How Oroville Dam is used to reduce flood risk to downstream communities

One feature of the Oroville Dam is the ability to reduce flood risk by leaving space in the reservoir to absorb flood waters and then releasing those waters at a much lower rate. The controlled release of water allows dam operators to reduce the chances of downstream flooding by reducing water flows and loadings on downstream levees. Figure 1 displays the space reserved in the reservoir for flood waters and Figure 2 shows the difference in flow rates of water coming into the reservoir (inflow) and the lower rate of the controlled release (outflow).

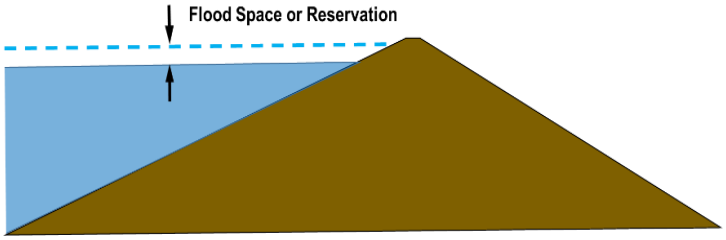

Figure 1: Reservoir Flood Space

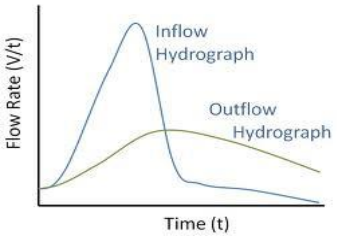

Figure 2: Reservoir Inflow/Outflow

During winter months, Oroville Dam operators typically maintain a flood space of between 10% and 20% of the total capacity of Lake Oroville, or up to 750,000 acre-feet (for scale, 1 acre-foot of water would cover an entire football field one foot deep). The gated Flood Control Outlet (FCO) at Oroville Dam was designed to work with the flood reservation to significantly absorb flood flows coming into Lake Oroville as high as 440,000 cubic feet per second (cfs) – the equivalent of 5 Olympic swimming pools every second – and reduce the outgoing flow from the FCO to 150,000 cfs into the Feather River (see Figure 3 below for the historical inflow/outflow activity).

