

2017 Flow and Temperature Monitoring Report Tumalo Creek: Stations 14070920 and 14070980

Jason Gritzner, Forest Hydrologist, Deschutes and Ochoco National Forests

In accordance with Special Use Permit BEN1158, and conditions set forth for monitoring the effects of the diversion of municipal water off of US Forest Service lands over the duration of the City of Bend's Special Use Permit (SUP), stream flow and temperature monitoring was carried out on upper Tumalo Creek below the confluence of Bridge Creek and Tumalo Creek known as Location A (Station ID 14070920) at river-mile ~15.8, and further downstream at the Skyliners Bridge, Location B (Station ID 14070980) for the 2017 calendar year. Temperature monitoring was also carried out at river mile ~3.2, Location C, by the City of Bend (Figure 1). Since gauges A and B were installed in June and August 2016 respectively, this first year's monitoring report will include data from the beginning of the period of record to December 31, 2017. Figure 2 shows the various administrative boundaries as they relate to the monitoring locations.

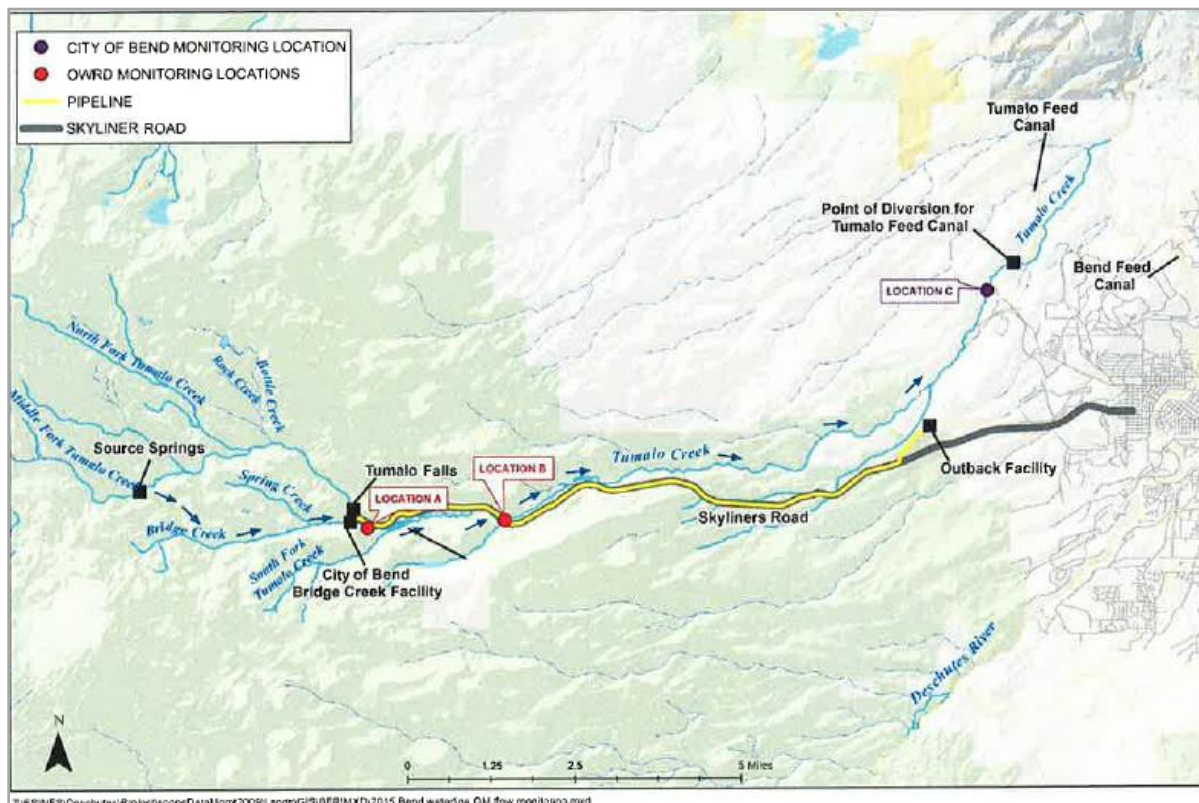


Figure 1. Monitoring station map.

The City of Bend contracted with the Oregon Water Resources Department (OWRD) to install the two temperature and flow gaging stations mentioned above to aid the US Forest Service and the City of Bend in monitoring the effects of municipal water diversions by the City of Bend and to help guide adaptive management as called for in the Special Use Permit. Station 14073520 located at RM 2.8 also provides flow and temperature data for Tumalo Creek, however, because it is located below the Tumalo Irrigation District's (TID) surface water diversion, flow and temperature characteristics of the stream at this location

are driven by TID’s operations, and not the operations of the City of Bend’s municipal water system, and therefore is not used for this report.

