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Operations and Services
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WEATHER FORECAST OFFICE HYDROLOGIC OPERATIONS

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SUMMARY OF REVISIONS: This directive supersedes NWS Instruction 10-921, "*Weather Forecast Office Hydrologic Operations,*" dated December 1, 2011. Changes made to reflect the NWS Headquarters reorganization effective on April 1, 2015.

The following revisions were made to this instruction:

1) Changed all occurrences of Hydrometeorological Prediction Center (HPC) to Weather Prediction Center (WPC).
2) Updated URL to AWIPS or PC-based application for dam failure rules of thumb.

Signed 9/14/2017
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Weather Forecast Office Hydrologic Operations

Table of Contents Page

1. Introduction. This directive specifies national instructions for hydrologic operations at the National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS) Weather Forecast Offices (WFOs). Its purpose is to achieve basic operational consistency among all WFOs, while providing flexibility in appropriate areas for operations to meet unique partner/user requirements in each county warning and forecast area (CWFA) and hydrologic service area (HSA). Instructions on content of WFO hydrologic products are contained in NWS Instruction 10-922, *Weather Forecast Office Hydrologic Products Specification* (NWS Instruction 10-922) and NWS Manual 10-923, *Weather Forecast Office Hydrologic Product Examples* (NWS Manual 10-923). This directive covers the operations conducted to produce those products and other services.

2. Staff Operational Responsibilities. Hydrologic operations are a team effort of the WFO staff as described in this section.

2.1 Meteorologist In Charge. The meteorologist in charge (MIC) is ultimately responsible for the quality of WFO hydrologic services. The MIC sometimes represents the WFO hydrology program at media briefings or other high-level meetings with partners/users, but delegates most program leadership responsibilities to the service hydrologist or hydrology focal point.

2.2 Service Hydrologist. Selected WFOs have a service hydrologist to serve as the Hydrology Program Manager (HPM) for their office. In coordination with the warning coordination meteorologist (WCM), the service hydrologist reviews requirements of partners and other users, assesses hydrologic forecast and warning services, and makes improvements to WFO hydrologic operations and services to meet requirements and recommendations. In coordination with the science and operations officer (SOO), the service hydrologist provides training to WFO staff on operational hydrologic responsibilities such as issuance of river forecasts and flood warnings. He/she performs program leadership tasks requiring in-depth hydrologic expertise. In some cases, a service hydrologist is designated to support the hydrology program for one or more nearby WFOs. This typically involves training, applications support, and partner/user interaction for the supported WFO in collaboration with the supported office's hydrology focal point (see section 2.3).

As the office's HPM and member of the WFO operational team, the service hydrologist also works operational shifts, if qualified, up to 20 percent of the annual work hours. Service hydrologists supporting more than one WFO should be assigned lesser operational shift work commensurate with their increased responsibilities.

2.3 Hydrology Focal Point. Each WFO not having a service hydrologist position designates a hydrology focal point from their operational staff to serve as their HPM. The hydrology focal point receives assistance and support from a service hydrologist at a nearby office. He/she performs most routine support functions for the WFO's hydrology program and coordinates activities requiring in-depth hydrologic expertise with the supporting service hydrologist. In coordination with the SOO, the hydrology focal point provides training to WFO staff on operational hydrologic responsibilities. It is recommended that the hydrology focal point work at least 20 percent of their annual work hours on HPM duties. From here on in this directive, service hydrologists and hydrology focal points are collectively referred to as HPMs.

2.4 Meteorological Forecasters. Meteorological forecasters are primarily responsible for WFO hydrologic operations, including monitoring the hydrometeorological situation, anticipating hydrologic threats (e.g., rising river stages, excessive precipitation) and the appropriate NWS response (e.g., watches, warnings), and preparing and issuing scheduled and event-based hydrologic products.

2.5 Warning Coordination Meteorologist. The WCM works with the HPM in coordinating hydrologic products and services with partners and other users and educating them about the NWS Hydrologic Services Program. In coordination with the HPM, the WCM assesses how well the WFO is prepared to conduct meteorological and hydrologic operations, with a specific emphasis on the effectiveness of warning applications. The WCM is usually the leader of service evaluations and related activities, which are conducted following extreme hydrologic/ hydrometeorologic events in the WFO area. The WCM collaborates with the HPM when hydrologic expertise is needed during these activities. In coordination with the HPM, the WCM also works with the service coordination hydrologist(s) (SCH), who provides WFOs with technical guidance and training assistance needed for effective hydrologic science and service outreach.

2.6 Science and Operations Officer. The SOO, as overall science and training leader of the WFO, works with the HPM to conduct hydrologic training for the office staff. The SOO works with regional headquarters, development and operations hydrologist(s) (DOH) and SCH(s) at supporting River Forecast Center(s) (RFC), and the HPM to develop a training and professional development plan for the HPM.