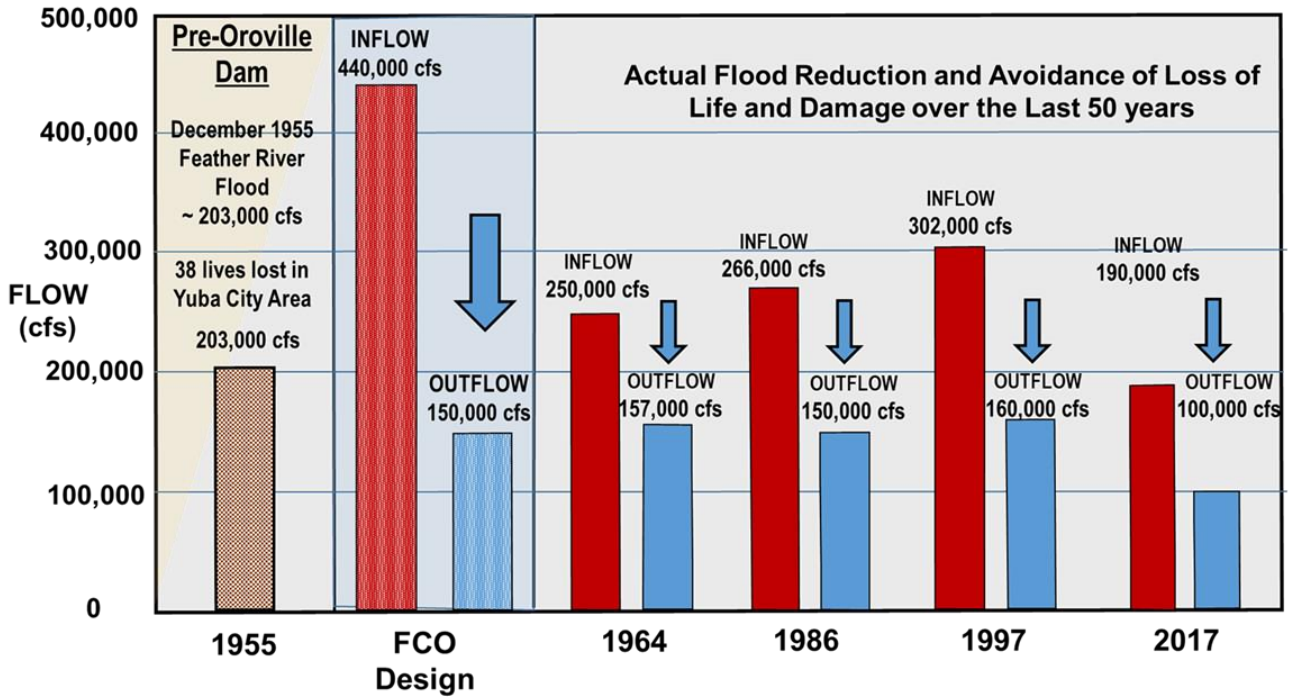

Figure 3: Historical Inflow - Outflow at Oroville Dam

The 440,000 cfs design inflow was established by the United States Army Corps of Engineers during the 1960's dam design as the Standard Project Flood (see below). The outgoing design flow of 150,000 cfs was established based on estimates made at the time that this was the maximum flow in combination with other contributing downstream flows that levees along the Feather River would hold. For comparison, in December 1955 (before Oroville was constructed), Feather River flood flows peaked at approximately 203,000 cfs and caused a failure of the west levee of the Feather River at Yuba City, resulting in the loss of 38 lives.

Since the construction of Oroville Dam began in the early 1960's, the dam and FCO have significantly reduced water flows in the Feather River to significantly reduced levels during four major flood events (1964, 1986, 1997, and 2017 – see Figure 3). This has prevented the loss of countless lives and avoidance of extensive property destruction. The dam is designed to withstand the Probable Maximum Flood (see below), and the FCO chute in combination with the Emergency Spillway weir can prevent overtopping of the dam, however in an event of this magnitude the entire watershed would experience severe flooding, independent of the operation of the dam.

The FCO chute and Emergency Spillway were reconstructed in 2017 and 2018, and will continue to reliably release water flows at a rate that reduces flood risk downstream.

How Dam engineers have used the "Standard Project Flood" and "Probable Maximum Flood"
Engineers who designed and managed dams in the 1960s were guided by two common estimates of water inputs – the Standard Project Flood and the Probable Maximum Flood. Each of these estimates informed dam design and operation but were used in different ways. Understanding how they are used is important to understanding some of the differences between flood risk management objectives and dam safety objectives.

The Standard Project Flood is the water estimated to reach a dam that is reasonably characteristic of the geographic region. The Standard Project Flood represents reservoir inflow rates that are possible and sometimes have occurred in recent history (e.g., relatively rare events, sometimes estimated to be flood events with 200 – 500 average recurrence intervals). Engineers design dams with a conservative expectation that during the life of the project, water levels associated with the Standard Project Flood may occur and design the dam so that the reservoir is able to absorb the inflow while allowing the dam to release the outflow at a lower rate in order to reduce the chances of downstream flooding.

The Probable Maximum Flood is the water estimated to reach a dam that is the most extreme combination of precipitation, snow melt (where applicable), and flood-producing conditions in the watershed that could occur. The Probable Maximum Flood is a flood of epic proportions derived from atmospheric conditions. It is not statistically based but would have a very low probability of occurrence, such as once in 10,000 years (about the same period of time since the last ice age). Engineers use the Probable Maximum Flood to guide the design to avoid overtopping of the dam. If a Probable Maximum Flood did occur, the outflows required to protect the integrity of the dam would result in severe flooding in the downstream watershed, including overtopping and severely damaging levees. It is also important to note that if the Probable Maximum Flood occurred, there would be extreme flooding in the watershed regardless of the higher levels of outflow from the reservoir.