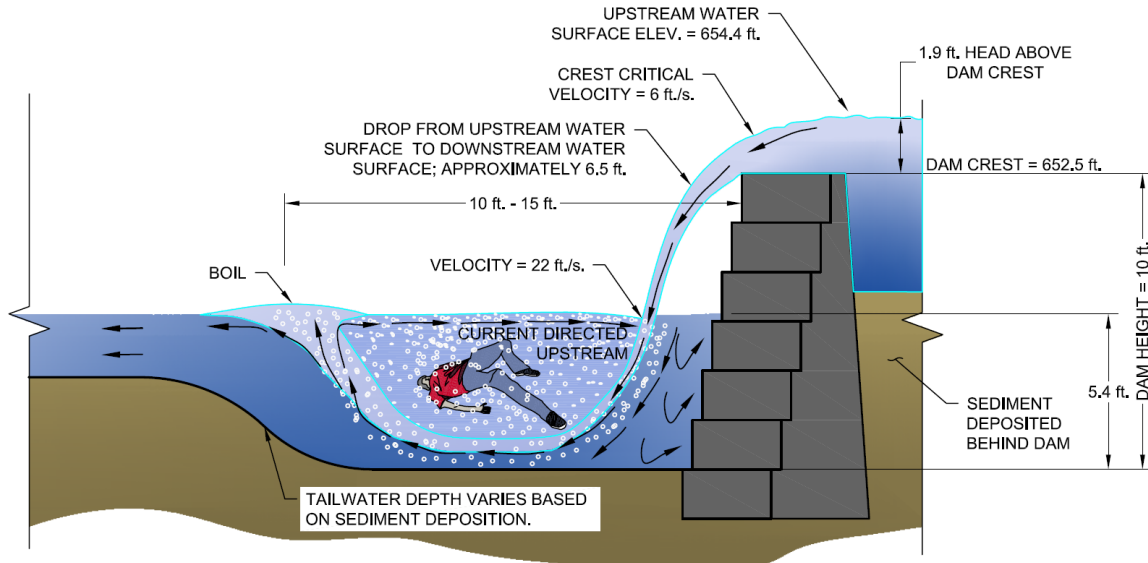
The Result

1,400+ fatalities have been reported throughout the United States²

There are likely many more incidents that have not been classified as low-head dam related incidents