2.7 Observing Program Leader. The Observing Program Leader (OPL) has overall responsibility for observation collection activities in the WFO's CWFA and HSA. The OPL ensures the office's observation quality control (QC) program is providing the best possible data to support WFO hydrologic operations. The OPL is responsible for the efficient operation of cooperative stations within the CWFA and HSA. OPL duties associated with the QC program include, but are not limited to:

a. Monitoring and reviewing observations.

b. Taking corrective action to resolve problems as appropriate.

c. Conducting station inspection visitations.

2.8 Hydrometeorological Technician. Hydrometeorological technicians (HMT) are responsible for data collection, QC, and dissemination. They also support administration of the hydrology program. Under the oversight of a senior forecaster, HMTs may also prepare and issue routine hydrologic products, event-driven flood/flash flood products, and related informational products.

3. WFO Hydrologic Functions. WFOs have five primary hydrologic functions: (1) hydrologic forecast and warning operations; (2) hydrology program leadership activities; (3) RFC support; (4) hydrologic/hydrometeorological data program management (includes observation network oversight, data collection, and QC); and (5) interagency support (includes forecast and data exchanges).

3.1 Hydrologic Forecast and Warning Operations. WFOs prepare and disseminate forecast and warning products for rivers, streams, and/or areas as part of the integrated operations performed by all staff. These products are described in *NWS Instruction 10-922* and *NWS Manual 10-923*. WFO hydrologic forecast and warning operations involve a variety of thought processes, actions, and tasks, including (but not limited to):

a. Maintaining continuous situational awareness, considering all possible causes of flooding in the CWFA and HSA. Monitoring radar and all other available hydrologic and meteorological data, applying techniques and principles learned in flood/flash flood operations training, and evaluating whether those causes are or could be leading to flooding.

b. Performing mesoanalysis of environmental data trends for areas near existing storms as part of the process in determining potential for flooding.

c. Reviewing RFC products (discussions, forecasts, graphics, etc.) to obtain a briefing on antecedent conditions, current activity, and the outlook for future flooding.

d. Collaborating with other WFOs and the servicing RFC(s) regarding flood/flash flood potential, accuracy of radar-based precipitation estimates, accuracy of flash flood guidance, need for additional river model runs, and need for extended hours of RFC operation.

e. Evaluating the potential for development and evolution of convective precipitation areas and considering their possible operational impacts, applying knowledge of the biases of numerical model analyses and forecasts.

f. Briefing forecasters arriving for the next shift on the current hydrometeorological situation, covering recent rainfall, flash flood potential, current flooding, and forecast flooding.

g. Reviewing quantitative precipitation forecasts (QPFs) and coordinating WFO position with the WPC and RFC(s), as needed.

h. Ensuring quality of radar-based precipitation estimates for the WFO area, applying knowledge of the strengths and weaknesses of various applicable Z/R (radar reflectivity to rain rate) relationships.[1] Coordinating changes to any radar parameters with nearby WFOs and all affected RFCs.

i. Monitoring work station for receipt of products needed in hydrologic operations, including satellite-derived precipitation estimate messages, RFC hydrometeorological coordination messages (HCM), hydrometeorological discussions (HMD), and river forecasts (RVF). Ensuring the work station is set to trigger an alarm or alert upon receipt of these products.

[1] A Z/R relationship is an empirical formula that is used to estimate rainfall rates from reflectivity signal strength for certain radar sites.

j. Aggressively seeking rainfall/gage data, flood information, and spotter reports to validate radar estimates and assist in the flood/flash flood warning and verification processes.

k. Ensuring flood warning applications, such as FFMP, are displayed, monitored, and incorporated into the warning decision process.

l. Issuing flood/flash flood watch/warning/advisory/statement products, as needed.

m. Coordinating efforts with staff members engaged in severe weather operations to optimize AWIPS workstation use, and maximize the effectiveness of warning services for all types of events.

The lead forecaster on duty should maintain awareness of current and potential future hydrologic conditions in the WFO area and determine the need for one or more shift personnel (sometimes referred to as a flood analyst) to conduct the above-described thought processes, actions, and tasks associated with hydrologic operations.

3.1.1 Areal Hydrologic Warning Operations. WFO forecasters maintain a continuous hydrologic watch over their areas of responsibility, using decision-assistance tools to monitor observed precipitation, near-term QPFs, and flash flood guidance. When the potential or likelihood of flooding over an area (e.g., county or zone) is indicated, which is not accounted for in point-specific river/stream forecasts, appropriate areal hydrologic outlook, watch, warning, or advisory products are issued.