Flow monitoring data from the two OWRD gauges presented in this report was obtained and processed following procedures established by the U.S. Geological Survey’s *Measurement and Computation of Streamflow: Volumes 1 & 2 Measurement of Stage and Discharge* (USGS, 1982). Temperature data was obtained and processed by OWRD following USGS guidance and protocols outlined in the *National Field Manual for the Collection of Water-Quality Data* (USGS, 2006), and *Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting* (Wagner et al., 2006). The City of Bend follow similar procedures outline in their Standard Operating Procedures (2014), and the Environmental Protection Agency’s manual for *Best Practices for Continuous Monitoring of Temperature and Flow in Wadeable Streams* (EPA, 2014). Past monitoring reports and related information can be found on the City of Bend Utility Department Web pages about the Bend Municipal Watershed (Link: <https://www.bendoregon.gov/government/departments/utilities/stormwater/watershed>)

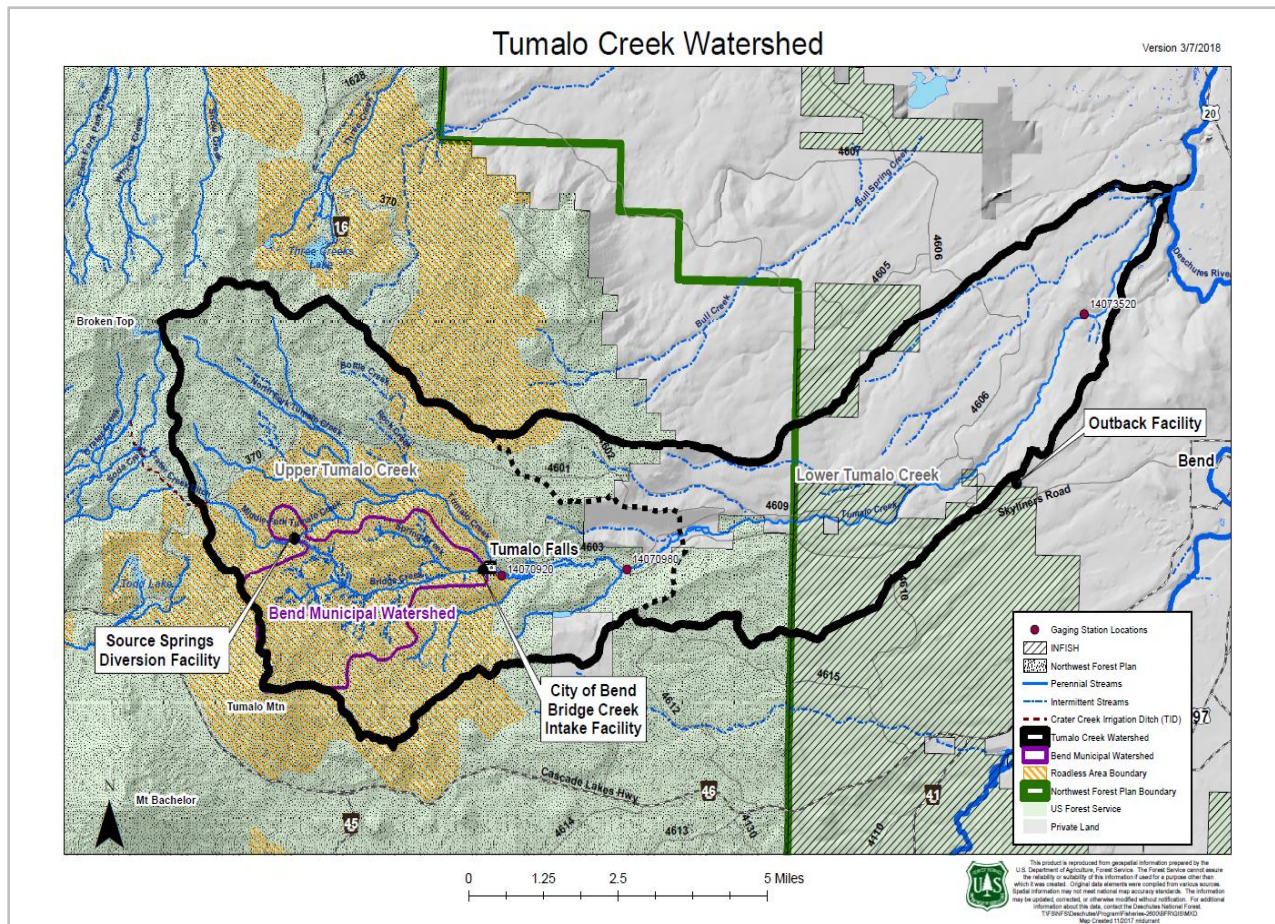


Figure 2. City of Bend’s municipal watershed, Tumalo Creek gauging stations, and land ownership/management designations.

