The NHWC Transmission

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NHWC 2015-17 Officers and Directors

Dam Overtopping Analyses for Automated Notifications

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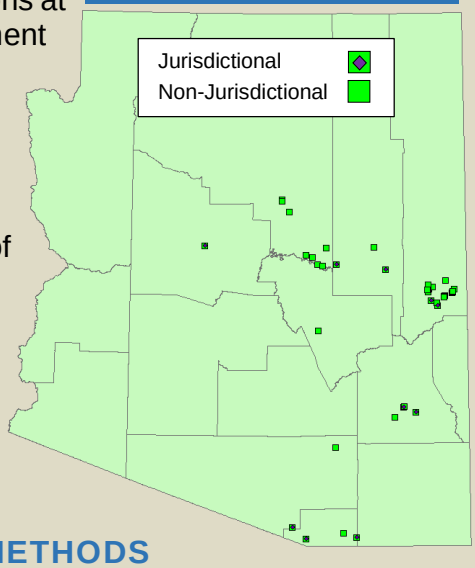
The Arizona Game and Fish Department owns 36 dams located throughout Arizona (see **Figure 1**). Of these, 10 have jurisdictional ratings of high or significant hazard. In 2007, the Department, with JE Fuller Hydrology (JEF), designed and installed ALERT stage/precipitation stations at each jurisdictional dam. To give Department emergency response personnel a better understanding of the risk of overtopping given current hydrologic conditions, JEF performed HEC-1 hydrologic analyses to quantify the amount of precipitation that would result in dam overtopping at each of the 10 jurisdictional dams for a range of antecedent hydrological conditions.

Figure 1: Arizona Game and Fish Department Dams



AZGFD Jurisdictional Dams	
Arivaca	Lee Valley
Big Lake	Lynx Lake
Black Canyon	Parker Canyon
Cluff Ranch	Pena Blanca
Fool Hollow	Roper

METHODS

Hydrologic modeling parameters established for each dam's design and/or Emergency Action Plan (EAP) were assimilated into new HEC-1 models. Models were developed for Arivaca, Big Lake, Cluff Ranch, Fool Hollow, Lee Valley, Lynx Lake, Parker Canyon, Pena Blanca, and Roper. The rainfall loss parameters, as well as the spillway and dam crest parameters remained unchanged as compared to existing versions. To simplify the ensuing iterative modeling process, all models in this study included 1 sub-basin, with the exception of the Fool Hollow model which includes four sub-basins and three upstream reservoirs (Rainbow, Scott, and Show Low). For purposes of this study, the upstream reservoirs were assumed to be full since they are un-gauged.

The most recent Black Canyon Dam hydrologic model was compiled in the early 2000s by the US Army Corps of Engineers shortly after the Rodeo-Chedeski fire. This HEC-HMS model was developed to assess the post-fire change in hydrology, and several sub-basins were used to model this. A new, single sub-basin HEC-1 model was developed for use in this study that utilized an area-weighted average SCS curve number of 79 established in the original HEC-HMS model.

Three storm durations were modeled for all dams; a 3-hour duration was chosen to approximate the highly-convective, high-intensity monsoonal rainfall events; a 24-hour duration was selected to approximate low-intensity winter precipitation storms; a 6-hour duration was chosen to provide a midpoint between the 3-hour and 24-hour durations. The balanced storm approach was used in all models to compute the hyetograph for the three modeled durations. Probable maximum precipitation (PMP) was established at each dam using the PMP Evaluation Tool developed by the Arizona Department of Water Resources.

Depth-frequency values corresponding to the 100-year event for each of the three durations were used. The HEC-1 JR (multi-ratio option) record was then applied in order to increase the precipitation depth incrementally until overtopping occurs. The PMP hyetographs were modeled in HEC-1 using PI records which define the incremental precipitation time series input. Each model was analyzed using a range of starting water surface elevations of the lake in order to compute the required precipitation for overtopping based on the ability of the lake to attenuate the discharge.

HYDROLOGIC RESULTS

Table 1 below shows the required precipitation over each duration that would result in overtopping (OT). While this table depicts required precipitation when the starting water surface is at the emergency spillway, the HEC-1 models were developed over a range of starting water surface elevations, extending down to 25 feet below the spillway. Results for Big Lake and Roper are not included below, as rainfall in excess of the PMP would be required to overtop the dam.