3.1.2 Hydrologic Forecast and Warning Operations for Forecast Points. The shared mission of WFOs and RFCs is to provide timely, accurate hydrologic forecasts and warnings. This requires collaborative operations and effective two-way communication to maximize the saving of lives and property. WFO forecasters maintain a continuous hydrologic watch over river/stream locations, where hydrologic forecasts are obtained from a supporting RFC or a local forecasting procedure. Such forecasts are provided where a user requirement has been identified for point-based forecasts and warnings, and sufficient real-time data, gaging station rating tables, and other required resources are available. When necessary, WFOs prepare and issue hydrologic forecast and warning products to the public for these points.

The forecast points for which hydrologic forecast and warning operations are conducted can be divided into small and large scales. In coordination with its associated RFC(s) and regional headquarters, each WFO will develop and maintain a mutually agreeable list of which forecast points fall into each of these scales. Some operational aspects of the distinction between small- and large-scale forecast points are as follows:

a. **Small-scale forecast points**: To support hydrologic forecast and warning operations for small-scale forecast points, WFOs may use RFC forecast values and/or output from local site-specific forecast procedures. WFOs and RFCs work together to develop and support these local site-specific forecast procedures and ensure they reasonably simulate observed streamflow values for small-scale forecast points. WFOs may produce, revise, or update hydrologic forecasts and

issue forecast and warning products for small-scale forecast points whenever they deem it appropriate.

b. **Large-scale forecast points**: RFC modeling for these rivers requires complex hydrologic simulations, which account for multiple sub-drainage inputs, multiple upstream tributaries, reservoirs, diversions, and/or channel hydraulics. WFO hydrologic operations for large-scale rivers involve incorporation of RFC forecast values into WFO flood products for forecast points (flood watches, warnings, and advisories for forecast points and associated follow-up products), for which locally acquired information is added to address impacts to nearby areas. A WFO may have a hydrologic procedure capable of generating forecasts for a few of these points. When preparing a hydrologic forecast or warning product for large-scale forecast points, a WFO may modify the forecast values provided by the supporting RFC. However, modifications are explicitly coordinated with the RFC unless an emergency situation exists, such as a communications outage, a rapidly changing event when time does not permit contacting the RFC, or an event is occurring when the RFC is closed or otherwise unavailable. During the coordination process, all reasonable effort will be made to arrive at a consensus, but in the unlikely event that agreement on proposed modifications to RFC forecast values cannot be reached, WFO forecasters will use the RFC values in the official forecast.

   If RFC forecast values are unavailable for a large-scale forecast point during an event, a WFO may issue appropriate preliminary forecast or warning products. Initial flood warnings may indicate the category of flooding if exact values are uncertain and it is critical to get the warning out in a timely manner. Such actions should be coordinated with the supporting RFC before the preliminary product is issued, unless an emergency situation exists as described above. If it was necessary to issue the preliminary product before it could be coordinated with the supporting RFC, the RFC will be notified once it is again available.

When it is determined that changes need to be made to WFO- or RFC-generated forecast values during production of point-based flood products, the changes will be made to the hydrologic database rather than the products to be issued. This ensures integrity of the Valid Time Event Code (VTEC) and consistency between forecasts displayed through the NWS's hydrology web presence and forecasts provided in WFO flood products.

3.2 Hydrology Program Leadership Activities. The HPM performs several hydrology program leadership activities in support of WFO hydrologic operations. At offices that do not have a service hydrologist position, some of these functions are divided between the hydrology focal point and the supporting service hydrologist from a nearby WFO.

3.2.1 Hydrologic Service Coordination. The HPM coordinates WFO hydrologic services and service requirements with associated RFCs, emergency management agencies, partners and other users, and the regional headquarters. These coordination activities are performed under the oversight of the MIC and in coordination with the WCM, and include (but are not limited to) the following:

a. Identifying and planning programmatic changes in WFO hydrologic products and services.

b. Determining product and service requirements of partners and other users in the HSA.

c. Evaluating sites and areas subject to floods and flash floods and leading the establishment of new hydrologic services for these locations.

d. Participating in appropriate planning meetings and related flood preparedness activities, such as dam failure exercises.

e. Setting requirements for the hydrologic data network.

f. Providing local hydrologic expertise, as appropriate, to facilitate decision support services (DSS) activities in which the WFO is engaged.

3.2.2 Hydrologic Forecast System Support. HPMs conduct several development and maintenance activities to support the WFO hydrologic forecast system (WHFS). These activities include, *but are not limited to*, maintaining the system (e.g., templates, data and metadata files); troubleshooting problems; establishing the local site-specific forecast procedure for small stream basins; updating hydrologic model parameters; expanding the local dam catalog; adding to flood history information in the hydrologic database; and conducting field work to populate the WHFS database with other location-specific information, which can be included in hydrologic products.