Streamflow Monitoring

Tumalo Creek Data at Station 14070920 below Bridge Creek Confluence:

Streamflow data collected at Station 14070920 (Figure 3) includes the cumulative surface runoff in Tumalo Creek and all of its upstream tributaries, minus the City of Bend’s municipal surface water diversion. Tributaries include Middle Fork Tumalo Creek, Bottle Creek, North Fork Tumalo Creek, Rock Creek, Spring Creek, Crater Creek Ditch (Tumalo Irrigation District diversion from Soda Creek subwatershed to Upper Tumalo Creek subwatershed), Bridge Creek (includes partial flow diverted from Prowell Springs on the Middle Fork of Tumalo Creek), and several unnamed tributaries and spring sources. The City of Bend diverts water from Bridge Creek 0.2 miles upstream from its confluence with Tumalo Creek. This gauge illustrates the greatest direct impact the City’s diversion has on Tumalo Creek.

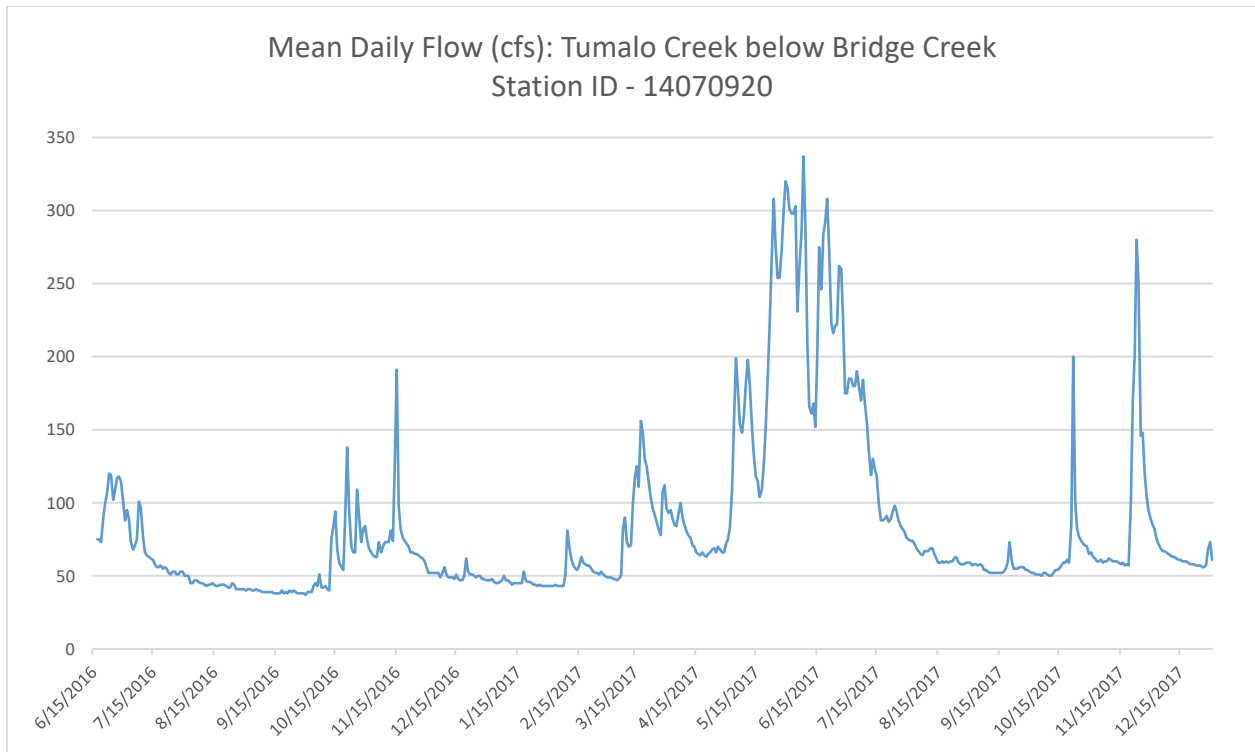


Figure 3. Station 14700920 flow data from 6/17/16 to 12/31/17.

