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Water quality

Shasta Dam, USA

A Temperature Control Device (TCD), with a unique selective withdrawal system routes water through California's Shasta Powerhouse and maintains the required temperature for fish without restricting power generation.

Overview

Completed in 1945, Shasta Dam is a 183 metre tall, curved concrete gravity structure having a gated overflow spillway with a crest elevation of 316 meters above mean sea level. Shasta Dam impounds water from the Pit, McCloud, and upper Sacramento Rivers to form Shasta Lake, the largest reservoir in California.

Shasta Powerplant is located directly below the dam and comprises five turbine-generators with a combined rated capacity of 629 MW. Shasta is operated as a hydropeaking plant, releases varying hourly, daily and seasonally as a function of electricity and/or water demand. In addition to generating electricity, Shasta Dam controls floodwaters and stores surplus winter runoff for summer irrigation in the Sacramento and San Joaquin Valleys. Maintaining navigability and providing flows for fish conservation in the Sacramento River are also functions of Shasta Dam.

Dam name

Scheme operator
US Bureau of Reclamation

Country
United States of America

River
Sacramento

Construction years

1938-1945 - original construction
1995-1996 - modified

Size of scheme (MW)
629

Catchment area
17,262.35 km^2

Effective reservoir capacity
5.52 x 10^9 m^3

Reservoir size
5.62 x 10^9 m^3

External recognition

The National Hydropower Association (NHA) presented Reclamation with a 2002 Hydro Achievement Award in the category of Technical solutions for its state-of-the-art Shasta Temperature Control Device (TCD).

Details

Shasta Dam presents a large, impenetrable barrier to anadromous fish species that undergo spawning migrations to the upper tributaries, such as Chinook salmon and steelhead trout. The dam also elevates water temperatures in downstream environments to levels above the tolerance limits for spawning salmonids, resulting in egg and fry mortality. These impacts on the Salmonid population of the Sacramento system have been recognised since the 1970's. By 1989 the Chinook salmon was listed as an endangered species in the Sacramento River under both state and federal Endangered Species Acts (ESA).

Attempts to reduce the impact on water temperatures below Shasta Dam started in 1987, with the controlled release of deeper, colder water from Shasta lake through the low-level outlet works. These releases could not be passed through the Shasta Powerplant, hence power generation at the plant was significantly reduced and alternative electricity was purchased from competitors.

As part of the Central Valley Project Improvement Act, the construction and operation of a selective withdrawal structure for Shasta Dam was advocated in October 1992. A specially designed Temperature Control Device (TCD) had been designed and installed at Shasta Dam by February 1997.

The results of the project have been dramatic, with vastly increase electricity generation negating the need to purchase alternative power. The TCD releases met the river temperature targets almost continuously, particularly during the critical times for salmon reproduction. Chinook fish populations appear to have improved considerably since 1997.

In addition, strategies to improve water clarity and dissolved oxygen concentrations downstream of the dam are significantly benefiting the winter, fall, and spring Chinook salmon runs whilst meeting contractual electricity generating obligations.

Other Aspects

Biodiversity & threatened species
Regulation and alteration of temperature regimes in the Sacramento River have had a detrimental impact on Chinook Salmon since the 1970's. This culminated with the declaration of this species as endangered in the Sacramento River in 1989. Subsequent to the installation of a TCD at Shasta, Chinook salmon now experience optimal spawning conditions and appear to be increasing in number.

Resource Use
In addition to the environmental benefits offered by the TCD, its installation enables power system operators to generate electricity using water released for salmonid

spawning. This water was previously bypassing turbines, resulting in significant loss of generation potential and forcing the purchase of electricity from alternative sources.

Further information

Source: Hydropower Good Practices Workshop, Annex VIII - Examples for Good Practice Report, Villach, Austria, October 2005. International Energy Agency.

http://recbd.ca.gov/

Design Summary, Shasta Temperature Control Device, Central Valley Project, California, United States Department of the Interior, Bureau of Reclamation, Technical Service Center, Denver, Colorado, September 1997.

Higgs, Jim A, and Vermeyen Tracy B., Shasta Temperature Control Device CFD Modelling Study, Memorandum Report, U.S. Bureau of Reclamation, Technical Service Center, Denver, Colorado, September 1999.

Shasta Power Plant, Our Power Facilities, Bureau of Reclamation's Power Program's Website.

Vermeyen, Tracy B, "Shasta Dam's Temperature Control Device: Meeting Expectations." Hydro-Review, 19, 34-37.

Vermeyen Tracy B, "First Year Selective Withdrawal Performance of the Shasta Dam Temperature Control Device," Proceedings of ASCE's International Water Resources Engineering Conference, Memphis, Tennessee, August 3-7, 1998, pp. 944-949

Presentation Data, Water Resources Research Laboratory, Bureau of Reclamation, 2002

National Hydropower Association Form, Bureau of Reclamation, 2002

Personal Communications with several regional and field personnel from Reclamation and other agencies involved in the project

Vermeyen, Tracy B., " Shasta Dam Temperature Control Device," US Committee on Large Dams Newsletter, Issue No. 117, March 1999

Shasta Dam Temperature Control Device Report, Fletcher General Construction, 1996