Crane Valley Hydroelectric Project, FERC No. 1354

Crane Valley Water Temperature Monitoring Results – 2009

Addressing License Article 405 and U.S. Forest Service Condition No. 5

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Power Generation
Crane Valley Hydroelectric Project, FERC No. 1354

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1.0 INTRODUCTION

1.1 Objective

The Crane Valley Water Temperature Monitoring Program was initiated in 2005 to evaluate water temperature in the stream reaches downstream of project dams. The program consisted of preparing a water temperature monitoring plan and performing water temperature monitoring for a six year period. The water temperature monitoring plan was completed and approved by early 2005. Data collected during 2009 represent the fifth year of water temperature monitoring for the Crane Valley Project.

1.2 FERC License Article 405 and U.S. Forest Service 4(e) Condition No. 5

Pacific Gas and Electric Company (PG&E) filed with the Federal Energy Regulatory Commission (FERC) a water temperature monitoring plan on September 24, 2004 that was prepared in consultation with the California Department of Fish and Game (CDFG), the U.S. Fish and Wildlife Service (USFWS), the U.S. Forest Service (USFS), and the State Water Resources Control Board (PG&E 2004). The water temperature monitoring plan was verbally approved by the USFS on September 17, 2004 pursuant to USFS 4(e) Condition No. 5. An Order was issued by FERC on January 18, 2005, approving the water temperature monitoring plan pursuant to Article 405 and subject to the modifications outlined in the Order (FERC 2005).

1.3 Project Area

The Crane Valley Hydroelectric Project (Project), FERC No. 1354 is located in Madera County, and includes North Fork Willow Creek (NFWC), South Fork Willow Creek (SFWC), mainstem Willow Creek, two major tributaries (Peckinpah Creek and Whiskey Creek), and four lakes (Bass Lake, Manzanita Lake, Chilkoot Lake, and Corrine Lake) (Figure 1.1-1; located behind text and tables of this document). The Project was constructed between 1895 and 1920 by the San Joaquin Electric Company and later the San Joaquin Power and Light Corporation (Studley et al. 1995). FERC issued a new license to PG&E for the continued operation of the Project on September 16, 2003 (FERC 2003). Project elevations range from 966 feet at A. G. Wishon Powerhouse on the San Joaquin River at Kerckhoff Lake to 7,497 feet at Chilkoot Lake.

Bass Lake is the main storage reservoir for the Project and has a drainage area of 50.4 square miles and a maximum water surface elevation of 3,377 feet. Bass Lake is formed by the Crane Valley Dam and is approximately 4 miles long. Bass Lake receives inflow from NFWC, SFWC (through the 2-mile long Browns Creek conduit), and other small streams.

Upstream of Bass Lake, Chilkoot Dam is located on Chilkoot Creek and creates Chilkoot Lake. The Chiquito Creek Pick-up ditch collects water, primarily spring runoff, and delivers it to Chilkoot Lake. When the water stored in Chilkoot Lake is released, it flows down Chilkoot Creek to NFWC and then into Bass Lake.

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Operational Flows including Releases to Tunnels, Canals and Bypass Flows

Water from Bass Lake enters an intake structure then passes through a tunnel beneath the lake and through the dam into the Crane Valley Powerhouse. Outflow from the powerhouse travels approximately 3.5 miles through the No. 3 Conduit to a forebay upstream of the San Joaquin No. 3 Powerhouse. Outflow from that powerhouse enters NFWC at the upper end of Manzanita Lake and is diverted again at Manzanita Lake Dam into the No. 2 Conduit, which carries water approximately 3 miles to the No. 2 Forebay. Water then travels approximately 0.75 miles through a penstock to the San Joaquin No. 2 Powerhouse.

Water from the San Joaquin No. 2 Powerhouse combined with water diverted from NFWC (including water diverted from SFWC into NFWC) travels to the San Joaquin No. 1A Powerhouse via approximately 5 miles of conduit. Water released from the powerhouse flows into Corrine Lake, which is the forebay for the A.G. Wishon Powerhouse. Water is released from the A.G. Wishon Powerhouse into Kerckhoff Lake.

Instream Flow Release Points that Support Fish and Riparian Vegetation habitats along NFWC, SFWC and Willow Creek

Required by Condition No. 4 of the Project license, instream flows are managed in accordance with the Crane Valley Instream Flow Measurement Plan (PG&E 2009b), which was approved by FERC on January 20, 2010. Water is released into NFWC below Bass Lake and supplemented with flows from a spill channel below Crane Valley Powerhouse via a 6 inch diameter pipe. The flows in NFWC below Bass Lake are measured at stream gage W3 and are required to be a minimum of 2 cubic feet per second (cfs), all water year (WY) types, year round. Water is diverted into Manzanita Lake from San Joaquin Powerhouse No. 3. Water is released from Manzanita Lake into NFWC. The License requires PG&E to release a minimum of 2 cfs, all WY types, year round from Manzanita Lake, as measured at stream gage W29. Below Manzanita Lake water from NFWC flows into the North Fork Diversion Dam and is released to its confluence with SFWC. With respect to SFWC, flows are released into SFWC via Browns Creek Diversion Dam with a 4.5 cfs to 10 cfs minimum flow requirement that is month dependent (June through January 4.5 cfs, February and May 8.0 cfs, and March and April 10 cfs). The required flows are measured at stream gage W33. In dry or critically dry water years, Condition 4 of the license allows minimum instream flows in South Fork Willow Creek to be reduced to an instantaneous minimum flow of 3 cfs year-round or the natural flow, whichever is less, to achieve the lake level requirements specified in Condition 10. Below the confluence of NFWC and SFWC (Willow Creek) no water is diverted into the system. Nominal water flows are returned to Willow Creek from the San Joaquin No. 1 Conduit when the project is in operation to ensure that flow as measured at stream gage W26 is no less than 0.5 cfs, all WY types, year round.

