North Dakota Office of the State Engineer

Emergency Action Plan Guidelines for Dams

I. Introduction

An Emergency Action Plan (EAP) is "a formal document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize loss of life and property damage".[1]

North Dakota Century Code (N.D.C.C.) Section 61-03-25, which became effective August 1, 2015, states:

> *"The owner of a high-hazard or medium-hazard dam shall develop, periodically test, and update an emergency action plan to be implemented if there is an emergency involving the dam. The emergency action plan and any subsequent updates must be submitted to the state engineer for approval."*

This purpose of this document is to provide additional guidance for developing, testing, and updating EAPs in order to comply with N.D.C.C. Section 61-03-25.

EAP's are the responsibility of the dam owner. However, the dam owner will need to hire a qualified registered professional engineer to prepare inundation mapping for their dam, which is one component of the EAP as discussed in more detail later in this document. Typically, the dam owner will have their engineer prepare the entire EAP.

Development of the EAP must be coordinated with local emergency management authorities. Copies of the completed EAP should be provided to local emergency management authorities and the ND Office of the State Engineer.

II. Format of an EAP

An EAP should contain the following basic information:

- Procedures to assist the dam owner in detecting and evaluating an emergency situation at the dam
- Responsibilities and expected actions of all parties involved in responding to an emergency at the dam
- A map identifying downstream areas that could be impacted by a dam failure (see section III of this document for further details)

- ☐ A communications directory and notification flowchart. Because the appropriate response may differ depending on the level of emergency, a notification flowchart should generally be prepared for each of the following scenarios:
    - An unusual event that is slowly developing
    - A potential dam failure situation that is rapidly developing
    - An urgent event with dam failure imminent or in progress
- ☐ A description of emergency remedial measures that can be taken to moderate or alleviate a problem at the dam
- ☐ A list of locally available resources and contractors that can be utilized in the event of an emergency at the dam
- ☐ Site specific information such as access to the dam, including alternate access routes in cases where the main access may be flooded during an emergency

The recommended basic format for an EAP is available in a template developed by the Natural Resources Conservation Service (NRCS). This template is available on the ND State Water Commission website at http://www.swc.nd.gov/reg_approp/damsafety/. While the basic format in this template is recommended, it can be modified as needed for the specific situation.

Additional general guidance on developing an EAP is available in the document "*Federal Guidelines for Dam Safety – Emergency Action Planning for Dams*", FEMA 64, July 2013. This document is also available on the ND State Water Commission website at http://www.swc.nd.gov/reg_approp/damsafety/.

III. Inundation Mapping

One of the most important components of an EAP is a map identifying potential downstream impacts if the dam were to fail, including homes, roads, and other infrastructure. This map helps dam owners and emergency management authorities identify infrastructure and population-at-risk that may require warning, evacuation, or other protective measures. The required level of analysis for the map differs depending on whether it is for a high hazard or medium hazard dam. The requirements for each are discussed further below.

A. High Hazard Dams

The EAP for a high hazard dam must include an inundation map showing the area that would be inundated by a dam failure. The inundation map must be prepared by a professional engineer registered in North Dakota. The engineer must have experience in hydrology and hydraulics, including modeling of unsteady flow and dam failure modeling. The inundation map for a high hazard dam must be based on a dam break model, using a hydraulic model such as HEC-RAS that is capable of unsteady flow

routing. The use of a 2D hydraulic model, such as HEC-RAS 2D, is acceptable and is encouraged in situations where the conditions warrant the use of such a model. Field surveyed cross-sections or LIDAR data should be used in the model as necessary to adequately define the area downstream of the dam.

Inundation mapping should be prepared for a dam failure under both normal "sunny day" operating conditions and flood conditions. The sunny day failure assumes that the dam fails with the reservoir and inflow at normal operating levels. For the flood condition failure, the dam is assumed to fail during a flood event. The inflow to the reservoir is assumed to be the probable maximum flood (PMF) or other technically justifiable value such as the inflow design flood (IDF). Failure of a dam during a flood event will result in downstream inundation at higher elevations and will result in additional impacts compared to a sunny day failure. Other model assumptions are left to the judgment of the engineer, but must be technically sound and justifiable.

The flood wave must be routed downstream to a point where the floodwaters are contained within the channel banks, or to a point where the floodwaters no longer present a hazard to life or property. For a failure during the PMF or IDF, the flood routing may be stopped at a point where the incremental impacts resulting from the dam failure no longer present a hazard to life or property.

