

Canton Lake Water Quality: 2021

The Canton Lake dam is located on the North Canadian River at river mile 394.3, about two miles north of the city of Canton in Blaine County, Oklahoma. The impoundment extends into Dewey County, OK, and the lake is within Hydrologic Unit Code 11100301. The conservation pool of Canton Lake was first filled in July 1948 after final storage began in April 1948. Authorized purposes include flood damage reduction, water supply, irrigation, fish and wildlife, and recreation. The watershed above the Canton Lake dam site extends to the headwaters of the North Canadian River near Des Moines, NM. The total drainage area above the dam is ~12,782 square miles; however, the contributing area is ~7,601 square miles (Figure 1). Land use/cover in the basin is dominated by grassland/pasture (~42%), cultivated cropland (~39%), and shrub/scrub (13%). Based on a 2016 bathymetric survey, at the conservation pool elevation of 1,615.4 feet (NGVD 29) lake capacity has diminished by about 18% since impoundment due to sedimentation. Descriptive characteristics of Canton Lake are included in Table 1.

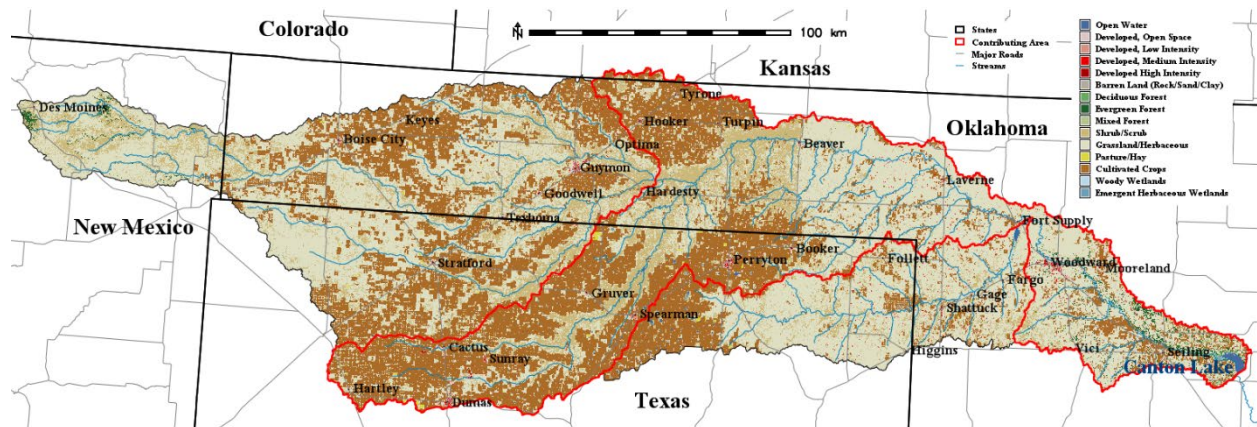


Figure 1. The Canton Lake (North Canadian River) Watershed above the Canton Lake Dam. The area outlined in 'red' identifies uncontrolled contributing below the Optima and Ft. Supply Dams.

Table 1. Descriptive Characteristics of Canton Lake, OK.

Parameter	English Units	Metric Units
Lake Elevation (Conservation Pool)	1,615.4 ft. NGVD	492.37 m
Lake Surface Area (Conservation Pool)	7,709 ac	3,120 ha
Lake Volume (Conservation Pool)	108,580 ac-ft	133.931*10 ⁶ m ³
Total Drainage Area (contributing)	7,601 mi ²	19,686.5 km ²
Mean Depth	14.1 ft.	4.3 m
Maximum Depth (Conservation Pool)	32 ft.	9.75 m
Shoreline Length	38.8 mi	62.4 km
Shoreline Development Index	3.3	3.3
Annual Inflow, Average 1923 – 2021 [Water Years]	144,620 ac-ft	178.386*10 ⁶ m ³
Annual Inflow, 2021 [Calendar Year]	92,321 ac-ft	113.876*10 ⁶ m ³
Hydraulic Residence Time, 2021 [Calendar Year]	433.2 d	1.18 yr

Data derived from the Tulsa District's Pertinent Data Book (U.S. ACE - Tulsa District, 2004), the FY 2021 Annual Water Control Report (U.S. ACE - SWD RCC, 2021), Tulsa District's Water Control page for Canton Lake (U.S. ACE - Tulsa District, 2023), and the 2016 bathymetric survey (Bowen Engineering & Surveying, Inc., 2016).