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2.0 METHODS

2.1 Sample Locations

Water temperature was measured at 13 stream locations from May 1 to October 31, 2009 (Figure 1.1-1). These water temperature monitoring stations are listed below, and photos of each station are included in Appendix E.

T1 NFWC below Bass Lake at the Crane Valley Powerhouse tailrace
T2 NFWC below Bass Lake at river mile 7.13
T3 NFWC upstream of Manzanita Lake at river mile 4.39
T4 NFWC at the Manzanita Lake Diversion Dam
T5 NFWC downstream of Manzanita Lake at river mile 3.00
T6 NFWC upstream of North Fork Diversion Dam at river mile 0.25
T7 SFWC upstream of the Browns Creek Diversion Dam at river mile 6.59
T8 SFWC downstream of the Browns Creek Diversion Dam at river mile 6.5
T9 SFWC above South Fork Diversion Dam at river mile 0.1
T10 Willow Creek at Gage W-26, river mile 4.3
T11 Willow Creek at Whiskey Creek, river mile 1.8
T12 Willow Creek at U.S. Geological Survey (USGS) Gage 2465, river mile 0.37
T13 Willow Creek downstream of the Sand Trap Spill Channel confluence, river mile 6.1

The rationale for selection of each sample location is provided in Table 2.1-1.

In addition to the thirteen stream water temperature monitoring stations, seven water temperature profiles were collected on a monthly basis (April – November 2009) from Bass Lake near the outlet structure (Figure 1.1-1).

2.2 Water Temperature Data Collection

Stream water temperatures were automatically measured *in situ* at 20-minute intervals from May 1 through October 31, 2009 with VEMCO MiniLog 12 TR digital temperature loggers. The MiniLog 12 TR is a miniature microprocessor controlled water temperature logger that stores data in non-volatile memory. The MiniLog 12 TR has an accuracy of ± 0.1 degrees Celsius (°C) between 5 and 40°C. Data were downloaded approximately monthly to a laboratory computer and stored. Data downloads occurred on May 26, June 30 and July 1, August 4 and 5, September 2 and 3, October 6 and 7, and November 2 and 3, 2009. These data are provided in Appendix A.

During field visits to download data from the water temperature recorders, Bass Lake water temperature profiles were also collected. From April through September, reservoir temperature profiles were collected using a YSI™ 600XL multiparameter water quality measurement system coupled with a YSI™ 610 DM Display/Logger. The YSI™ 600XL instrument has an accuracy

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of approximately ±0.15°C between -5 and 50°C. During October and November, reservoir temperature profiles were collected using a Hydrolab™ multi-parameter water quality monitoring system, with an accuracy of ±0.10°C between -5 and 50°C. Water temperature was recorded in 0.1 meter intervals for the profiling of Bass Lake. Reservoir temperature data are also provided in Appendix A.

Certification of water temperature monitoring equipment quality assurance/quality control (QA/QC) calibration is included as Appendix D. Other quality assurance procedures consisted of employing redundant loggers and a thorough post-collection data review (Section 2.5). Following application of the QA/QC procedures, the hourly arithmetic mean (mean) of water temperatures recorded during each day were calculated in an Excel spreadsheet for both tabular and graphical presentation.

2.3 Stream Flows (Preliminary and Provisional)

In addition to water temperature, stream flow was measured continuously at 20 existing PG&E maintained gaging stations and two USGS gaging stations during the monitoring period (one of the USGS stations, USGS 2465, is maintained by the Southern California Edison Company [SCE]) (Figure 1.1-1). Reservoir storage volumes were also collected at two locations (Bass Lake and Corrine Lake). A list of the instream flow monitoring stations, operational flow monitoring stations and reservoir storage monitoring stations is below. All associated preliminary and provisional stream flow and reservoir storage data within the Project are located in Appendix B (on CD) along with plots of daily mean flows.