With the operation of the City of Bend’s new water system, the City has the ability to respond to demand by diverting only the amount of water needed at the system’s intake, rather than a constant diversion of 18.2 cfs and managing demand by returning unneeded water from its distribution center at the Outback Station as was done with the previous system. With this change in operation, any unused water less than the 18.2 cfs permitted diversion potential remains in-stream through the length of Reach A (13.2 miles). This has the potential of increasing flow in Tumalo Creek (Figure 4).

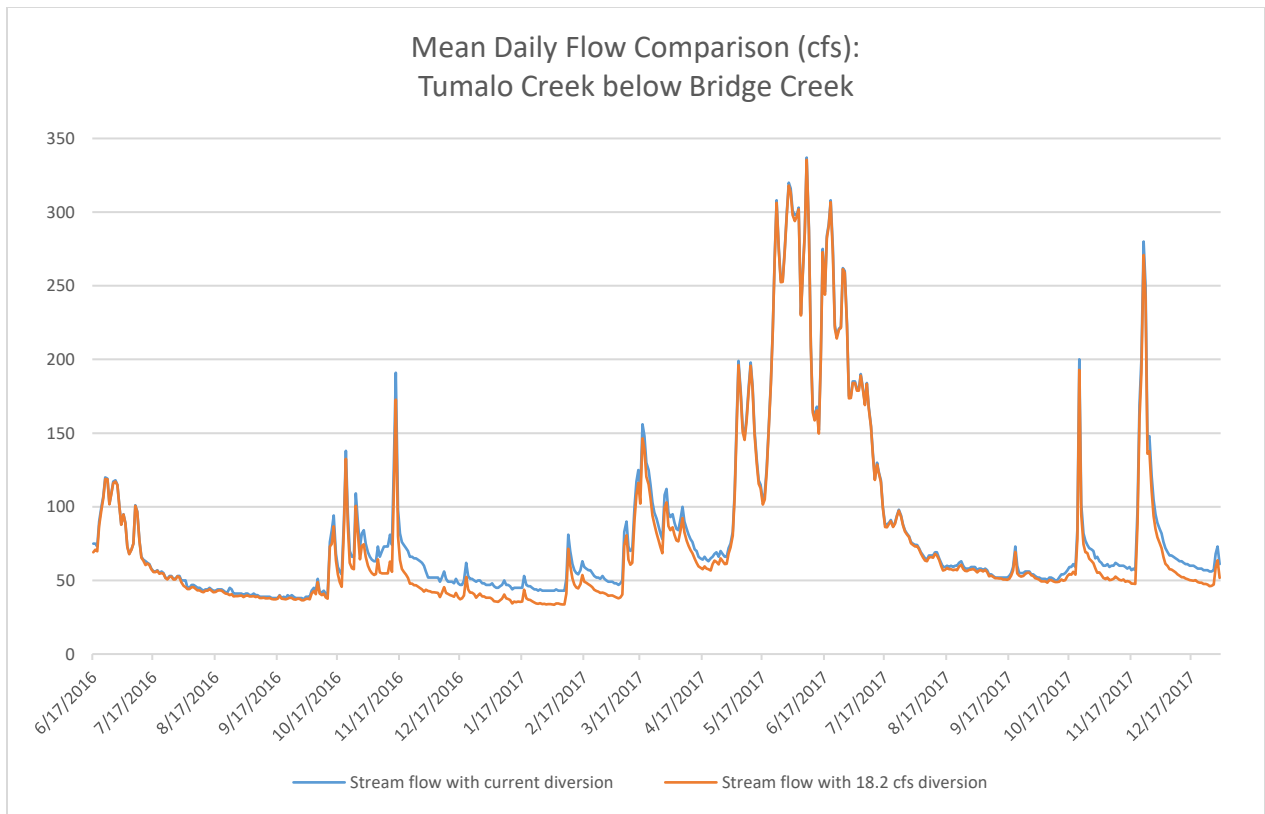


Figure 4. Actual flow rates at Station 14700920 compared to instream flow rates that would have been seen under a constant 18.2 cfs diversion rate of the previous system from 6/17/16 to 12/31/17. Current daily City diversion rates were converted to cubic feet per second (cfs) from millions of gallons per day.

From the beginning of the period of record through the end of 2017, greatest seasonal flow improvements under normal operations were seen through the winter months (November 1 – March 31) with average flow increases of approximately 9.6 cfs. Maximum daily flow increase during normal operations was 12.3 cfs. In-stream flow augmentation of 18.2 cfs did occur between November 9th and 28th 2016 during a period that the system was shut down for maintenance.