Dam	Duration and Depth					
	3-hour		6-hour		24-hour	
	OT (in)	100-year (in)	OT (in)	100-year (in)	OT (in)	100-year (in)
Arivaca	7.16	*3.41*	7.16	*3.87*	7.82	*4.77*
Black Canyon	5.60	*3.73*	7.34	*4.32*	7.85	*5.61*
Cluff Ranch	4.79	*2.52*	5.23	*2.68*	6.12	*3.22*
Fool Hollow	3.49	*3.26*	3.69	*3.62*	4.26	*4.68*
Lee Valley	10.50	*3.50*	11.65	*4.16*	13.53	*5.01*
Lynx Lake	5.55	*3.63*	5.73	*3.87*	8.28	*5.63*
Parker Cyn	6.08	*3.20*	6.95	*4.09*	7.47	*4.67*
Pena Blanca	4.89	*3.42*	5.18	*3.88*	5.68	*4.77*

Table 1: Overtopping and 100-Year Precipitation Depths and Durations for Arizona Game and Fish Department Dams

Table 2 lists each of the ten dams and the fraction of the probable maximum flood (PMF) that would result in overtopping of the dam crest. The starting water surface elevation for this analysis was set equal to the emergency spillway brink elevation to provide a conservative result. Both Big Lake and Roper do not overtop during the PMF, because the ratio of the lake area to the watershed area is quite large. Seven of the ten lakes would overtop at a flow rate that is less than half of the PMF, with Pena Blanca overtopping at the lowest fraction of the PMF. Because Big Lake and Roper do not overtop under a PMF scenario, these two dams were omitted from the automated notifications described below.

Dam	% PMF Resulting in OT
Arivaca	41%
Big Lake	> 100%
Black Canyon	27%
Cluff Ranch	43%
Fool Hollow	38%
Lee Valley	85%
Lynx Lake	33%
Parker Canyon	31%
Pena Blanca	26%
Roper	> 100%

Table 2: Percent of Local Storm PMF Needed to Overtop the Dam with Initial Pool Elevation at Spillway

AUTOMATED NOTIFICATIONS

A custom Python program run as a service on the Department's ALERT base station server was developed to produce real-time notification of precipitation events which meet user-defined thresholds of percent of overtopping precipitation depth. The program compares real-time ALERT precipitation and lake stage data to linearly-interpolated HEC-1 results to determine the precipitation depth needed to overtop each dam for each of the three durations (3-hour, 6-hour, and 24-hour) for current measured lake levels.

Actual precipitation recorded over the past 3, 6, and 24 hours is sampled and compared to the precipitation thresholds. If the actual precipitation exceeds the threshold for any duration, then a notification action is triggered. The user has the option to receive real-time notifications via email or cellular text messaging and to configure individual and group settings. **Figure 2** below shows an example email notification.

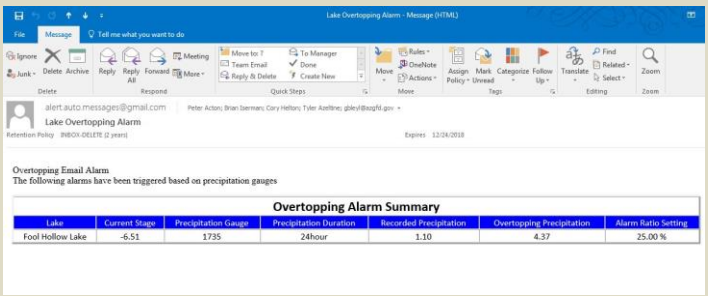


Figure 2: Email Notification Received Recently for Fool Hollow Dam

Membership Renewal

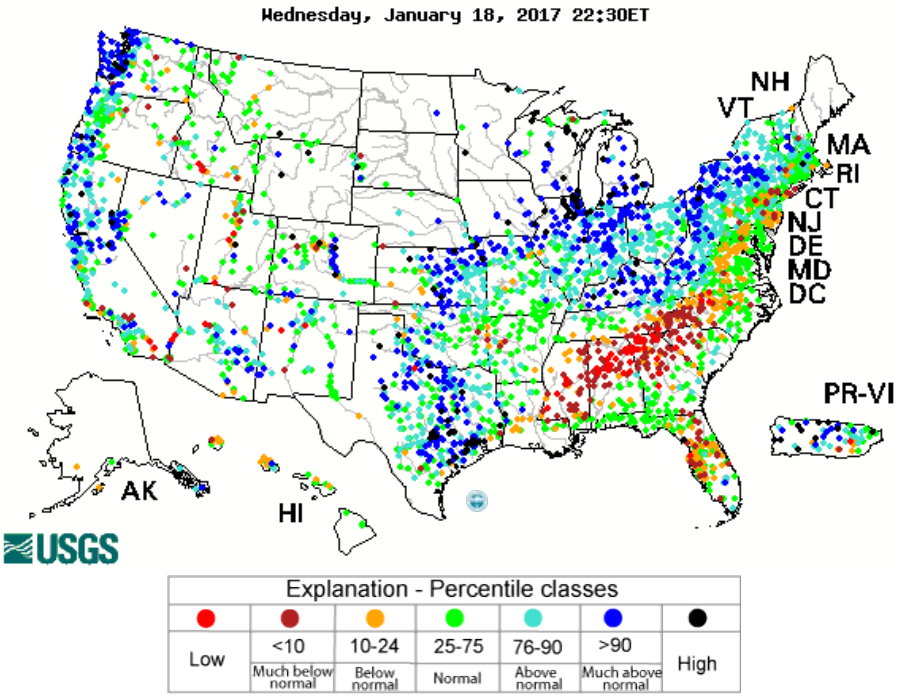
It's time to renew you annual NHWC Membership. New members are welcome. Click **here** to join/renew your membership.