<u>Instream Flow Monitoring Stations</u>

WC3 North Fork Willow Creek near Bass Lake – Total Flow
W24 North Fork Willow Creek near Sugar Pine (USGS maintained gage)
W3 North Fork Willow Creek near Bass Lake
W33 SFWC below the Brown's Creek Diversion Dam
W29 Instream Flow on North Fork Willow Creek below Manzanita Lake Dam
W26 Willow Creek below Confluence of North and South Forks
2465 Willow Creek at Mouth (USGS-SCE gage)

<u>Operational Flow Monitoring Stations</u>

W1 Browns Creek Canal at Bass Lake
W19 Crane Valley Powerhouse
W4 Conduit No. 3 near Bass Lake
W6 San Joaquin No. 3 Powerhouse
W9 No. 2 conduit
W11 San Joaquin Powerhouse No. 2
W8 North Fork Willow Creek Spill below Manzanita Lake

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W15 North Fork Willow Creek Spill below North Fork Diversion Dam
W13 South Fork Willow Creek Spill below South Fork Diversion Dam
W12 South Fork Willow Creek Canal above North Fork Willow Creek
W14 Willow Creek Diversion to No. 1 Conduit
W27 No. 1 Conduit Spillway at San Joaquin No. 2 Powerhouse
W25 No. 1 Conduit below Bass Lake
W16 San Joaquin No. 1A Powerhouse
W18 A.G. Wishon Powerhouse

Reservoir Storage Monitoring Stations

W2 Bass Lake Storage
W17 Corrine Lake Storage

All stream flow data are presented as daily mean flow data in cfs and storage data are presented in acre feet (AF). All flow and storage data are considered preliminary and subject to revision until a final review of the data has been completed.

2.4 Meteorological Stations

To collect data on ambient weather conditions during the sampling period, two PG&E meteorological stations were monitored within the Project area. The meteorological stations were located near the Crane Valley Powerhouse (at an elevation of 3,400 feet) and at the A.G. Wishon Powerhouse (at an elevation of 966 feet). Date, time, and hourly mean air temperatures were recorded at the meteorological stations. Relative humidity and solar radiation were also measured in order to supplement the water temperature monitoring data; this information will be useful if a modeling effort is conducted in the future.

The raw data for air temperature is provided in Appendix C (on CD) for both meteorological stations during the 2009 monitoring program period (May – October). Raw data were extracted into Excel spreadsheets, and daily mean and daily maximum air temperatures were calculated, by month, for use in both tabular and graphical presentations.

2.5 Quality Assurance/Quality Control

The Quality Assurance Program Plan (QAPP) prepared by PG&E was developed to provide guidance and quality assurance for water temperature and water quality monitoring studies that are required for various PG&E projects, including FERC relicensing and compliance monitoring activities (PG&E 2007). This QAPP was utilized during data acquisition and synthesis to provide quality assurance and quality control guidance.

Continuous Water Temperature Monitoring
At the 13 stream sites, continuous water temperature monitoring involved collection of water temperature data at 20-minute intervals with VEMCO MiniLog 12 TR digital temperature

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loggers. As required by the QAPP, the MiniLog 12 TR has an accuracy of ± 0.1°C between 5 and 40°C (PG&E 2007). Two loggers were placed at each site so that if data from one logger were lost, data from the redundant logger would be available. Primary and redundant logger placement at each site was generally no more than 5 meters apart, a spacing chosen to minimize data variation. For the few primary and original loggers placed further apart, field staff tried to ensure that the placement of both loggers was in similar stream settings (i.e., deeper channel, with the most flow available resulting in a representative water temperature of the stream reach). To further reduce data loss, loggers were placed in metal housings with protective foam inserts and metal chains and locks were used to anchor loggers.

One set of VEMCO MiniLog 12 TR digital temperature loggers was employed for the 2009 monitoring effort and each logger was calibrated in a laboratory setting prior to use. This set was calibrated by PG&E in the off-season and was used from May 1 to October 31, 2009. Calibration information for each logger is provided in Appendix D.

During the May 26 field visit, only three out of the thirteen sites were visited due to a communication error between the field computer and the VEMCO water temperature logger interface. However, all May data were retrieved during the June field visit. All thirteen sites were visited during the remaining field visits, with the exception of sites T7 and T8 during the August 5 field visit due to lack of access. This is further discussed in Section 3.0.

Reservoir Temperature Profiles

The Bass Lake temperature profiles consisted of collecting temperature data at 0.1-meter intervals at the deepest part of the reservoir. These data were collected using an YSI™ 600XL multi-parameter water quality measurement system that has an accuracy of approximately ±0.15°C between -5 and 50°C. Pre-deployment, the unit was calibrated by field staff during each site visit. During October and November only, reservoir temperature profiles were collected using a Hydrolab™ multi-parameter water quality monitoring system which has an accuracy of approximately ±0.1°C between -5 and 50°C. This unit was calibrated prior to deployment by the manufacturer.

Data Representativeness, Completeness, and Accuracy

PG&E specifies representativeness, completeness, and accuracy objectives for temperature data acquisition in the QAPP (PG&E 2007). Representativeness is ensured via the placement of the loggers and location of reservoir profile measurements, as well as the measurement intervals. Representative locations and measurement intervals were described above. Accuracy for field measurements is defined as the degree of conformity of a measured/calculated quantity to its actual (true) value, while completeness is the number of valid measurements divided by the number of measurements collected. Accuracy and completeness are discussed below.