3.2.3 Support for NWS Hydrology Web Presence. The HPM conducts several development and maintenance activities in support of the NWS's hydrology web presence (currently referred to as the Advanced Hydrologic Prediction Service (AHPS) web page). These activities include generation of data, quality controlling station reference information to ensure accuracy and compatibility, and troubleshooting problems.

3.2.4 Operational Hydrologic Training. The HPM provides hydrologic/hydrometeorological training to operational staff. The goal is for all operational staff to be able to perform hydrologic forecast and warning operations and routine hydrometeorological duties in the WFO. These and other activities, such as administration of regionally/nationally developed teletraining and correspondence courses, are coordinated with the SOO and, when appropriate, DOHs at supporting RFC(s).

3.2.5 Hydrologic Reports and Specialized Forecast Products. The HPM prepares WFO hydrologic reports as described in NWS Instruction 10-924, *Weather Forecast Office Hydrologic Reporting*. HPMs also prepare specialized hydrologic forecast products as needed to meet user requirements in the HSA. After unusually damaging flood events, the HPM serves as the WFO hydrologic expert for service assessments.

3.2.6 Hydrologic Data and Network Support. The HPM is the WFO expert on data and networks, as they apply to hydrologic operations in the HSA. The HPM assists the OPL in supporting automated flood warning systems, mesonets, stream gaging networks, and Geostationary Operational Environmental Satellite system (GOES) data collection platform networks. When requested, they both assist partners in the setting of requirements, design, and

implementation of such networks. The HPM works with the OPL to maintain and establish stations in the "b" network operated by the Cooperative Observing Program.

3.3 River Forecast Center Support. In addition to regular coordination of hydrometeorological conditions with supporting RFCs, several operational activities conducted by WFOs support hydrologic modeling and forecast operations at RFCs.

3.3.1 Hydrometeorological Forecasts. Routinely produced WFO precipitation and temperature forecast information may be used by RFCs as input to their snowpack modeling operations.

3.3.2 Forecast Point Information. WFOs' hydrologic databases contain metadata for forecast points which are essential to RFC operations. These metadata, which are also provided on E-19/E-19a forms, include river and station name, location (e.g., latitude/longitude), alpha-numeric descriptor (e.g., NWS location identifier), flood stage, and flood impact (e.g., effects of flooding at various stages). These and other metadata, which are needed for river forecasting operations, will be transferred to the appropriate RFC(s) whenever forecast point description and history information are updated in the WFO hydrologic database.

3.3.3 Outreach to Partners and Other Users. As is feasible within existing resource limitations, WFOs collaborate with RFCs on efforts to improve hydrologic services to partners and other users. WFOs should coordinate ideas and proposals for improving hydrologic services with their supporting RFCs and regional headquarters.

3.3.4 WFO/RFC/WPC Collaboration. WFOs, RFCs, and the WPC should make collaboration and teamwork an intentional activity. Programs, initiatives, and ideas that advance NWS' hydrologic services should be identified, recognized, and shared. Each WFO should work with its supporting RFC(s) to develop a hydrologic collaboration plan to increase the sharing of technology and information, as well as to improve support for the education of partners and other users.

3.4 Hydrologic/Hydrometeorological Network and Data Management. Management of hydrologic/hydrometeorologic networks and data in the HSA is an essential WFO operation. Procedures on hydrologic services related aspects of these networks are contained in NWS Instruction 10-940, *Hydrologic Data Network Services*.

WFOs collect, perform quality control on, and disseminate data sets from networks operated by the NWS (including the NWS Cooperative Observer Network) and external partners (e.g., GOES data collection platforms (DCP), SNOwpack TELemetry (SNOTEL), or automated flood warning systems (AFWS)). These data sets include river/stream stage, precipitation, and temperature observations from ground-based sensors. RFCs receive most if not all of these data at the same time and use them in their hydrologic models. To ensure they receive the best possible RFC forecasts, WFOs should coordinate with their supporting RFC(s) when data errors are found and disseminate corrected data in products (e.g., RRx) when appropriate. When an equipment outage or malfunction is noted in an individual data sensor, the WFO should notify the appropriate owner or entity responsible for maintaining the equipment.

WFOs should not retransmit any GOES DCP stream gage data that is available through the Hydrometeorological Automated Data System (HADS). Retransmission could overwrite data in the RFCs' database, after potential local adjustments to the values have been made. Similarly,

WFOs should not retransmit corrected river gage data as RFC hydrologists can glean critical information from certain "bad" gage data (e.g., ice effects). This policy is not meant to deter WFOs from performing quality control on river gage data that would still be needed for the AHPS page and other WFO operations. Corrected river gage data can be stored locally. This policy only applies to river gage data available through HADS and does not apply to stream gage data collected via telephone or radio (e.g. ALERT, or IFLOWS).