Designated beneficial uses of the impoundment created by the Canton Lake Dam include Public and Private Water Supply, Fish and Wildlife Propagation as a Warm Water Aquatic Community, Agriculture, Primary Body Contact Recreation, and Aesthetics (OAC 2020a). Based on the 2022 Integrated Water Quality Assessment prepared by the Oklahoma Department of Environmental Quality (ODEQ 2022), Canton Lake is listed as impaired by turbidity affecting Fish and Wildlife Propagation as a Warm Water Aquatic Community.

Physical and chemical water quality data were collected monthly by USACE from three in-lake sites and the stilling basin at Canton Lake beginning 06 April and ending 07 September 2021 to define existing limnological conditions, provide a basis for future water quality investigations, and to support operational and environmental missions of the Tulsa District. Sampled sites included CANOKN0230 (over channel at the dam), CANOKN0231 (mid-lake near Big Bend Public Use Area), CANOKN0233 (upper lake), and CANOKN0229 downstream of the stilling basin below the dam. In-lake sites were accessed by boat, and samples were collected from locations over the deepest portion of the stream channel (thalweg). Sampling locations are identified in Figure 2.

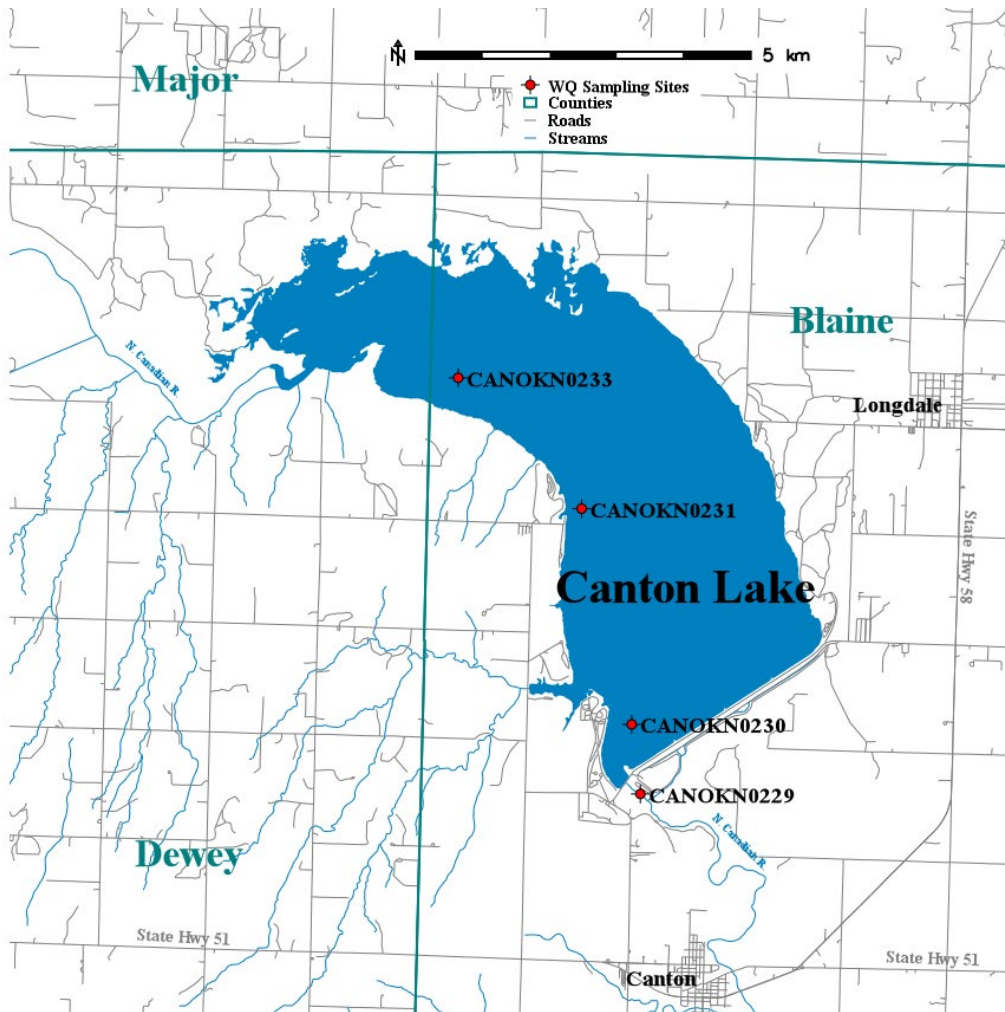


Figure 2. Locations of water quality sampling sites at Canton Lake, OK, 2021.