The accuracy objective for the Crane Valley Temperature Monitoring Program is 90 percent (PG&E 2007). To verify calibration during the Project, at each temperature logger download event an *in-situ* instantaneous water temperature was collected using a hand-held National Institute of Standards and Technology (NIST) traceable thermometer with an accuracy of 1°C between -20 and 100°C. When compared to one another, the majority of the available instantaneous measurements did not vary by more than 1°C from corresponding hourly mean

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temperature collected by either the primary or redundant logger. Water temperature recorded between the primary and redundant logger never varied by more than 1.1°C during the course of the Project, suggesting that the instruments maintained their calibration throughout the monitoring season.

The completeness objective for the Crane Valley Temperature Monitoring Program is 90 percent (PG&E 2007). In 2009, the completeness objective was met for all Bass Lake profiles, as 100 percent of all data were valid, while the completeness objective for the stream monitoring sites were met for all sites except T7 and T9. To determine completeness and identify valid measurements, each month the daily mean, maximum, and minimum temperatures from each month were graphed. These graphs were then used to visually represent the data at each monitoring site. Data from periods when it could be determined that the VEMCO MiniLog 12 TR digital temperature loggers were not recording *in-situ* conditions were excluded from data reports generated with the database.

In two cases where the primary logger had been out of the water, the data set was completed by using data collected for the redundant logger. At site T11, a redundant logger, T11B, was reassigned to the role of primary logger in June because the original primary logger, T11A, was found out of the water during the June download due to flow reductions. Hence, the loss of 11A data did not affect the data set's completeness. Also, the primary logger T13A was found out of the water at site T13 during the September field visit. The redundant logger, T13B was reassigned the role of primary logger in September. Therefore, no data were lost at site T13.

Upstream of the South Fork Willow Creek Diversion Dam, at site T9, data were lost for 22 days in June, due to flow reductions. From June 9 through June 30, both the primary and the redundant recorders were stranded due to fluctuating water levels. This resulted in a total reduction in the dataset size of 12 percent. Upstream of the Browns Creek Diversion Dam, at site T7, data were lost for 44 days from July 19 through September 1. Both the primary and the redundant recorders were stranded due to flow reductions and this site was not accessible during the August field visit. This resulted in a total reduction in the dataset size of 24 percent.

Altogether, there was a reduction in data loss during 2009 as compared to 2008. An increased effort was demonstrated by field staff to optimize data retention during the 2009 field season.

3.0 RESULTS

Temperature data are presented in Section 3.1. A summary of flow data throughout the Project area is included in Section 3.2. The 2009 temperature monitoring study results are discussed in Section 3.3.

3.1 Water Temperatures and Meteorological Conditions

Water temperature recorders were deployed at all 13 sites (T1 through T13) on April 29 and 30, 2009. Temperature data collected for this Project are summarized in Table 3.1-1. All daily maximum, mean and minimum water temperatures have been plotted and are presented in

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Figures 3.1-1, 3.1-2 and 3.1-4 through 3.1-14. The primary temperature logger was used to develop daily water temperature statistics, unless otherwise indicated. Raw and reduced water temperature data are located in Appendix A. Bass Lake water temperature profiles are presented in Figure 3.1-3. Because water temperature monitoring sites T2, T3, T5, T8, T9, T10 and T12 are located at or in close proximity to stream gaging stations W3, W29, W33, W13, W26, and USGS 2465 respectively, the flow data collected at the gages are also presented with the water temperature data in Figures 3.1-2, 5, 6, 8, 10, 12, and 14.

Ambient air temperature data were collected at the A.G. Wishon and Crane Valley Reservoir weather stations. A comparison between daily mean water temperature, daily mean air temperature and daily flow (if available) is provided in Figures 3.1-15 through 3.1-27 for each water temperature monitoring site. Raw air temperature data are located in Appendix C.

A station-by-station discussion, from the upper elevation stations to the lower elevation downstream stations, is provided below.

Water Temperature Monitoring Sites T7 and T8: SFWC upstream of the Browns Creek Diversion Dam at river mile 6.59 and SFWC downstream of the Browns Creek Diversion Dam at river mile 6.5, respectively

Water temperature monitoring sites T7 and T8 are located in close proximity to each other. T7 is located upstream of the Browns Creek Diversion Dam, while T8 is located downstream of the diversion dam. The minimum, maximum, and mean daily water temperatures recorded at both sites are nearly identical (Figures 3.1-1; 3.1-2; 3.1-15; and 3.1-16). The mean daily water temperature did not exceed 17.7°C at both sites during the monitoring period. On August 5, loggers at both sites were not downloaded during the field visit due to inaccessible roads during construction activities. During the initial logger installation at site T7, both loggers were installed within a fork off of the main stream channel. This was due to high water levels within the main channel that created unsafe conditions for access. On September 2, both loggers at site T7 were out of the water. Both of the loggers were moved to deeper water within the main stream channel to ensure proper data collection for the remainder of the monitoring period. The data show that both loggers were out of the water beginning on July 19. The mean daily water temperatures for T7 and T8 resembled the same trend as the mean daily air temperatures throughout the monitoring period, with the exception of the missing data at T7 (Figures 3.1-15 and 3.1-16; respectively).