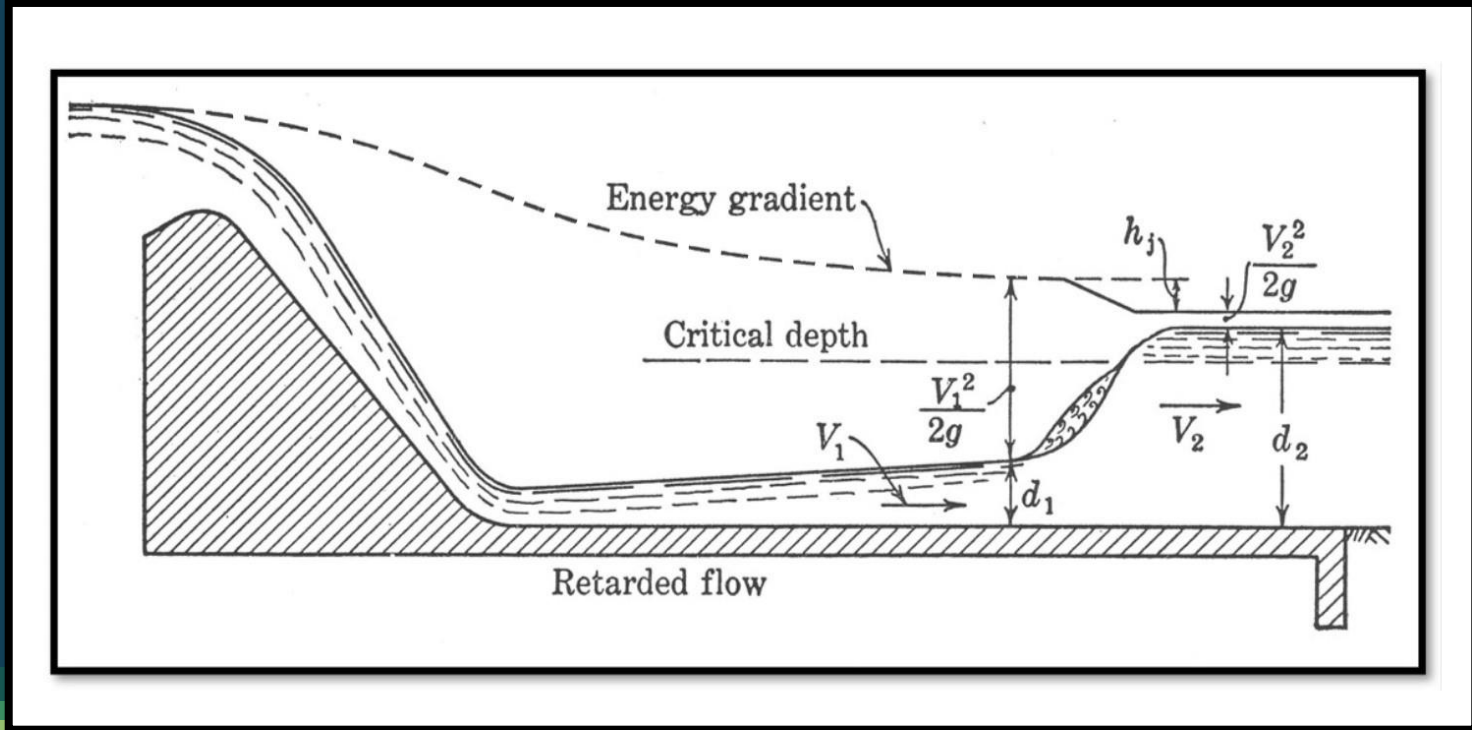


The Result = “Drowning Machines”