Average daily flow increases between April 1 and October 31, 2017 were approximately 3.5 cfs. The minimum daily flow improvement during this time was 0.1 cfs, with relative daily flow increases under 1.0 cfs occurring on 94 individual days during the warmer months mostly between May and September. Average daily flow increases seen in Tumalo Creek outside of the maintenance period from June 15, 2016 through December 31, 2017 were approximately 5 cfs higher than what would have been recorded with the operation of the old system (Figure 4).

Tumalo Creek Data at Station 14070980 at Skyliners Bridge:

Flow data at Station 14070980 includes the cumulative surface runoff in Tumalo Creek and all of its upstream tributaries, minus the City of Bend’s municipal surface water diversion (Figure 5). Surface water contributions include all of those named for the upstream gauge, as well as South Fork Tumalo Creek, Tumalo Lake Creek, and several groundwater sources along the approximately three miles between the two gauges below Bridge Creek, referred to as the accretion zone (Figure 6). This gauge captures all tributary inputs for Tumalo Creek below the City’s point of diversion, and provides an assessment of net flow conditions for approximately 10 miles of stream prior to TID’s diversion at RM 2.8. The same flow

increases under the operation of the new City of Bend water system discussed above applies through this gauge, and all downstream reaches to TID’s point of diversion. Minor instances where flow below Bridge Creek exceeds flow at Skyliners Bridge are a result of changed stream conditions during high flow events that alter the calibrated stage-discharge relationship, causing a minor error in discharge estimates.

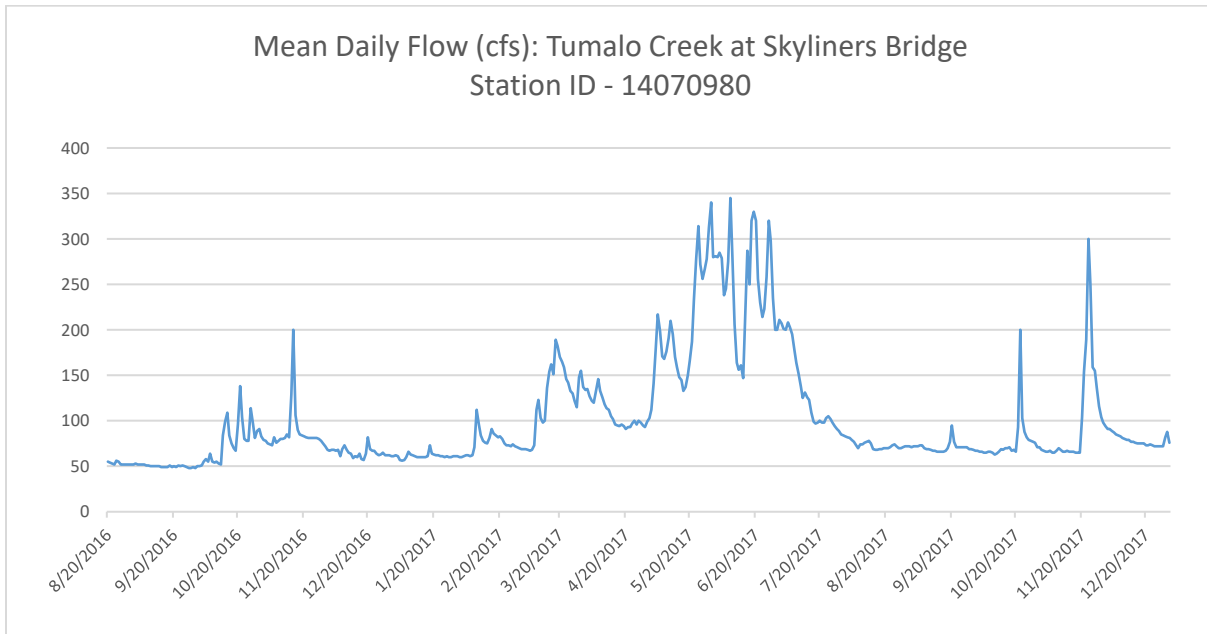


Figure 5. Station 14700980 flow data from 8/15/16 to 12/31/17.