Bass Lake Temperature Profile

Seven water temperature profiles of Bass Lake were collected between April 30 and November 3. All seven profiles are graphically shown in Figure 3.1-3. The water temperature profile taken in late April showed a warming trend in Bass Lake with a thermocline forming within the first five meters of depth. Bass Lake became more stratified after the June profile and exhibited a thermocline above six meters on August 5, 2009. The thermocline remained through September, but dropped to a depth of approximately eight meters. The October and November water temperature profiles were both orthograde, indicating that fall turnover had occurred before the October 7 download. The water levels at Bass Lake were unusually low during the October

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profile compared to data collected during past years. A rain event occurred between the October and November profile collection dates, which explains the increase in water levels between those months.

Water Temperature Monitoring Site T1: NFWC below Bass Lake at the Crane Valley Powerhouse Tailrace Overflow Spillway

The water temperature recorders at T1 recorded the outflow from Bass Lake via the overflow spillway channel from the No. 3 Conduit below the Crane Valley Powerhouse. Between May 1 and September 12, the mean daily water temperature in the spill channel remained fairly constant, between 7.2 and 10.4°C (Figure 3.1-4). The mean daily water temperature increased to 12.1°C on September 15 and continued increasing until October 5, when the mean temperature reached a high of 16.7°C. After October 5, the mean daily water temperatures decreased slowly until the recorders were removed. The mean daily water temperature never exceeded 16.7°C for the entire monitoring period. However, because of its proximity to Bass Lake (immediately below the dam), the water temperature at T1 is likely most affected by the water temperature released from Bass Lake. The warmest water temperatures recorded at T1 were from September 15 through October 31 and coincided with the fall turnover of Bass Lake (Figure 3.1-17). The warmer July air temperatures did not result in a noticeable increase in water temperatures at this location.

Water Temperature Monitoring Site T2: NFWC below Bass Lake at river mile 7.13

Water temperature monitoring station T2 is located downstream of Bass Lake on NFWC near gage W3. Between May 1 through May 10, water temperatures steadily increased from a mean daily water temperature of 12.7°C up to a mean daily water temperature of 18.6°C (Figure 3.1-5; 3.1-18). After May 10, the mean daily water temperature steadily decreased to 9.6°C on May 29. The mean daily water temperature increased on May 30 to 15.8°C, which corresponded to a mean flow increase from 3.8 cfs to 13.0 cfs. The mean daily water temperature showed an overall increasing trend between May 29 and June 28. After June 28, the mean temperature decreased steadily until July 22 at 10.6°C when the temperatures remained constant for the most part. These mean water temperatures followed the same trend as mean flow values. On September 15, the mean daily water temperature increased to 12.6°C and continued increasing until October 9 at 15.2°C. After October 9, the mean temperatures fluctuated between 15.2°C and 12.9°C. The mean daily water temperature never exceeded 22.5°C for the entire duration of the monitoring period. The mean daily water temperatures showed occasional correlation with the mean daily air temperatures (Figure 3.1-18).

Water Temperature Monitoring Site T3: NFWC upstream of Manzanita Lake at river mile 4.39

T3 showed an overall increase in mean daily water temperature from May 1 through June 29 when the mean daily temperature peaked at 22.5°C (Figure 3.1-6; 3.1-19). After June 29, the mean daily temperature showed an overall decrease until the recorders were removed. The mean daily water temperature never exceeded 22.5°C for the entire monitoring period. The mean daily water temperature resembled the same trend as the mean daily air temperatures throughout the monitoring period (Figure 3.1-19).

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Water Temperature Monitoring Sites T4 and T5: NFWC at the Manzanita Lake Diversion Dam and NFWC downstream of Manzanita Lake at river mile 3.00 respectively

Sites T4 and T5 are located within 150 feet of each other. T4 is located on the upstream side of Manzanita Dam, while T5 is located downstream of the dam just below a weir and gage.

Daily mean water temperatures at T5 had an overall constant trend from May 1 until May 28, with a variation in mean temperature between 9.6°C and 12.9°C. After May 28, the mean temperatures increased steadily until June 2 when the temperature reached 20.2°C. At this point, the mean daily water temperatures basically followed the same trend as the daily mean air temperatures until September 15 when the temperature decreased to 13.3°C. After September 15, the mean daily water temperatures fluctuated between 13.3°C and 16.2°C. The mean daily water temperatures at T5 never exceeded 25.0°C throughout the monitoring period. The mean daily water temperatures at T4 exhibited the same overall temperature trend as T5, but showed cooler temperature trends overall. The mean daily water temperatures at T4 did not exceed 23.4°C throughout the monitoring period.

Overall, both T4 and T5 appeared to show occasional correlation between mean daily water temperatures and mean daily air temperatures (Figure 3.1-20 and Figure 3.1-21, respectively). The values at gage W29, which is located below Manzanita Lake, started out at 14 cfs on May 1. On May 2 and 3, the mean flow values increased to 89 cfs and 112 cfs, respectively. The mean flow values decreased after May 3 and continued to decrease until May 23, when the flow value was 5.8 cfs. After May 27, the mean flow values fluctuated between 5.7 cfs and 37 cfs until July 16. After July 16, the flow values stayed below 9 cfs other than October 14 when the mean flow value was 33 cfs.

