= Pensacola Dam =

The Pensacola Dam , also known as the Grand River Dam , is a multiple @-@ arch buttress dam on the Grand River in @-@ between Disney and Langley in the U.S. state of Oklahoma . The dam is operated by the Grand River Dam Authority and creates Grand Lake o ' the Cherokees . After decades of vision and planning , it was constructed between 1938 and 1940 for the purposes of hydroelectric power generation , flood control and recreation . It is Oklahoma 's first hydroelectric power plant and is referred to as the longest multiple @-@ arch dam in the world .

= = Background = =

The idea to construct a dam on the Grand River originated in the late 1800s with Henry C. Holderman , a Cherokee Nation citizen , who wanted to provide electric power to the Cherokee Nation . Holderman and a few colleagues soon conducted the first survey of the river in 1895 on their own handmade houseboat . Holderman later left the United States at the age of 16 and worked on dam projects in India and Africa before returning to Oklahoma . He sold his land holdings and borrowed money from friends in order to purchase rights to the dam sites he had prospected . Over several decades , Holderman and a group known as the " Rainbow Chasers " tried to secure funding to construct the a dam ; making several trips to Washington DC .

The dam was almost built in 1914 by British capitalists but plans were halted due to World War I. In 1920 , Holderman refused an offer given by Chicago businessmen and in 1929 , the Wall Street Crash ended the hopes of Canadian engineers and investors building the dam for Holderman . In DC , supporters of the dam , which later included state and federal officials , argued for the dam as a source of hydroelectric power and that it could stimulate the state 's economy but local energy providers opposed the possibility of a state @-@ run electric utility . The onset of the Great Depression would revive and accelerate plans to construct the dam . Just prior in 1928 , Oklahoma Representative Everette B. Howard secured $ 5 @,@ 000 in funding for the U.S. Army Corps of Engineers to survey the Grand River . The results of the study concluded that it would cost over $ 6 @.@ 2 million to construct a dam at the " Pensacola site " for flood control . The name " Pensacola " was derived from the only available means of identifying the site at the time : an old store on a Cherokee plantation . Because of limited state funding and a limited water supply on the Grand River , the project was not proposed at first for federal funding under the scope of hydroelectric power but instead for flood control .

Oklahoma set up the Grand River Dam Authority (GRDA) on January 10 , 1935 . Eventually , on September 18 , 1937 , with the help of Oklahoma Representative Wesley E. Disney , Senator Elmer Thomas and engineer W. R. Holway , President Franklin D. Roosevelt approved $ 20 million in funding through the New Deal 's Public Works Administration for the dam . The higher cost for the dam was attributed to a project that was approved for additional purposes , including hydroelectric power generation and recreation . Additional costs for the dam were covered by the state government and by GRDA municipal bond auctions which appropriated or raised $ 11 million . Disney had pushed much of the legislation for the dam , comparing the higher electric utility rates in Oklahoma compared to other states . Senator Thomas helped appropriate additional state and public funding for the dam while also being instrumental in its legislation .

Once approved and funded , Holway , the main engineer on the project and previous engineer of the nearby Spavinaw Dam , began survey and engineering work on October 25 , 1937 . The multiple @-@ arch buttress design was adopted because materials were expensive at the time of the Great Depression and the limestone and chert foundation was considered " ideal " for the design . John Duncan Forsyth served as the architect for the dam and applied an Art Deco @-@ style to it and the power house . Massman Construction Company out of Kansas City , Missouri was selected to construct the major superstructures , including the dam and power plant . Thousands of workers moved to the area to work on the dam before construction began and 3 @,@ 000 eventually did , earning about $ 16 a week .

= = Construction = =

Initial construction began in February 1938 and included the excavation of over 1 @,@ 600 @,@ 000 cu yd (1 @,@ 200 @,@ 000 m3) of earth and rock . Workers also constructed the first cofferdam on the east side of the river and left it in place until the arches were above the normal water level . Once this was achieved , workers removed the east cofferdam and constructed another on the west side of the river to divert water from the location of the future power plant . On December 30 , 1938 , Massman began the first concrete pour . Pouring was conducting 24 @-@ hours a day for 20 months , totaling 510 @,@ 000 cu yd (390 @,@ 000 m3) . A total of 23 @.@ 9 million pounds of steel and iron were placed into the dam 's structure to reinforce it . Major works on the dam were complete on March 21 , 1940 and the lake was filled by the end of that year 's summer . The dam 's power plant , with four original hydroelectric generators , began commercial operation in 1941 . The dam was finished in 26 months , ahead of schedule . Much of this was attributed to eastern Oklahoma having its 18 driest months on record during construction which alleviated obstacles from flooding . The federal government took control of the dam in November 1941 to aid in the World War II effort and returned it to the GRDA in 1946 .

= = = Effect on Native Americans = = =

The construction of the Pensacola Dam resulted in the loss of 1 @,@ 285 acres (520 ha) of Cherokee land and 802 acres (325 ha) of the Quapaw Indian Agency , most of which belonged to the Seneca @-@ Cayuga Tribe . This land was condemned and later flooded by the reservoir in 1940 . Half of the Seneca @-@ Cayuga Elk River ceremonial area was flooded as well . Although losing significant portions of land , some tribe members were able to find work on the dam project .