In order to model the flood failure scenario, the reservoir inflow hydrograph must be determined for the flood event to be modeled. This hydrograph must be determined by an updated, or verifiable, hydrologic analysis. Specifically, the hydrology given in the National Dam Safety Program Phase I Inspection Reports, prepared for many dams in the late 1970's and early 1980's, is not acceptable unless verified. A suitable program such as HEC-HMS must be used for the hydrologic analysis.

The inundation map should identify and label all downstream hazards that are within the inundation zone. The map should also show the estimated travel time and depth at selected locations. Further guidance on preparing inundation maps is available in the document "*Federal Guidelines for Dam Safety – Emergency Action Planning for Dams*", FEMA 64, July 2013. This document is available on the ND State Water Commission website at http://www.swc.nd.gov/reg_approp/damsafety/.

B. Medium (Significant) Hazard Dams

The EAP for a medium, or significant, hazard dam must include a map of potential downstream hazards identifying homes, roads, and any other infrastructure that could be impacted by a dam failure. A dam break model is not required to prepare the map. However, the map must be prepared by a professional engineer registered in North Dakota with experience in hydrology, hydraulics, and dam failure analysis. Downstream hazards can be identified based on engineering judgment and a field

review of the downstream area. The map must identify and label all downstream hazards.

For some dams, it may be very difficult to adequately identify all potential downstream hazards without a detailed dam break model as described above for high hazard dams. In those cases, it is up to the engineer and the dam owner to judge whether the use of a simplified downstream hazards map is appropriate, or whether more detailed inundation maps are needed.

IV. EAP Exercises

The purpose of an EAP exercise is to familiarize participants with the dam, the contents of the EAP, and their roles and responsibilities during an emergency at the dam. The dam owner is responsible for exercising the EAP, but may do so with assistance from their engineer or from local emergency management authorities.

There are various levels of EAP exercises that can be conducted, ranging from simple discussion-based exercises where key personnel meet in a conference room type setting, to a full-scale exercise where a realistic dam failure scenario is played out. For the purposes of N.D.C.C. Section 61-03-25, a simple discussion-based exercise is all that is required.

The simplest form of a discussion-based EAP exercise is a coordination meeting between the dam owner and emergency management officials. The coordination meeting consists of a discussion to familiarize the meeting participants with the dam and the contents of the EAP. A tabletop exercise takes the coordination meeting one step further. In a tabletop exercise, a potential emergency scenario is described and required actions are discussed. The coordination meeting or tabletop exercise provides an opportunity to improve coordination between the participants, assess the adequacy of the EAP and reveal any changes that may need to be made, and clarify the roles and responsibilities of all involved parties.

An EAP exercise for a dam should be held at least once every five years. In areas where the same local emergency management officials would be involved with multiple dams, a regional exercise covering multiple dams may be organized.

V. EAP Updates

Periodic updates are necessary to ensure that the EAP is effective in an emergency. Contact information in particular can quickly become outdated and ineffective. The EAP should be reviewed annually and updated as needed. The dam owner is responsible for updating the EAP document, with assistance from their engineer as desired.

Contact information in the EAP should be verified as part of each review by calling the contacts to verify that the phone numbers and persons in the specified positions are current. The EAP should also be revised as necessary based on improvements identified in the EAP exercise. Inundation maps and contact information may need to be updated if new development occurs in the downstream area.

Copies of all EAP updates should be provided to everyone who has a copy of the EAP, including local emergency management authorities and the ND Office of the State Engineer.

VI. Changes in Hazard Classification

The hazard classification of a dam can change over time due to changes in development downstream of the dam. When the classification of a dam changes from low hazard to medium hazard or high hazard, an EAP must be completed for the dam in accordance with N.D.C.C. Section 61-03-25 and the requirements outlined in this document.

If a medium hazard dam with an existing EAP is upgraded to a high hazard dam, the inundation mapping in the EAP must be updated to meet the requirements for a high hazard dam, as outlined in this document.

VII. A Note on Low Hazard Dams

Although not required, owners of low hazard dams are encouraged to develop a simplified EAP for their dams. The EAP for a low hazard dam may consist of only a notification list of individuals and agencies to be contacted upon dam failure. An EAP for a low hazard dam can be completed by the dam owner.

For more information, contact the
North Dakota Dam Safety Program
Karen Goff, P.E., Dam Safety Engineer
(701) 328-4953
kgoff@nd.gov

[1] "*Federal Guidelines for Dam Safety – Emergency Action Planning for Dams*", FEMA 64, July 2013.