Water Temperature Monitoring Site T6: NFWC upstream of North Fork Diversion Dam at river mile 0.25

T6 is located at the upstream face of the North Fork Diversion Dam. The mean daily water temperatures increased steadily from May 1 until July 20, when the mean temperature peaked at 23.2°C (Figure 3.1-9). In August and September, the mean daily water temperature decreased and never exceeded 22.7°C. The mean daily water temperature continued to decrease until October 6 at 11.2°C, and then fluctuated until the end of the monitoring period. This decrease in mean daily water temperature coincided with a decrease in mean daily air temperature (Figure 3.1-22). The mean daily water temperatures at T6 did not exceed 23.2°C throughout the monitoring period. The flow value at spill gage W15 below North Fork Diversion Dam was 0 cfs on May 1 and 2. On May 3, the flow value increased to 77 cfs and then decreased rapidly until the mean value of 2 cfs was reached on May 12. The mean flow values remained at zero after May 12 until June 3, when the flow increased to 6 cfs. The flow continued to increase and peaked at 47 cfs on June 7. The flow decreased after June 7 to 30 cfs on June 12. Between June 14 and October 11, the flow values were 0 cfs, other than July 12 when the flow value was 7 cfs. After October 11, the flow values remained at or below 7 cfs, other than October 14 when the flow value was 17 cfs.

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Water Temperature Monitoring Site T9: SFWC above South Fork Diversion Dam at river mile 0.1

Water temperature monitoring site T9 is located upstream of the South Fork Diversion Dam. In July, the daily mean water temperature did not exceed 21.2°C (Figure 3.1-10). In August, the mean daily water temperatures did not exceed 21.2°C. Mean daily water temperatures decreased throughout August and September until a low of 9.9°C was reached on October 8. After October 8, water temperatures increased slightly until the end of the monitoring period. The mean daily water temperature values demonstrate the same overall trend as the daily mean air temperatures and did not exceed 21.2°C (Figure 3.1-23).

Some data loss occurred at this site. Both temperature recorders were placed at this site on April 29 during high water levels. This site was not visited during the May 26 field visit due to a communication error between the field computer and the VEMCO water temperature logger interface. During the June 30 field visit, the water level was drastically lower[1] and both temperature recorders were found out of water. Data from June 9 through June 30 were removed due to both recorders being displaced from the water (Figure 3.1-10; 3.1-23). Both loggers were relocated downstream to a tree within the stream channel. During the September 2 field visit, the water level at this site had dramatically increased and was not accessible by foot. PG&E operators lowered the water levels at this site prior to the October 6 field visit and both loggers were accessible. Subsequently, both recorders were relocated downstream near the diversion dam and data were recorded for the remainder of the monitoring period without incident.

Water Temperature Monitoring Site T13: Willow Creek downstream of the Sand Trap Spill Channel confluence, river mile 6.1

Site T13 is located below the spill channel of the No.1 Conduit Sand Trap, downstream of the confluence of NFWC and SFWC. The mean daily water temperature values showed an overall increase from May 1 to July 20 to a mean high of 22.4°C. After July 20, the daily mean water temperatures decreased overall until the loggers were removed (Figure 3.1-11). The mean daily water temperatures never exceeded 22.4°C for the entire monitoring period. The overall warming and cooling trend of water temperatures followed the overall air temperature fluctuations throughout the monitoring period (Figure 3.1-24). During the September 2 field visit, T13A was found out of water. Data from T13B were used to replace the data lost from T13A. Thus, no data loss occurred at this site.

Water Temperature Monitoring Site T10: Willow Creek at Gage W-26, river mile 4.3

Site T10 is located below the confluence of NFWC and SFWC downstream of gage W26. The mean daily water temperature at T10 never exceeded 21.9°C in June. In July, the daily mean water temperature increased and did not exceed 22.9°C. Daily mean water temperatures decreased in August to a high of 22.8°C. In September, the daily mean water temperature continued to decrease to a maximum of 21.0°C (Figure 3.1-12). The lowest daily maximum mean water temperature occurred in May with a value of 10.0°C. The water temperatures noted

[1] Spill had changed from about 200 cfs to 0 cfs.

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at T10 generally corresponded to fluctuations in air temperatures and flow levels (Figure 3.1-25). This site has high sun exposure for the majority of the day with limited opportunities for hiding the loggers under rocks or other material within the stream.

Water Temperature Monitoring Site T11: Willow Creek at Whiskey Creek, river mile 1.8

Site T11 is located on the main stem of Willow Creek just below its confluence with Whiskey Creek. The water temperature at T11 is influenced by the inflow from Whiskey Creek. The mean daily water temperature at T11 never exceeded 22.3°C in June. In July and August, the daily mean water temperatures peaked at 23.9°C during both months. The daily mean maximum water temperature in September decreased to 23.0°C. The daily mean water temperature continued to decrease in October with a high of 16.0°C. The increases and decreases in mean daily water temperature at T11 correlate with the increases and decreases in mean daily air temperature (Figure 3.1-26).