= = = Power plant upgrades = = =

In the 1950s , two additional generators were added to the power station , bringing the total to six . Between 1995 and 2003 , the dam 's six hydroelectric generators were upgraded , bringing the installed capacity of the power plant from 92 MW to 120 MW and increasing its generation 20 % . Each autumn , a generator was taken out of service , upgraded and returned to service by spring of the next year . The sixth and final generator upgrade was completed in May 2003 . Among the components principally upgraded were the turbine shafts and runners .

= = Design = =

Pensacola Dam is a multiple @-@ arch buttress type consisting of 51 arches and one main spillway , two auxiliary . It has a maximum height of 150 ft (46 m) above the river bed . The total length of the dam and its sections is 6 @,@ 565 ft (2 @,@ 001 m) while the multiple @-@ arch section is 4 @,@ 284 ft (1 @,@ 306 m) long and its combination with the spillway sections measure 5 @,@ 145 ft (1 @,@ 568 m) . Each arch in the dam has a clear span of 60 ft (18 m) and each buttress is 24 ft (7 @.@ 3 m) wide . The thickness of the buttress sidewalls ranges from 5 ft (1 @.@ 5 m) at the base to 2 @.@ 2 ft (0 @.@ 67 m) at the crest . Inside of each buttress are 18 in (460 mm) thick transverse walls that act as " stiffeners " . The buttresses were the widest of their type prior to 1938 and are designed to withstand 500 lbf / in2 (3 @,@ 400 kPa ; 35 kgf / cm2) .

The main spillway , part of the eastern end of the dam , is a 861 ft (262 m) long Ogee @-@ type and utilizes twenty @-@ one 25 ft (7 @.@ 6 m) tall and 36 ft (11 m) wide tainter gates that are operated by two 60 @-@ ton hoists . The auxiliary spillways are located about 1 mi (1 @.@ 6 km) northeast of the dam and are controlled by another twenty @-@ one 37 ft (11 m) wide and 15 ft (4 @.@ 6 m) high tainter gates stretched over their combined 860 ft (260 m) length . The lip of the spillways lie at an elevation of 730 ft (220 m) above sea level while the tops of the gates are 755 ft (230 m) . All three spillways have a combined maximum discharge of 525 @,@ 000 cu ft / s (14 @,@ 900 m3 / s) . The two @-@ lane State Highway 28 crosses over the top of the dam and a

bridge that stretches over the main spillway . It is accessible by cars and trucks within weight .

The dam 's reservoir , Grand Lake o ' the Cherokees (Grand Lake over the Cherokees) , has a storage capacity of 1 @,@ 672 @,@ 000 acre · ft (2 @.@ 062 × 109 m3) of which 540 @,@ 000 acre · ft (670 @,@ 000 @,@ 000 m3) is flood storage . The reservoir 's surface area is 46 @,@ 500 acres (188 km2) and it extends 66 mi (106 km) upstream , creating 1 @,@ 300 mi (2 @,@ 100 km) of shoreline . Normal surface elevation is 742 ft (226 m) above sea level .

The dam 's power station is located at the base of the dam 's western end and its building is 279 ft (85 m) long , 72 ft (22 m) wide and 60 ft (18 m) tall . The building houses six 20 MW Francis turbine generators that generate 335 million kWh annually and are each fed with their own individual penstock . The power plant is designed to accommodate four additional generators . It operates at its highest generation levels during the summer and lowest during the winter . Just west of the power station is its substation and an observation house .

= = Regulation = =

The power station is regulated by the Federal Energy Regulatory Commission (FERC) , under the Federal Power Act , with the current license issued in 1992 and set to expire in 2022 . The first license was granted by the FERC 's predecessor , the Federal Power Commission in 1939 . When the reservoir 's elevation exceeds 745 ft (227 m) , control of the dam 's discharges are transferred to the U.S. Army Corps of Engineers (USACE) who manage flood control in the larger basin . By federal regulation , the GRDA and the Corps of Engineers often coordinate discharges and reservoir levels .

= = = Impact = = =

FERC and USACE regulated releases downstream from the dam have been the center of controversy in recent years . Since the dam is a multi @-@ purpose project , there are conflicting interests between flood control , environmental conservation , recreation and hydroelectric power production . The USACE may request minimal releases to prevent flooding in areas downstream and in hot mid @-@ summer periods , releases can be minimal . This reduces dissolved oxygen (DO) levels in the river downstream . Such reductions resulted in the death of at least 5 @,@ 000 fish downstream in July 2007 . Significant releases from the dam have drawn opposition from people such as Oklahoma State Representative Doug Cox . He argues that the large releases effect the state 's economy as an off @-@ road recreational rock park is flooded downstream . Inconsistent releases are blamed for the overall problem and a better regulation of releases has been proposed while the GRDA is contemplating the installation of aeration devices and conducting studies along with other measures . The 1992 FERC license had addressed problematic DO levels and required the GRDA to plan methods to monitor and improve DO levels to a consistency with state water quality standards .

= = Tourism = =

Between Memorial Day and Labor Day , the GRDA offers free tours of the dam . In 2010 , there were over 9 @,@ 000 visitors ; a number which has been steadily growing in recent years . Additionally in 2010 , the Ecosystems and Education Center was completed and has become part of the tour . The center serves as a water and fish monitoring research lab while offering visitors information about hydropower and water / electrical safety .