President Obama Signs Major Water Bill

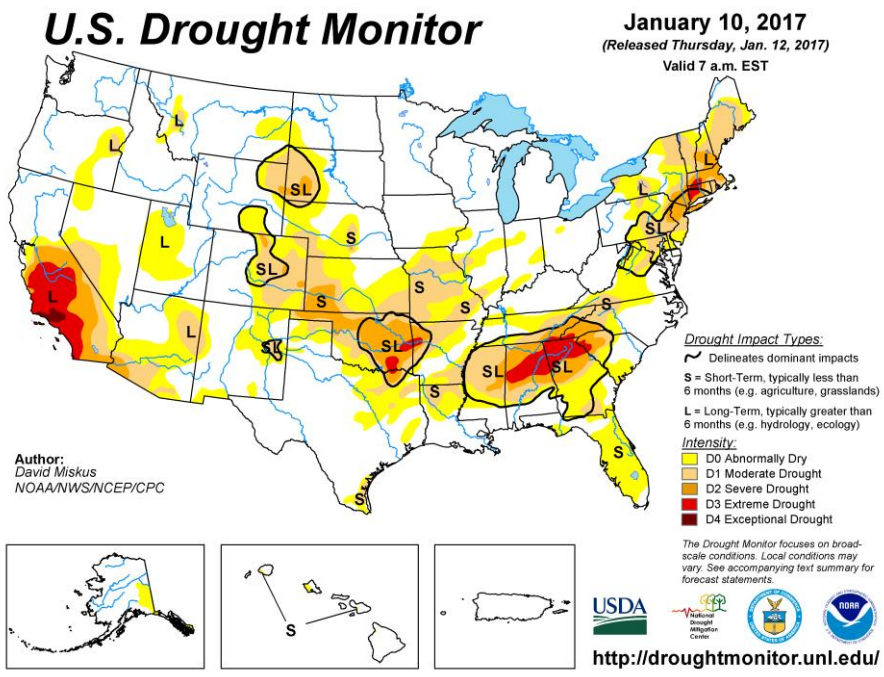
On December 16, President Obama signed a major new law, the "Water Infrastructure Improvements for the Nation (WIIN) Act," passed by Congress six days earlier. The bill contains provisions for improvements to the rivers and harbors of the United States, to provide for the conservation and development of water and related resources, and for other purposes. The bill includes broad support for water infrastructure coast to coast. A high hazard dam rehabilitation program was created by the bill which authorized important infrastructure programs, including 30 new projects for the U.S. Army Corps of Engineers. Drought relief, prioritization of flood risk management projects, and stream restoration projects are also included.

The full text of the WIIN Act can be found **here**.

Hydrologic Conditions in the United States
Through January 10, 2017



Latest stream flow conditions in the United States. (courtesy USGS)



Latest drought conditions in the United States.
(courtesy National Drought Mitigation Center)

February Newsletter Articles Focus:

Data Collection

The NHWC is requesting articles that focus on practices, technologies and tools used to gather and disseminate real-time hydro-meteorological data.

Please consider writing an article that highlights how your organization collects and disseminates real-time data.

Submit your article to:

editor@hydrologicwarning.org

February 8th is the deadline for inclusion in the February issue.

Future Newsletter Articles Focus

To give you more time to prepare articles, below is the article focus schedule for the next four months:

Feb - Data Collection
Mar - Hydrology
Apr - Hazard Communication & Public Awareness
May - Modeling/Analysis

NHWC Calendar

June 5-8, 2017 - NHWC 2017 Training Conference & Exposition, Squaw Valley, California [Abstracts Due January 9th, 2017]

General Interest Calendar

April 30 – May 5, 2017 - ASFPM 41st Annual National Conference, Kansas City, Missouri

May 21-25, 2017 - American Society of Civil Engineers, EWRI World Environmental & Water Resource Congress 2017, Sacramento, California

November 5-9, 2017 - AWRA Annual Conference, Portland Oregon

(See the event calendar on the NHWC website for more information.)

Parting Shot

Chehalis River Basin Flood Warning Authority
Haywire Ridge Rain & Temperature Gage

Jeff Budnick of WEST Consultants performs maintenance and troubleshooting in December, 2016. Data generated by this station and others can be accessed at the Chehalis River Basin Flood Warning Authority real-time data website.

Photo by Lyman Petersen, WEST Consultants