The Canton Lake pool elevation was at or above the conservation pool elevation throughout the sampling period in calendar year 2021. Calendar year 2021 lake elevation, conservation pool elevation, basin precipitation, calculated evaporation rate, and water quality sampling dates are shown in Figure 3.

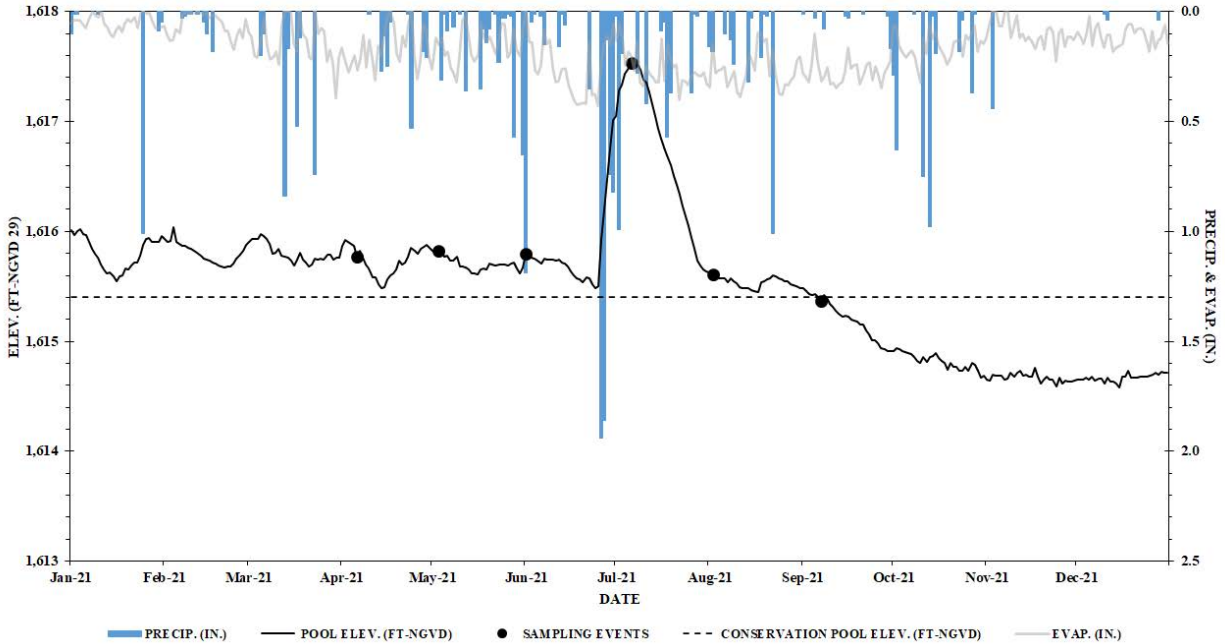


Figure 3. Daily lake elevation (feet, NGVD at 0800 hours), seasonal conservation pool elevation (feet), basin precipitation and evaporation (in.), and water quality sampling dates at Canton Lake, OK, 2021.

Water temperatures varied seasonally (ranging from 14.06 to 28.01 °C) peaking in August. Water temperatures, on individual sampling dates, displayed nominal variation. Weak thermal stratification was observed at site CANOKN0230 in July. The study period lake-wide median dissolved oxygen concentration was 8.03 mg/l. Observed in-lake dissolved oxygen concentrations ranged from 2.70 to 12.33 mg/l. Lowest dissolved oxygen concentrations were observed at the dam site (CANOKN0230) in July. Highest dissolved oxygen concentrations were observed near the surface at sites CANOKN0231 and CANOKN0233 in September corresponding with highest observed chlorophyll-a concentrations. Lake-wide total organic carbon concentrations were high with a study period median of 8.59 mg/l. Observed median total organic carbon concentrations were similar at all in-lake sites.