The NWS's hydrology web presence provides heightened visibility for near-real-time stream gage observations stored in WFO databases. Particular attention should be given to the quality control of these data to ensure bad readings do not appear in observed/forecast hydrographs on the web. Instructions on the quality control of manual and automated observations are provided in NWS Instruction 10-1305 - *Observational Quality Control - General*.

3.5 Interagency Support. WFOs coordinate hydrologic forecast and warning activities with local, state, and regional cooperators, and share data, forecasts, and other information per established agreements.

WFOs maintain working relationships with partners responsible for the management of stream gaging stations, such as district offices of the U.S. Geological Survey (USGS). Procedures should be maintained for the transfer of information between agencies, including real-time streamflow measurements and other data, during significant flood events. WFO phone numbers are provided to the cooperators for posting in stream gage houses. WFOs and cooperators should meet periodically to keep informed on the activities of each agency and collaborate on hydrologic field work (e.g., surveying high water marks, establishing staff gages), when appropriate.

3.6 Dam Failures. WFOs serve as the point of issuance for public hydrologic products associated with dam failures or potential dam failures in their CWFA.

3.6.1 Readiness for Events. WFOs should be continuously prepared for dam failure events by conducting the readiness activities listed in Appendix A.

3.6.2 Operations During Events. Upon notification of a dam failure or potential dam failure, a WFO will take the following steps:

a. **Confirm Report**: If a report of an actual or potential dam failure was received by someone other than a reliable source—e.g., the owner of the dam, emergency services personnel, or local law enforcement officials—or the report seems suspicious, the WFO should attempt to confirm the report. If the report cannot be verified, the WFO should use best judgment in selecting the appropriate course of action, and obtain as much information as possible about the actual or potential failure. Forms such as the ones in Appendices C and D should be used to log this information.

b. **Issue the Appropriate Initial Product:** The WFO should generate and issue the appropriate initial product as described in NWS Instruction 10-922. Additionally, the WFO should determine the appropriate product to issue from the following options:

(1) If the dam has already failed or failure is expected, issue a flash flood warning (FFW) as quickly as possible for those areas below the dam, which will be affected in the short-term (generally within the first six hours of the dam failure), and require immediate action to save lives and property. To save time, the person receiving the phone call may delegate the issuance of the FFW to another member of the operational staff while he/she continues to obtain as much information as possible from the caller. The initial warning should be qualitative, emphasizing the life-threatening nature of the situation, and urging people in the affected area to take immediate life-saving actions. Information received from reliable sources should be included in the warning along with specific identification of the source(s).

(2) If the dam has not yet failed but the owner or operator has expressed concern for the safety of the dam, and a failure or large release is possible, the WFO should issue a Flash Flood Watch (FFA) for the flood plain downstream of the dam. The watch should emphasize the potential danger, so people in the affected area can begin to take appropriate action. For cases where a potential dam failure is a sufficient threat to warrant the evacuation of downstream areas, the WFO may also issue a product under the Civil Emergency Message (CEM) identifier to convey the urgency of the situation and ensure the widest dissemination of information. In general, the WFO will know if it needs to issue this product after coordination with emergency management officials. The CEM product is covered in Appendix C of NWS Instruction 10-518, *Non-Weather Related Emergency Products Specification*.

c. **Make Contacts**: After issuance of the initial product, the following persons should be contacted in the order listed below:

(1) Dam Owner (if not already contacted) - obtain as much information as possible concerning the dam failure or problem.

(2) Supporting RFC - to brief on the situation, request support, and pass along information about the dam.

(3) Adjacent WFO (if the failure is likely to affect their CWFA as well).

(4) MIC and HPM (if they are away from the WFO) - to brief on the situation.

(5) MIC at the WFO designated as the state liaison office (SLO) - to brief on the situation so that he/she may have the information needed to provide support to the state emergency services office, if requested. The SLO will then notify their HPM of the situation.

(6) Hydrologic services personnel at regional headquarters - to brief on the situation.

d. **Issue Follow-up Products:** When more quantitative information becomes available (e.g., crest time/magnitude at downstream locations, inundation area),

the appropriate follow-up products will be issued–i.e., flash flood statements (FFS) after an initial flash flood warning or follow-up FFA after an initial flash flood watch. The WFO should coordinate follow-up products with the RFC. Coordination may also be necessary with the dam owner and/or local emergency services. When the extent or magnitude of a failed dam's impact is unknown, the WFO may make a judgment call as to the farthest point downstream that the flash flood warning applies, and then issue a flood watch for the area farther downstream from that point.

e. **Issue Flood Warnings for Lower Reach (if needed):** In cases when a large dam fails and the required FFW/FFS products have been issued for the reach immediately below the failed dam, the WFO should issue a flood warning (FLW) for locations farther downstream from the dam, if it is likely they will also flood and it is possible for an RFC to provide river forecasts. The initial FLW product could be an areal flood warning, followed by a point-specific flood warning, when additional quantitative information (i.e., RFC forecasts) becomes available. Once flash flooding has subsided in the reach immediately below the failed dam and flooding is expected to continue farther downstream, a flash flood statement should be issued stating that future information on this event will be available under the FLW/FLS identifiers.