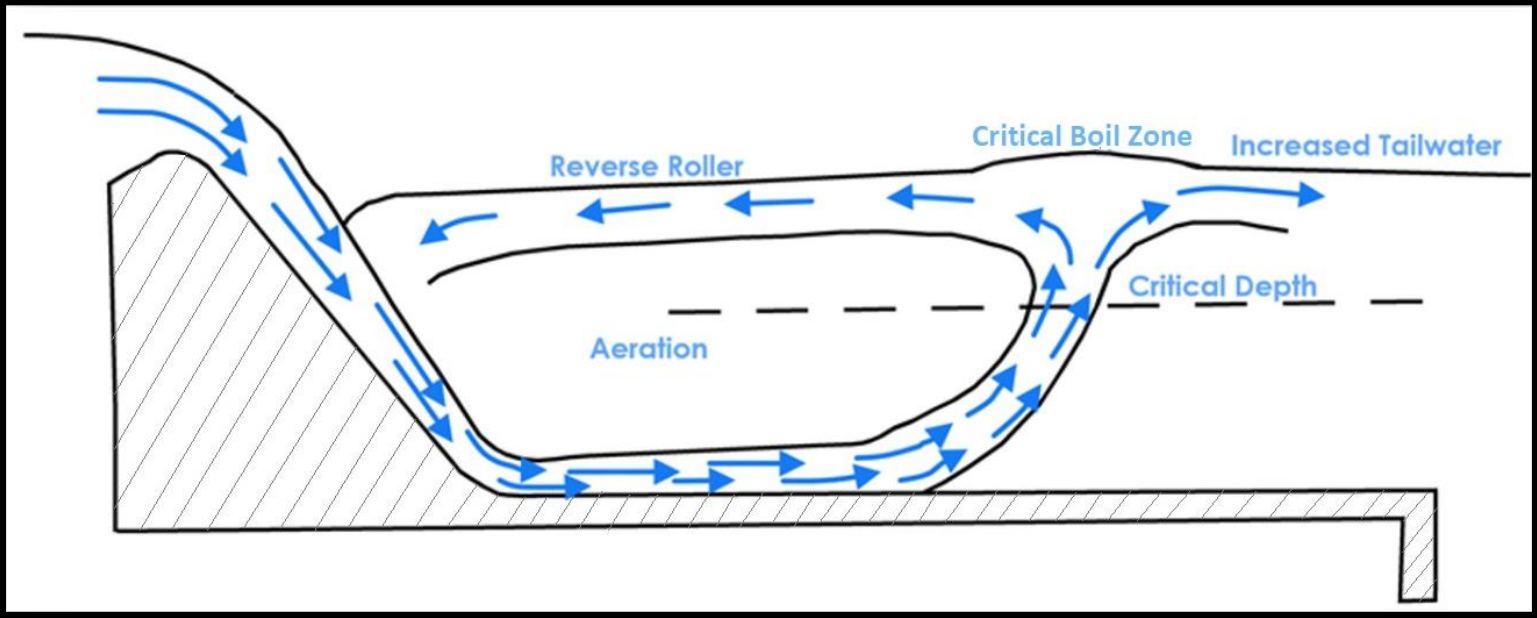


- Reduced Buoyancy – due to air entrainment
- Continuous and Forcible Dunking
- Reverse Current – traps victims
- Additional Concerns – debris, hypothermia, disorientation

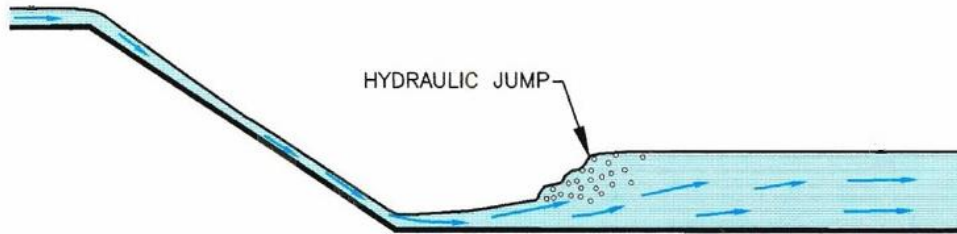
Normal Hydraulic Jump



Submerged Hydraulic Jump



Four Cases of Tailwater Depth

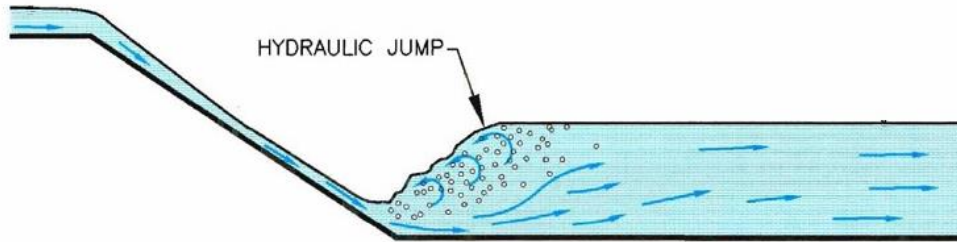


HYDRAULIC JUMP

LITTLE ENTRAPMENT POTENTIAL

CASE I

- LOW TAILWATER WITH SWEEP-OUT JUMP
- PERSONS WILL USUALLY BE SWEEPED DOWNSTREAM



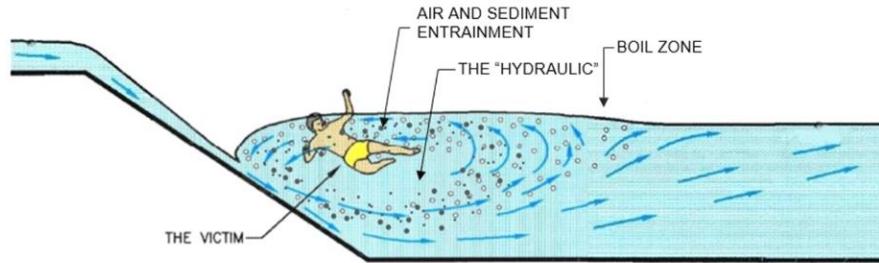
HYDRAULIC JUMP

MODEST ENTRAPMENT POTENTIAL

CASE II

- NORMAL TAILWATER WITH OPTIMUM JUMP.
- MODEST ENTRAPMENT FOR PERSONS, ALTHOUGH LOGS AND SIDEWAYS CANOES CAN GET TRAPPED IN SMALL "HOLE".