T11A and T11B were both originally placed in an area within the stream with consistent flow and partial sun exposure. This original location was chosen based on safe access. However, the water levels at this site decreased throughout the monitoring period. During the June 30 field visit T11A was found out of the water. Water temperature data from T11B were used to replace the missing data. T11A was subsequently moved to a deeper area within the stream channel to minimize additional data loss. During the August 4 field visit, T11B was found out of the water and relocated to the same area that T11A was moved.

Water Temperature Monitoring Site T12: Willow Creek at USGS Gage 2465, river mile 0.37

Site T12 is the lowest on the Project (elevation 1,196 feet) and is located upstream of the confluence of Willow Creek and the San Joaquin River at the USGS/SCE gage 2465. In June, the mean daily water temperature at site T12 never exceeded 22.8°C (Figure 3.1-14). During June, both loggers were out of the water on June 23-24 and June 26-27. The highest mean daily water temperature reached 24.3°C on July 20. However, the highest mean daily water temperature was not recorded at T12 (24.3°C), but rather at T5 (25.0°C). The increases and decreases in mean daily water temperature at T12 correlate with the increases and decreases in mean daily air temperature (Figure 3.1-27) and fluctuating flows. Water flowing through T12 had a greater residence time and therefore more opportunity to be heated when compared to the other stations within the Project. Again, water temperature monitoring station T12 is the lowest in elevation and is therefore the most likely to experience the highest ambient air temperatures thus resulting in higher mean daily water temperature.

3.2 Stream Gage and Reservoir Storage Measurements

Preliminary and provisional stream flow data from 22 gaging stations and storage data from Bass Lake and Corrine Lake are presented as a summary of monthly mean flows in Table 3.2-1. These data encompass May 1 through October 31, 2009. All stream flow and reservoir storage raw data files are all located in Appendix B.

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Stream Flow (Preliminary and Provisional)

The majority of the highest mean, maximum, and minimum stream flow values recorded at each gaging station were observed during either the first two months (May and June) or the last two months of the monitoring period (September and October) (Table 3.2-1). The highest flows within NFWC, SFWC, or Willow Creek were recorded at USGS gage 2465 (located on Willow Creek at mouth) with a maximum flow of 943.4 cfs for October. The highest monthly mean flows were also recorded at USGS gage 2465 and averaged 296.3 cfs for the month of May. Of the eight gages located within NFWC, SFWC and Willow Creek (this does not include flows through Project canals), two gages (W15 and W13) recorded the spill over Project diversion dams and not actual stream flow. Gage W15 recorded zero spills for the majority of the monitoring period other than May 3 through May 10 (between 2 and 77 cfs), May 12 (2 cfs), June 3 through June 13 (between 6 cfs and 47 cfs), July 12 (7 cfs), and October 12 through October 31 (between 2 cfs and 17 cfs). Gage W13 recorded zero spills throughout the majority of the monitoring period other than May 1 through June 8 (between 25 cfs and 454 cfs), June 29 and July 6 (between 3.78 cfs and 7.06 cfs), October 15 through October 20 (between 4 cfs and 59 cfs), October 22 through October 26 (between 10 cfs and 21 cfs), and October 29 through 30 (6 cfs). It must be noted that while the spill gages frequently recorded zero spill, the actual flow within NFWC, SFWC, and Willow Creek was not zero and minimum stream flow requirements were being met and measured at other locations throughout the Project.

As described in Section 1.3 (Project Description), the Crane Valley Hydroelectric Project License and the Crane Valley Project Instream Flow Measurement Plan both specify minimum flow requirements within NFWC, SFWC, and Willow Creek. Within NFWC, a minimum flow of 2 cfs is to be measured at gages W3 and W29 year round. According to the preliminary and provisional stream flow data for NFWC during the 2009 Crane Valley water temperature study, as measured at W3 and W29, the minimum flow requirements were met for the study's duration.

Within SFWC, the minimum stream flow requirements during the course of the Crane Valley Project are set at 8 cfs for May and 4.5 cfs through October or natural flow, whichever is less. During dry or critically dry water years, flows can be reduced to an instantaneous minimum flow of 3 cfs year round, if necessary, to achieve the lake level requirements specified in Condition 10 (Lake Levels) of the License. The required flows are measured at stream gage W33, downstream of the Browns Creek Diversion Dam and water temperature monitoring sites T7 and T8. Gage 33 is a partial range gaging station which only measures instream flows up to a maximum of 29 cfs. In May, flows measured at W33 were greater than 29 cfs from May 1 through May 17 and October 14. Between May 18 and 31, the flows varied between 5.2 cfs and 19 cfs. During June and July, the flows remained above 3 cfs. The flows also remained above 3 cfs during the beginning of August until August 19 (at 2.8 cfs) and decreased to 2.5 cfs on August 21. During August 23 through 27, the flows were at or above 3 cfs. Between August 28 and September 14, the flow values were below 3 cfs. On September 15 the flow value was 3 cfs, then decreased below 3 cfs between September 16 through October 4. Between October 8 and 13, the flow values were below 3 cfs but the duration of the monitoring period had flow values above 3 cfs. During periods of low flow, the flows were not being diverted and were equivalent to upstream, natural flows. For the mainstem of Willow Creek, flows (as reported at W26) met or exceeded the 0.5 cfs minimum requirement for the entire monitoring period.