The WFO should evaluate the need for additional staffing for the post-dam failure period and augment if necessary. Factors to consider are the need to obtain and verify data pertaining to the situation, coordinate with the RFC, and handle media and other calls. If the event involves a large dam or a major metropolitan area, additional help will likely be needed.

3.6.3 Providing Quantitative Forecast Information. The WFO should incorporate quantitative information into watches/warnings/statements for dam failures whenever possible. At present, the amount of this information may be limited because the current hydraulic modeling applications at WFOs and RFCs do not fully support the provision of real-time, point-specific forecasts in an operational environment. Some RFCs may be able to provide some forms of quantitative support after the failure of some dams, but this is not currently mandated in National policy.

Emergency action plans, if available, should be considered as a source of quantitative forecasts during dam failure situations. The "Dam Failure Rules of Thumb" (see Appendix B) may also be used. Useful quantitative forecast information may also be obtained from the Dam Catalog. In most cases, inclusion of such data will be limited to follow-up statements issued after the initial warning. Whenever possible, the WFO should coordinate quantitative forecast information with the RFC prior to releasing it to the public. Coordinating this information with dam owners and/or local emergency services is also highly recommended.

3.7 Levee Failures. Response to the potential or actual failure of a levee may require similar actions as with dam breaks, depending on the severity of the impact. For example, the breach of a primary levee protecting a town or city could have a major impact. In such cases, forecasters should follow the applicable steps of the flash flood watch/warning decision process for a dam failure as described in Section 3.6.

3.8 Hazardous Materials (HAZMAT) Spills. When a WFO is notified of a HAZMAT discharge into a river or stream, it will take the following steps:

a. **Confirm Report** (if necessary): If a report was received by someone other than a reliable source such as a law enforcement official, or the report seems suspicious, the WFO should attempt to confirm the report. If the report cannot be verified, the WFO should use best judgment in selecting the appropriate course of action.

b. **Obtain and Record Information**: Record as much information as possible about the spill using the log in Appendix E.

c. **Notify NWS Incident Coordination Center (ICC)**: The ICC will be notified of the HAZMAT spill through an e-mail message to the following addresses: nws.icc@noaa.gov and noaa.hscenter@hq.dhs.gov. The ICC is alerted by e-mail messages to these addresses, is on call 24x7, and will contact the necessary response organization(s).

d. **Issue Hazardous Materials Warning (HMW)**. After (or while) the ICC is contacted, the WFO will issue initially known information on the HAZMAT spill received from another government agency in a HMW product, if the issuance criteria for an HMW has been met (see section 5 of NWS Instruction 10-518 - *Non-Weather Related Emergency Products Specification*). WFOs may collaborate with the appropriate supporting RFC, or another response organization, to develop estimates of the travel time for the spill. Quantitative information on the spill may then be provided in follow-ups to the initially issued HMW product.

APPENDIX A

Dam Failure Readiness Activities

WFOs should be in a continuous state of readiness for dam failure events through conduct of the following activities:

a. **Geographic Familiarization**. The WFO staff should be familiar with the major dams and high hazard dams located in the CWFA, as well as the river systems they affect. A map showing the locations of high hazard dams in the CWFA should be available as an AWIPS map background. It is also beneficial for WFOs to keep a list of high hazard dams that have not passed inspection, if this information is available. Site visits to high risk dams are strongly encouraged.

b. **Procedural Familiarization**. The WFO should have readily available and up-to-date documentation on applications used in dam failure situations. The staff should be familiar with the Dambreak Catalog Review and ESTimator (DAMCREST) (formerly the Dambreak Catalog Analysis Tool (DAMCAT)) functionality in the WHFS. The staff should be aware that some data stored in the catalog may be incorrect, and be prepared to ask relevant questions whenever a dam failure report comes in–e.g., what is the type of dam, what was the actual height of water behind the dam, etc.–especially data that will be used with rules of thumb.

c. **Product Templates**. The WFO should have preformatted templates, which are ready to be used in the office's product application(s) in the generation of watches, warnings, and statements for dam failures.

d. **Dam Failure Logs**. The WFO should have log sheets (see Appendices C and D), which are ready for use in dam failure situations. It is beneficial to have these logs prefilled in with the static information that is already available for as many dams as possible in the WFO area.