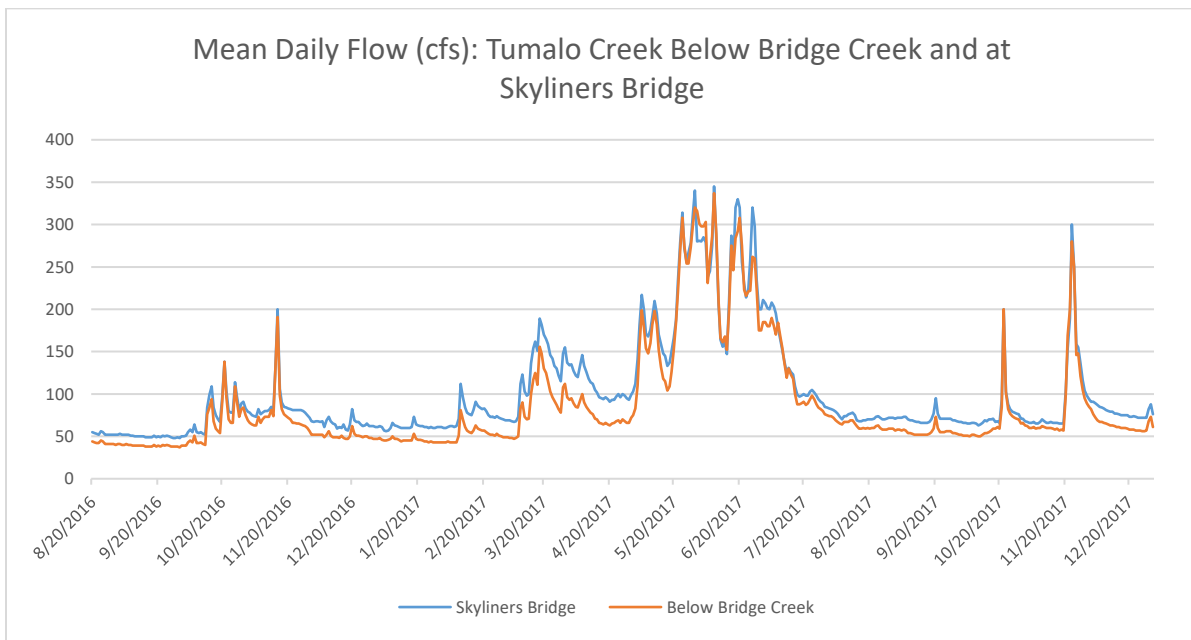


Figure 6 Composite hydrograph shows flow accretion from tributaries and groundwater between gauges.

Stream Temperature Monitoring

Within the Tumalo Creek watershed, Oregon State water quality standards for temperature vary. Above the confluence with Tumalo Lake Creek, the temperature standard is 12° C for bull trout spawning and juvenile rearing. This temperature standard was put in place during the period of time when Tumalo Creek was being considered for inclusion in designated critical habitat for bull trout. Following rigorous survey work that failed to find bull trout in this system, Tumalo Creek ultimately was not included in critical habitat for bull trout, but temperature standards have not yet been adjusted accordingly by the Oregon Department of Environmental Quality (DEQ). Below the confluence, the temperature standard is 18° C for salmon and trout rearing and migration.

Within the Tumalo Creek watershed where Tumalo Creek and its tributaries flow through National Forest System lands, riparian management objectives are described by both the Northwest Forest Plan (USDA, 1994) in the upper reaches of the watershed, and the Inland Native Fish Strategy (INFISH) (USDA, 1995) in lower reaches (Figure 2). While these management areas do describe general management objectives associated with stream temperature throughout the range of those management areas, they do not constitute or supersede water quality standards determining attainment or impairment of water quality standards established by the State on a reach by reach basis.

Tumalo Creek Data at Station 14070920 below Bridge Creek Confluence:

Instantaneous temperatures data were recorded at 15 minutes intervals at Station 14070920, providing an ongoing record over the life of the gauge. These data can be obtained at the OWRD's Near Real Time Hydrographics Data website (https://apps.wrd.state.or.us/apps/sw/hydro_near_real_time/). During the period of record analyzed for this report, there is a five week break in the data from August 16 to September 22, 2016. For the purpose of analyzing and assessing stream temperature in the State of Oregon, the 7-day average maximum is used to assess water quality and determine if standards are being met (Figure 7).

At this location on Tumalo Creek, Oregon State water quality standard for temperature is currently set at 12° C. Water temperatures in Tumalo Creek below the confluence with Bridge Creek remained below the standard throughout the period of analysis. The highest 7-day average maximum temperature was 11.5° C at the end of July 2016.

