INDIANA EMBANKMENT DAM HAZARDS LARGELY UNKNOWN AND UNDER-APPRECIATED

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Under current Indiana code for embankment dams (IC 14-27-7.5), dam owners are responsible for the operation, maintenance and safety of their dams. There are very few local ordinances, and no state codes, that address zoning, land use and permitting for lands within dam failure flood risk areas downstream from embankment dams that are typically larger than the 1 percent chance floodplain limits (regulatory floodplain, 312 IAC 10; also the flood insurance requirement zone). Those currently living within flood risk areas downstream of dams are overwhelmingly unaware of the risk that these dams pose to their lives and their properties.

In Indiana, state emergency planning and response are directed by the Indiana Department of Homeland Security (IDHS). In its 2008 Hazard Mitigation Plan, IDHS noted:

> *Dam and Levee Safety is an issue of growing national, regional and State importance. Dams are inherently hazardous structures because of energy that can be released by elevated/stored water. Many dams and levees in the State have deficiencies that will result in an emergency situation leading to a possible breach failure during an unusual loading condition such as a substantial rainfall event.*
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> *If dams or levees fail issues of primary concern include loss of human life/injury, downstream property damage, lifeline disruption (of concern would be transportation routes and utility lines required to maintain or protect life), loss of resource purpose and benefits, and environmental damage. Further, the threat of dam or levee failure requires substantial commitment of time, personnel, and resources.*
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> *Since dams and levees deteriorate with age, minor issues become larger compounding problems and the risk of failure increases. Further, the downstream areas become more populated and developed risking more lives and property, and escalating mitigation and rehabilitation costs. Like many critical infrastructure projects, dams and levees are also potential terrorist targets.*
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> *The failure of a dam or an important component of a dam may cause substantial flood damage. Depending on the size of an impoundment and the severity of a dam failure, the flood inundation area may be substantially deeper and larger than areas identified as 100-year flood plains for insurance purposes. The lack of the flood insurance flood plain maps to account for inundation due to dam failure is a problem common to all 75,000 (now known to exceed 90,500) plus regulated dams in the United States.*
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> *As the dam building era was more than 40 years ago, the inventory of dams is greatly aging and dams are deteriorating. Component and total failures of dams are becoming more common in the State. Additionally, with time residential development continues to increase near water resource features, thus increasing the number of individuals and property at risk due to dam failures. This development also is causing the hazard classification of existing dams to creep up. Dams that were designed and built to function as low hazard structures, because of uncontrolled downstream development now function as high hazard dams.*

One can see where development activities downstream from a dam can increase the potential risk from impounding water in an embankment structure without knowledge or involvement of the respective dam owner. Hazard classification in Indiana is a rating of relative risk to life and property if a dam would fail suddenly.

> *IC 14-27-7.5-2 "Hazard classification" Sec. 2. As used in this chapter, "hazard classification" means a rating assigned to a structure by the department based on the potential consequences resulting from the uncontrolled release of its contents due to a failure or misoperation of the structure. As added by P.L.148-2002, SEC.15. [Note: "department" above refers to the Indiana Department of Natural Resources, Division of Water (IDNR).]*

A development can quickly turn a low-hazard dam into a high-hazard dam. The expectation from IDNR then becomes that the dam must be rehabilitated by the owner, at the owner's expense. Along the same line, the construction of an embankment dam induces risk on downstream landowners, potentially without their knowledge, acknowledgement or consent.

The Indiana Flood Control Act (IC 14-28-1) regulates construction in an identified floodway. In fact, construction of residential structures is prohibited within floodways. By definition, a floodway is a portion of the overall floodplain. A floodplain is delineated by evaluating the effect of storms and events that have an annual risk of exceedance of 1 percent (in other words, a 100-year event). Most 1 percent floodplains are mapped in Indiana. However, potential dam failures are not considered a part of floodplain mapping. This creates a risk to landowners downstream of the embankment dam that is not routinely evaluated.

Risk areas downstream from dams are identified by calculating the area that would be flooded if a dam were to suddenly fail, or breach. The area covered by floodwater in a dam breach situation might be much greater than the associated 1 percent chance floodplain. The risk is frequently unknown or unrecognized by residents in the risk area and sometimes even the owner of the dam.

Dams that fall under the jurisdiction of the state regulatory body (IDNR, Division of Water) meet any of the following size criteria:

- Greater than or equal to 20 feet high
- Greater than or equal to one square mile contributing drainage area
- Store greater than or equal to 100 acre-feet of water

Dams that do not meet the size-based criteria for jurisdiction might still become jurisdictional if a written petition is filed by a concerned individual and the dam is found by the DNR to be a high-hazard structure. Each dam must meet stringent design criteria for total spillway capacity. Low- and significant-hazard jurisdictional dams must have total spillway capacity that can safely pass a 50 percent probable maximum precipitation (PMP) storm event without uncontrolled overtopping of the dam embankment. Storms by which spillway capacities of dams are judged are two to four times that of a 1 percent chance event (AKA a 100-year event).

If an embankment dam is determined to pose a high risk to life and property downstream (see definitions in code), they must meet the high-hazard design criteria, which is much more stringent. A high-hazard dam must safely pass a 100 percent PMP storm event without uncontrolled overtopping of the embankment. Very few high-hazard dams in Indiana meet a PMP spillway capacity criterion. It can be quite expensive to upgrade or modify a dam to meet this criterion.

As the size-based jurisdictional limits have existed for several decades, many dams in Indiana have been constructed such that they are just short of the threshold height criteria (20 feet), yet they still pose risk of loss of life and property downstream. They are technically high-hazard dams but were not permitted and not inspected. As a result, many of these types of dams have been designed, constructed and maintained at a sub-standard condition, posing higher safety concerns than the dams that are regulated. Frequently, when found or reported as a "failing dam," they are in very poor condition. The cost of rehabilitation would be high and the state and county have no authority to compel the owner to repair or remove the dam.

Many municipal government entities in Indiana have a multi-hazard mitigation plan in place. Most of those plans do not include accommodations or actions needed for an incident or emergency relating to dams in their communities, as the intent of the multi-hazard mitigation plan is for mitigation, rather than prevention or response actions. Grant-funded efforts by the Federal Emergency Management Agency (FEMA) through IDNR and by the Indiana Office of Community and Rural Affairs (OCRA) through IDHS have recently been completed to develop Incident and Emergency Action Plans (IEAP) for about 100 high-hazard dams, but the effort is far from inclusive of all high-hazard dams in the state. Even after development of the IEAP, implementation and activation are largely in the hands of the dam owners (as is IEAP document updating and coordination of IEAP tabletop exercises with first responders and stakeholders).

What do we do with this information? Ordinance requirements can be added requiring considerations for dams and levees. Refer to the 2016 revisions of the Boone County, Indiana, Stormwater Technical Manual, Chapter 10, Sections E and F titled "Requirements Associated with Dams and Levees" and "Requirement Associated with Proposed Developments Downstream of Dams." (www.boonecounty.in.gov/Offices/Surveyor/Drainage-Ordinances)

For additional Information on safety considerations relating to embankment dams, refer to: https://damsafety.org and www.in.gov/dnr/water/2458.htm.

Indiana code relating to dams can be found in Indiana Code 14-27-7.5 and 312 IAC Article 10.5.