Specific conductance (median 1,555 $\mu\text{S}/\text{cm}$) was elevated, consistent with regional geology. Total dissolved solids median concentration was 1,110 mg/l. High chloride and sulfate concentrations (medians 210.0 and 376.0 mg/l, respectively) were observed indicating significant contributions to dissolved solids. Alkalinity levels (median 149.0 mg/l as CaCO_3) imply a well-buffered system capable of maintaining pH levels. Hardness levels, median 468 mg/l as CaCO_3 , indicate extremely 'hard' water. Observed in-lake pH (7.11 to 8.64) ranged within regional norms. Highest pH was recorded near the surface at sites CANOKN0231 and CANOKN0233 in July, and lowest pH was recorded in April at site CANOKN0233.

The lake was moderately turbid through 2021. The study period median Secchi depth was 0.59 meters. Median Secchi depth increased from site CANOKN0233 (0.48 m) down-lake to the dam site (CANOKN0230, 0.68 m). In-lake median turbidity was 23.15 NTU, and 46% of all in-lake observations were greater than or equal to 25 NTU. Median total suspended solids concentrations (20.0 mg/l) decreased from the upper lake site (CANOKN0233, 21.0 mg/l) down to the dam site (CANOKN0230, 16.0 mg/l). The euphotic zone at Canton Lake ranged from ~1.0 meters in the upper lake to ~1.5 meters near the dam.

Lake-wide ammonia concentrations were moderate (median 0.09 mg/l), and nitrite plus nitrate concentrations were relatively low (median 0.08 mg/l). Total Kjeldahl nitrogen concentrations (median 0.71 mg/l) were moderately high. Estimated lake-wide median total nitrogen concentration during the 2021 study was 0.77 mg/l. Total phosphorus concentrations ranged between 0.13 and 0.21 mg/l (median 0.19 mg/l). Observations of dissolved ortho-phosphate, median 0.004 mg/l, were low throughout the lake. Nitrogen to phosphorus ratios (N:P) in 2021 were <10 (median 4.5), indicating a tendency toward limited nitrogen availability and the potential for phytoplankton dominance by cyanophytes.

Chlorophyll-a concentrations (in-lake) ranged from 6.2 to 30.9 µg/l, with a median concentration of 13.1 µg/l. Highest concentrations were observed at all three in-lake sites in September 2021. Figure 4, below, summarizes relative abundance and biovolume of divisions of phytoplankton observed at Canton Lake. Cyanophyte (blue-greens) abundance tended to increase through the sampled period, while biovolume shifted through the period from domination by Bacillariophytes (diatoms) to greater representation of Cyanophytes, Cryptophytes, and Chlorophytes.

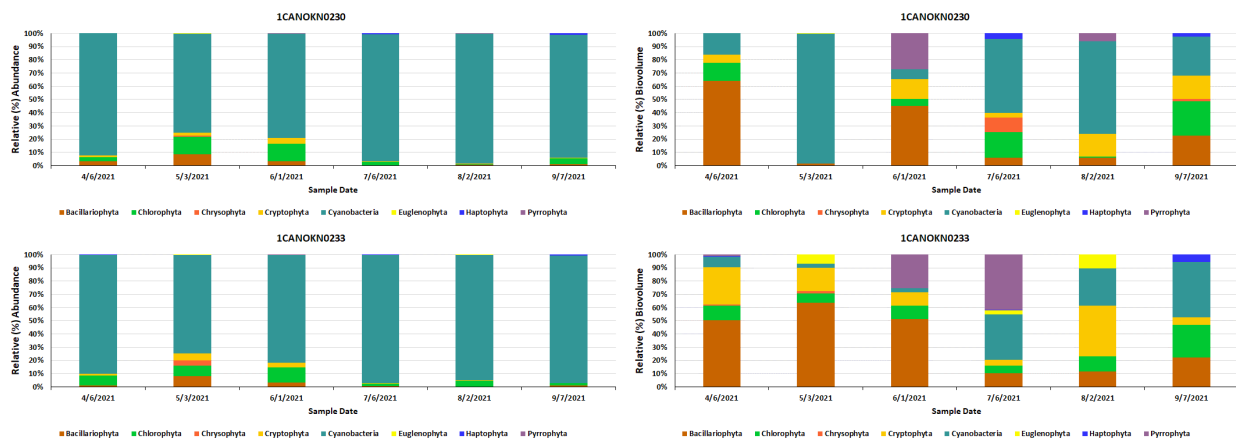


Figure 4. Phytoplankton relative abundance (left) and relative biovolume (right) at CANOKN0230, and CANOKN0233 April through September 2021.

