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Physical modeling of hydraulic structures is sometimes warranted when optimization of complicated design elements are critical and flood risk associated with failure of a hydraulic structure is significant, such as for a large dam or levee. Physical modeling can often be supplemented with numerical modeling to save time and costs, and as a way of modeling changes later in the design process. This "composite" modeling approach was applied in 2014 for the preliminary design of the Lake Palo Pinto Storage Restoration Project, a proposed large high-hazard dam in Palo Pinto County, Texas. The new 68-foot high dam will have significant design discharges with a 1% annual chance flood discharge of 61,800 cfs and a PMF discharge of 298,000 cfs.

The physical and numerical modeling of the preliminary spillway design was conducted to achieve four primary objectives; 1) optimize the RCC stepped spillway, stilling basin, discharge channel, and emergency spillway, 2) verify theoretical spillway rating curves, 3) evaluate impacts to downstream roadway infrastructure, and 4) evaluate value-engineering opportunities. Above all, the physical and numerical modeling helped verify the ability to safely pass the large spillway design floods required. Physical models were constructed and tested at the Utah Water Research Laboratory, and numerical models were developed using Flow-3D CFD.

In 2016, after additional site investigations and further evaluations of value engineering opportunities, design modifications required additional hydraulic modeling. Going back to the physical model was not possible, and the CFD numerical model would have been time consuming and costly. With the recent release of the HEC-RAS 5.0 software with easy-to-use and robust 2-dimensional modeling capabilities, a new HEC-RAS 2D model was developed to evaluate design changes to the spillway and discharge channel. With data from the physical model readily available, the new HEC-RAS 2D model could be reliably tested and calibrated. This provided a means to evaluate various design modifications efficiently and cost effectively.

This case study provides an evaluation of the HEC-RAS 2-dimensional modeling compared to actual physical hydraulic model results and Flow-3D CFD 3-dimensional and depth-averaged 2-dimensional numerical modeling of the proposed dam spillway, stilling basin, and discharge channel.