e. **Liaison with Local Emergency Services**. WFOs should maintain close liaison with the local emergency services personnel regarding actions to be taken during dam failure situations.

f. **WFO Contact Numbers in Emergency Action Plans**. WFOs should request that their office's 24-hour telephone number be listed in all Emergency Action Plans (EAP) for dams in the CWFA. WFOs should also request their name and number appear as high as possible on those lists. The benefit of placing the WFO name and number high on these lists can be highlighted by pointing out how NWS flash flood warnings alert communities through the EAS, as well as the Internet and NOAA Weather Radio All Hazards. If the WFO's request is denied, the HPM should inform hydrologic services personnel at regional headquarters.

g. **Access to Emergency Action Plans**. On station copies of EAPs for dams in the CWFA should be readily accessible to the WFO operations area.

h. **Dam Failure Drills**. WFOs should conduct dam-failure drills on an annual basis.

i. **Interagency Dam Failure Exercises**. WFOs should send representatives to inter-agency functional (table top) dam failure exercises held by dam operators. These exercises bring together all entities that would be involved in responding to failure of a particular dam, and are held to ensure the EAP accounts for the proper sequence of mitigation actions.

APPENDIX B

Dam Failure Rules of Thumb

The magnitude of flooding that occurs from a dam failure is related to several factors. The most important are as follows:

- volume of water impounded by the dam;
- starting water surface elevation or "head."
- size of the breach in the dam;
- distance to the nearest downstream town; and
- time required for the dam to fail, which is related to its composition. In general, an earth dam will fail more slowly than a concrete dam.

Some dam failure rules of thumb have been developed which are based on these factors and provide estimates of the flood wave height downstream from a failed dam. These rules of thumb are intended only to give general and quick guidance in the event of a dam failure. It should not be assumed they represent exact solutions applicable to all situations.

An AWIPS or PC-based application for dam failure rules of thumb can be downloaded from the Meteorological Development Laboratory's local applications database at the following web address:

https://vlab.ncep.noaa.gov/redmine/projects/nwsscp/wiki/DamBreachEstimatorAndRulesofThumb

The following three sections provide information on manually estimating the characteristics of a flood wave resulting from a dam failure. The first section discusses the height of the initial flood wave. The second section provides a means of estimating the speed at which the flood wave moves downstream. The third section describes a means of estimating the attenuation of the flood wave height as it moves downstream. The essentials in each section are underlined.

1. Right at the dam, the maximum height of the flood wave will be no greater than about half of the starting height of the water behind the dam before structural failure began. This assumes a rapid structural failure. If the failure takes a number of hours, the height will be less. For example:

    - A dam 50 feet high has water to a height of 40 feet in back of it. The initial flood wave at the dam site in the event of a rapid failure will be no higher than 20 feet. The longer the structural failure takes, the lower the initial flood wave height will be.

2. A flood wave moving downstream is a complex phenomenon which is affected by many channel characteristics, such as slope, cross-sectional area, and channel roughness. The average downstream speed of a flood wave is as follows:

- 3-4 miles per hour (mph) normal/shallow slopes
- 5-7 mph steeper slopes/foothills
- 8-10 mph steep slopes/mountains

The flood wave will attenuate in height and speed very quickly as it spreads across the flood plain. For example: Teton Dam in Idaho, 262 feet high, failed structurally very quickly–in about an hour. The flood wave moved as follows:

- 5 miles in about ½ hour
- 10 miles in about 1 hour
- 20 miles in about 9 hours
- 50 miles in about 30 hours

In another example, Buffalo Creek Dam in West Virginia, 45 feet high, also failed very quickly. The flood wave moved as follows:

- 5 miles in about ½ hour
- 10 miles in about 1 ½ hours
- 15 miles in about 3 hours

3. A reasonable assumption for the attenuation of flood wave height is that the flood wave will be reduced by about half for each ten miles of travel downstream.

   Example: A dam with 80 feet of water in back of it collapses very quickly. Approximate wave heights downstream are as follows:

   - At the dam site – 40 feet
   - 10 miles downstream – 20 feet
   - 20 miles downstream – 10 feet
   - 30 miles downstream – 5 feet
   - 40 miles downstream – 2 feet
   - 50 miles downstream – 1 foot

APPENDIX C

LOG SHEET - DAM FAILURE SITUATION

USE THIS FORM TO RECORD AS MUCH INFORMATION AS POSSIBLE FROM THE CALLER.