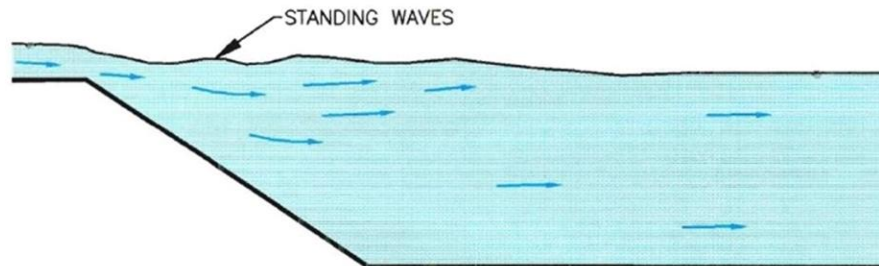
Four Cases of Tailwater Depth



HIGH ENTRAPMENT POTENTIAL
EXTREME HAZARD WITH TRANQUIL APPEARANCE

CASE III

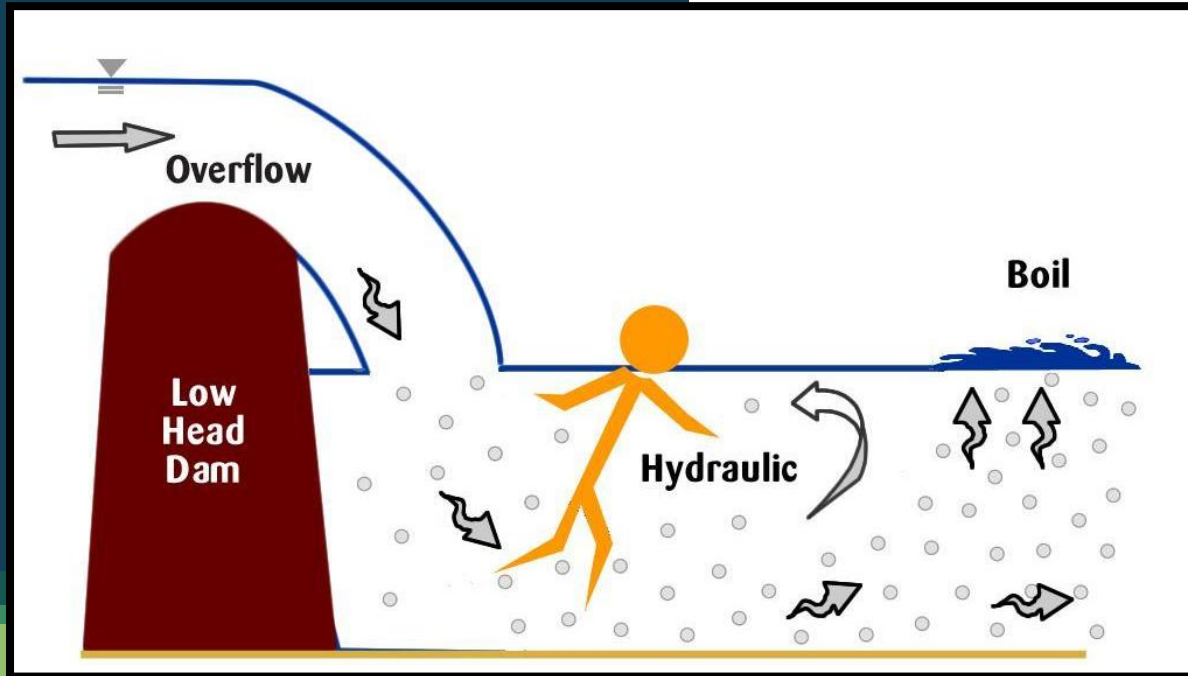
- HIGH TAILWATER WITH SUBMERGED HYDRAULIC JUMP
- THE RESULTING "HYDRAULIC" WILL TRAP A PERSON IN THE REVERSE ROLLING CURRENT IF THEY CROSS THE BOIL
- RESCUE BOATS WILL BE "SUCKED" TOWARDS DAM
- DIVING TO THE BOTTOM COULD CAUSE THE PERSON TO BE CARRIED DOWNSTREAM TO SAFETY