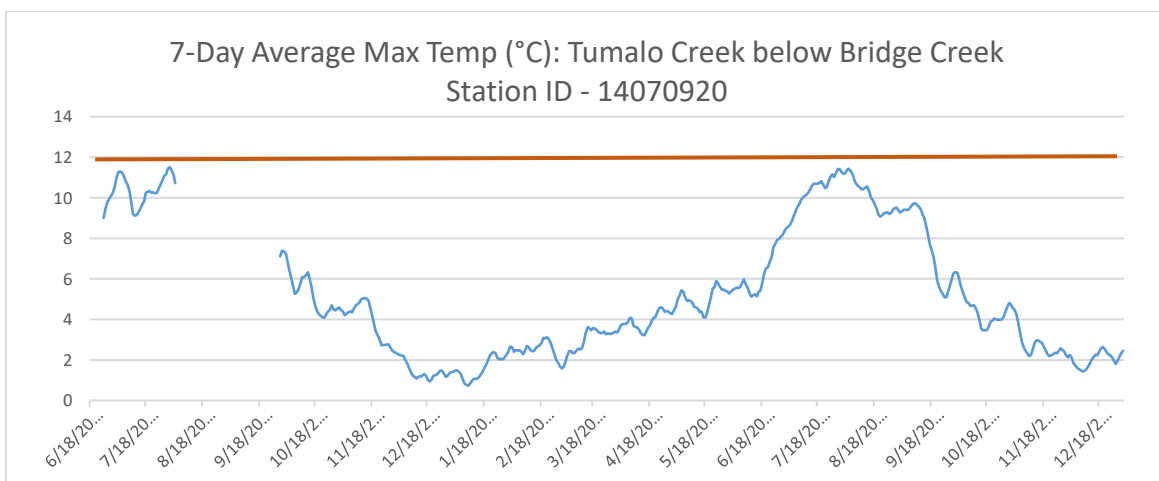


Figure 7. Tumalo Creek instantaneous temperature data at Station 14700920 from 6/17/2016 to 11/28/2017. The orange indicates the Oregon State temperature standard of 12° C.

Tumalo Creek Data at Station 14070980 at Skyliners Bridge:

Instantaneous temperature data are also recorded every 15 minutes at Station 14070920, with data provided at the same location indicated above. At this location on Tumalo Creek, the Oregon State water quality standard for temperature is set at 18°C.

Figure 8 provides an analysis of the 7-day average maximum temperature in Tumalo Creek at Skyliners Bridge. Through the period of record, the highest 7-day average maximum temperature was recorded at 13.4°C, well below the State water quality standard.

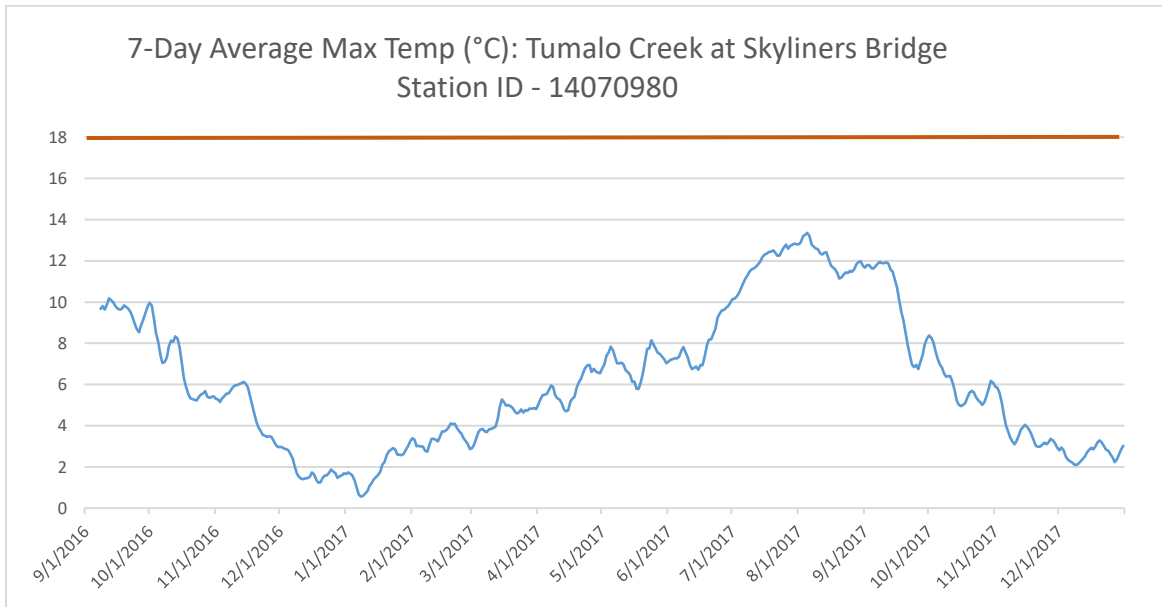


Figure 8. 7-day average maximum temperature data for Tumalo Creek at Station 14700980 from 9/1/16 to 12/31/17. The orange indicates the Oregon State temperature standard of 18°C.