The trophic status of Canton Lake in 2021, assessed using Carlson’s trophic state index (TSI), indicated a hyper-eutrophic lake as measured by Secchi depth (TSI(SD)) and total phosphorus concentrations (TSI(TP)). The index developed from chlorophyll-a concentrations (TSI(CHLa)) indicated a more moderate level of eutrophy (Figure 5).

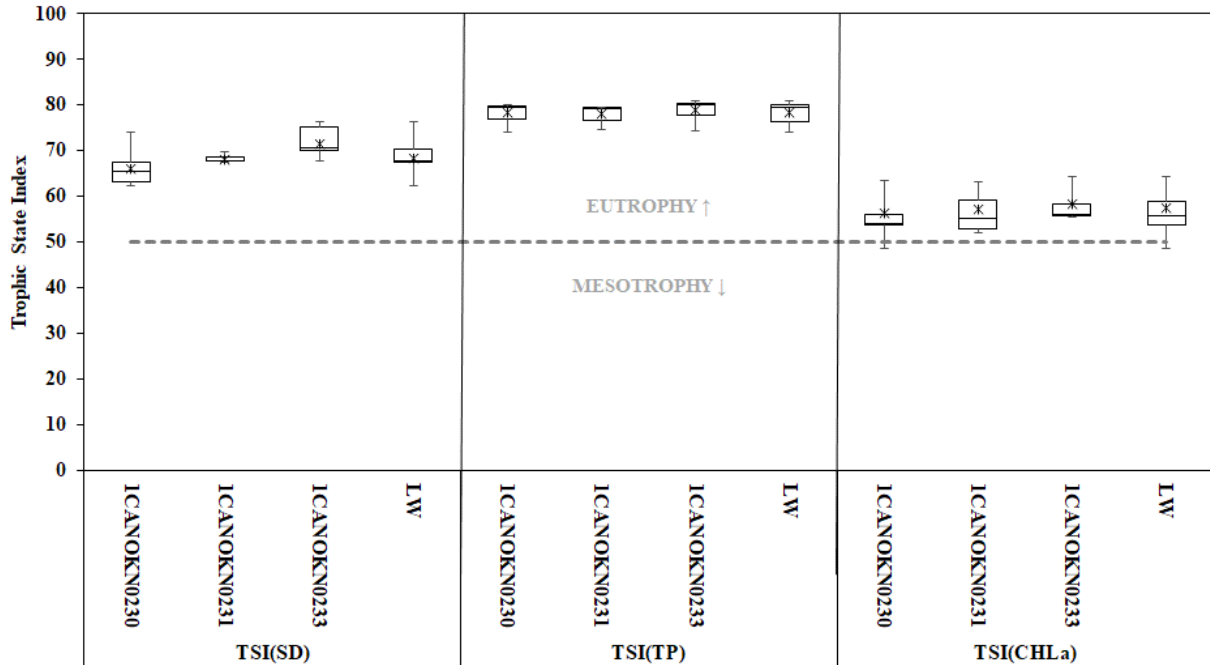


Figure 5. Distributions of Carlson's Trophic State Index (TSI), by sampling site and lake-wide (LW), based on observations of Secchi Depth (TSI(SD)), surface total phosphorus concentrations (TSI(TP)), and chlorophyll-a concentrations (TSI(CHLa)) at Canton Lake, OK, 06 April through 07 September 2021.

Total iron (median 0.14 mg/l) and manganese (median 0.03 mg/l) concentrations were moderately low. Reportable concentrations of arsenic were found in all in-lake samples collected with a median concentration of 0.0049 mg/l. Reportable concentrations of copper, nickel, and zinc were noted in all in-lake samples. Detectable chromium and lead concentrations were found in 87 and 96%, respectively, of in-lake samples collected. No samples revealed reportable concentrations of mercury.

Water samples collected from below the dam at site CANOKN0229 revealed constituent levels and concentrations similar to samples collected from the dam site (CANOKN0230). Slightly higher median concentrations of ammonia, dissolved orthophosphate, total Kjeldahl nitrogen, and total organic carbon were noted.

USACE conducted water quality sampling at Canton Lake, OK in 1995 and 2010. Both efforts indicated generally well-oxygenated conditions with weak summer month thermal stratification, and moderately reduced water clarity. An assessment of priority pollutant metals indicated the consistent presence of arsenic, probably from natural background sources, below concentrations of concern.