CALL RECEIPT:

Name of staff member completing this form: _____
Date of Call: _____ Time of Call: _____

CALLER:

Name_____ Phone # _____
Address (if available) _____
Caller's affiliation _____ (dam operator, gov't employee, sheriff, etc)
Original source/witness _____
Has any other government agency/department been notified by the person making the report? Y N If yes, what agency/department? _____

DAM:

Name of Dam (include nicknames): _____
Dam is on the _____River/Creek in _____/_____County/State
Nearest downstream city, town, village, or camp: _____
Name of dam owner (if known): _____
Does dam have emergency action plan (EAP)? Y N

CURRENT SITUATION:

Have any watches or warnings been issued for this situation? Y N
Has Dam failed? Y N or ____ Unknown, Time of Failure: _____ (local)
Any personnel at dam site? Y N Name _____ Phone # _____
Current condition of dam structure: (overtopped, cracked, flow around sides, etc)
_____
_____
Dam height: _____ Type of Dam (earthen, concrete, etc.): _____
Current water surface elevations (MSL): Pool: _____, Tail water:_____
Breach: Width_____, Depth:_____ Current Storage: _____
Are Elevation/Storage and Elevation/Area curves available? Y N (ask for a copy)
Any Upstream and/or Downstream Dams/Reservoirs Y N
Jam (ice, debris, etc.) Y N or ____ Unknown If so, length of jam_____
If jam exists, is water flow around or under? Y N ____Unknown
If rainfall is part of the current situation…
Rainfall Rates _____in/hour, 6 hour accumulations: _____in, Totals _____ in

ADDITIONAL INFORMATION:

_____
_____

VERIFICATION: (Required if person reporting failure is other than government agency)

Dam failure/potential verified with: _____ agency department
Name of person in agency/department: _____

APPENDIX D

DAM INCIDENT REPORT LOG

USE THIS SHEET TO LOG ACTIONS TAKEN FOR THE EVENT.

CHECK ONE: ☐ **ACTUAL FAILURE** ☐ **POTENTIAL FAILURE** ☐ **INFORMATION REPORT** ☐ **DRILL**

DATE/TIME CALL RECEIVED _____ **CALL RECEIVED BY:**_____

CALLER INFORMATION:

Name	*Agency*	*Telephone Number*

DAM INFORMATION:

Dam Name	*River/Stream*	*County*

Lake Elevation (Feet)	*Current Storage (Acre-Feet)*	*Max Storage (Acre-Feet)*

SITUATION DESCRIPTION: (Ask Questions! From their answers, can you determine what product to issue?)

STOP! THINK: IS THIS DAM IN OUR CWFA?

IF DAM IS OUTSIDE OUR CWFA:

Which other office notified:	*Name of person you notified:*	*Time of this notification*

☐ **I notified** _____ **at the** _____**RFC**
(Name)

IF DAM IS INSIDE OUR CWFA:

Additional information to collect from Dam Catalog

Dam Type (earth, rock, etc.)	*Nearest downstream town*	*Travel time to town (Minutes)*

Product Issued (Please attach)	*Time Issued*	☐ **Watch/Warning Log Completed and attached**

☐ **I notified the Service Hydrologist/Hydrology Focal Point** _____
(Name)

Regional HQ notified (if actual failure):	*Name of person you notified:*	*Time of this notification:*

☐ **I notified** _____ **at the** _____**RFC**
(Name)

APPENDIX E

LOG SHEET - HAZMAT SPILL INTO RIVER

USE THIS FORM TO RECORD AS MUCH INFORMATION AS POSSIBLE FROM THE CALLER.

CALL RECEIPT:

Name of staff member completing this form: _____

Date of Call: _____ **Time of Call:** _____

CALLER:

Name_____ **Phone #** _____

Caller's affiliation _____ (e.g., sheriff, RR transport co.)

Spill confirmed through other source? Y N If yes, what source? _____

LOCATION OF SPILL:

Name of affected river/stream: _____

Spill occurred (circle one**): above at below Location:**_____

_____

(pinpoint as closely as possible – e.g., include city/town name, landmark, and/or bridge/hwy #)

Spill originated from:

☐ **Fixed source (e.g., pipeline) Description:** _____

☐ **Surface transport (e.g., tanker) Description:** _____

Any downstream waterways threatened? Y N If yes, list: _____

_____

_____

Any downstream towns/cities threatened? Y N If yes, list: _____

_____

_____

_____

_____

NATURE OF SPILL:

Type of HAZMAT spilled:_____

Time spill occurred (or began) _____

Time period over which spill occurred:

☐ **Spill occurred instantaneously (e.g. truck crash, tank car rupture)**

☐ **Spill occurred over a period of time. How long (if known)?** _____

☐ **Spill is still occurring Additional info:** _____

Quantity of HAZMAT spilled (if known): _____

RESPONSE:

Has the NWS Incident Coordination Center (ICC) been contacted at nws.icc@noaa.gov and noaa.hscenter@hq.dhs.gov? **Y N**

Has a Hazardous Materials Warning (HMW) been issued? **Y N**

ADDITIONAL INFORMATION:

_____

_____