Tumalo Creek Data at Location C:

The furthest downstream location for water temperature monitoring on Tumalo Creek that is not affected by the management of water by TID is at Location C (Figure 1). At this location on Tumalo Creek, the Oregon State temperature standard is also set at 18°C.

Figure 9 provides an analysis of the 7-day average maximum temperature in Tumalo Creek at Location C. There was a break in data between 9/7/2016 and 10/5/2016. Here too, the seven-day average maximum temperatures remained below the State water quality standard eek through the period of record. The highest 7-day average maximum temperature was recorded at 16.3°C at the end of July 2016.

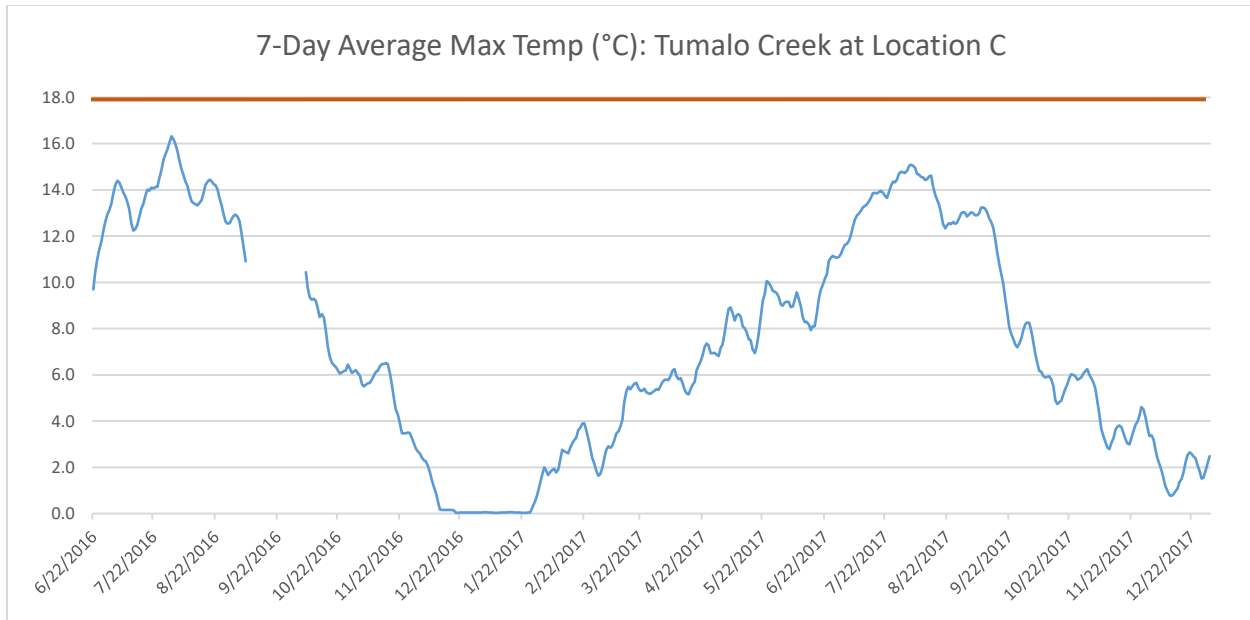


Figure 9. 7-day average maximum temperature data for Tumalo Creek at Location C from 6/22/16 to 12/31/17. The orange indicates the Oregon State temperature standard of 18° C.

Conclusion:

For the 2016-2017 monitoring period, stream flow and temperature data collected below the City of Bend’s surface water diversion in Reach A did not indicate any adverse effects to the aquatic environment in Tumalo Creek as a result of operations. Stream flows were on average 5 cfs higher in Reach A than what would have been seen under the operation of the previous system when surface water diversions from Bridge Creek were a constant 18.2 cfs.

The 7-day average maximum stream temperatures in Tumalo Creek were maintained below State water quality standards at all three monitoring stations within this reach. The highest temperatures recorded were at the end of July 2016 during a period of very low flow following a winter with a snow pack far below average. Tumalo Creek naturally buffers stream temperatures at very low flows as a relatively large proportion of runoff during periods of base flow is supported by springs and deeper groundwater. With the operation of the new water system, the additional water that is left instream helps to moderate stream temperatures throughout the year.

References:

- U.S. Environmental Protection Agency (EPA), 2014. *Best Practices for Continuous Monitoring of Temperature and Flow in Wadeable Streams*. Global Change Research Program, National Center for Environmental Assessment, Washington, DC; EPA/600/R-13/170F. Available from the National Technical Information Service, Springfield, VA, and online at <http://www.epa.gov/ncea>.
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