CASE IV

- VERY HIGH TAILWATER ASSOCIATED WITH HIGH FLOWS INUNDATES THE STRUCTURE
- NO HYDRAULIC JUMP OCCURS
- NO UNUSUAL HAZARD TO PERSONS OR BOATS

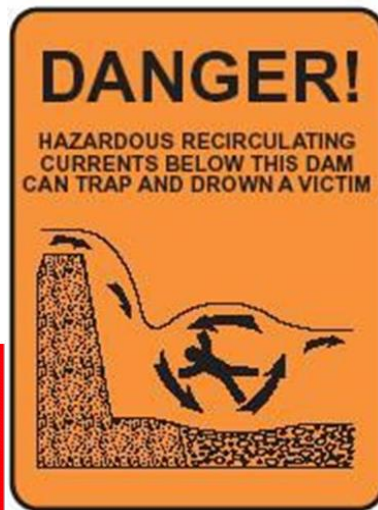
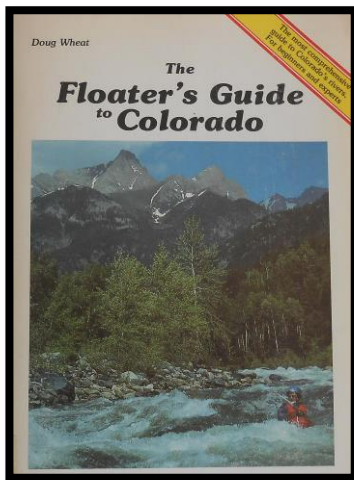
Low-head Dam Entrapment Illustration



- Dunking Force on victim is ~ 200 lbs
- Reverse Current is ~ 4 ft/sec
 - Average swimmer speed < 3 ft/sec
- Buoyance Reduction is ~ 10% (struggle to stay afloat)

Solutions

- Signage
- Guidebooks
- Rehabilitation
- Removal
- Design Considerations



This dam may be dangerous due to strong currents and turbulent water above and below the dam that can trap and drown a person.

Any person who enters these waters on the upstream or downstream side where marked commits a summary offense and is subject to a fine.

Fishing is permitted from banks unless otherwise posted

Penalty for Violation as Provided by Law – Pennsylvania Fish and Boat Commission

Solutions: Precautions to Recreationists

- Use caution if swimming or fishing near low-head dams
- Always carry canoes, kayaks, and tubes around low-head dams
- Do NOT jump in to rescue someone else
- If trapped in the “hydraulic”
 - Shed your life vest
 - Dive to the bottom and swim downstream



Solutions: Precautions to Engineers



Before



After

Modify existing dams to improve safety

How Can You Help?

Contact One or More of the Following Officers:

- Rollin Hotchkiss
rh@byu.edu
- Brian Crookston
brian.crookston@usu.edu
- Manuela Johnson
mjohnson@dhs.IN.gov

Assist a Task Force to create a national inventory of low-head dams in the U.S.

- ❑ Contact states to help accumulate their existing inventories
- ❑ Use Google Earth Pro to find low-head dams
- ❑ Help develop, disseminate and use phone apps for documenting low-head dams in the field (<https://mobile.lowheaddam.org/> to download)
- ❑ Using artificial intelligence and/or machine learning to locate low-head dams
- ❑ Contribute to a website devoted to this purpose

Additional Resources

- **Association of State Dam Safety Officials (ASDSO)**
www.damsafety.org/public-safety
- **Wright Water Engineers, Inc.**
www.wrightwater.com
- **Brigham Young University**
dams.byu.edu
- **Low-head Dams: Hidden Dangers Video**
<https://youtu.be/AcrInFgD8gA>

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