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With respect to the conduits, there were consistent flows through gages W1 (Browns Ditch) and W14 (Upper San Joaquin #1 Ditch) except during maintenance and when needed to support instream flow release requirements. Gage W12 (South Fork Ditch) only had consistent flows from August 21 through October 12. Browns Ditch was out of service between July 12 and October 2 for maintenance and re-lining work. The annual Crane Valley Project maintenance outage occurred from July 6 through August 16, 2009.

Flows in conduits, through gages W4 (San Joaquin #3 Ditch), W9 (San Joaquin #2 Ditch) and W25 (Lower San Joaquin #1 Ditch) are released from Bass Lake to support power generation. During the 2009 monitoring period, W4 recorded flow during May 1 through July 5 and August 11 through the duration of the monitoring period (October 31). W9 recorded flow during May 1 through May 27, June 3 and 4, and September 14 through October 31. W25 had flow during May 12 and 13, June 13, 20 and 21, July 2 through 5, August 7 through September 15, and September 17 through October 31.

Reservoir Storage

Reservoir storage was measured at Bass Lake and Corrine Lake. Bass Lake is the main storage reservoir for the Crane Valley Project while Corrine Lake (A.G. Wishon Forebay) is located outside of the Willow Creek Drainage and receives much of its water from the Willow Creek drainage.

From May 3 through May 28, storage decreased in Bass Lake from 34,700 to 34,100 AF of water. Between May 29 and June 15, storage increased from 34,300 to 34,700 AF of water. After June 15, storage in Bass Lake was no longer increasing. By October 31, storage had been reduced to 24,021 AF.

From May 1 through July 2, storage levels decreased in Corrine Lake from 67.14 to 31.91 AF of water. Between July 3 and July 5, storage levels increased from 39.24 to 69.08 AF respectively. After July 5, storage levels decreased until reaching a low of 0.91 AF on August 6. Between August 8 and August 13, the storage levels increased to 53.08 AF of water. Between August 14 and September 16, the storage levels fluctuated between 34.01 and 63.07 AF. After September 16, the storage levels flattened out and maintained levels between 44.52 and 52.76 AF.

3.3 Discussion of Results

The fifth year of the Crane Valley Water Temperature Monitoring Program occurred in 2009. In general, the water temperature increased as water flowed from the upper elevations of the Project to the lower elevations of the Project. Additionally, water temperatures within the system increased with the onset of summer, peaked near the end of July/early August, and decreased throughout the remainder of the study period.

The fifth year, 2009 was a Below Normal Water Year according to the San Joaquin Valley Water Year Type Index (information obtained from the Department of Water Resources California Data Exchange Center [CDEC] at http://cdec.water.ca.gov/cgi-progs/iodir/WSI).

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July was on average the warmest month with a monthly mean air temperature of 27.1°C at the A.G. Wishon Powerhouse and a monthly mean air temperature of 25.9°C at the Crane Valley Powerhouse. The high air temperatures and extended periods of daylight combined with the low flow conditions increased the water temperatures in NFWC, SFWC and Willow Creek. Flow into the bypass reach (Willow Creek downstream of confluence with North Fork and South Fork Willow Creek) was allowed from April 26 through August 6 (due to a partial failure of the Lower San Joaquin #1 Ditch and the planned maintenance outage for the Crane Valley Project in 2009) and again from October 12 through November 16 due to unanticipated loss of generating capability at AG Wishon Powerhouse.

The daily mean flow rates at W26 between May 1 (beginning of monitoring period) and August 6 ranged between 4.8 cfs and 807 cfs. The daily mean flow rates between October 12 and October 31 (end of monitoring period) ranged between 2.3 cfs and 836.1 cfs. These changes in flow levels could have affected water temperatures at T6, T9, T13, T10, T11 and T12. The partial failure of Lower San Joaquin #1 Ditch also contributed to the low water levels at Corinne Lake.

PG&E reduced the water level at Bass Lake during the recreation season at the request of the Division of Safety of Dams and FERC in the spring of 2009 to prepare a seismic retrofit repair plan. The current water level will continue to be reduced or maintained no higher than 10 feet below maximum water level during the recreation season until the construction of the Crane Valley Dam Retrofit Project is complete. This lowered water level will reduce the risk of a dam breach during a seismic event (PG&E 2009a). The lowered water level may have an effect on water temperature data collected during the monitoring period. Overall, the reservoir levels at Bass Lake in 2009 were lower than 2008 levels. They were also lower than the 2005, 2006, and the majority of 2007 water levels.

4.0 REFERENCES

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Tables and Figures

Table 2.1-1. Sample locations and the rationale for selection.

Station ID	Station Location	Monitoring Activity*	Rationale
Profiles	Bass Lake	TP	Determine water temperature changes in the water column of Bass Lake
Meteorology	Crane Valley Powerhouse	Met	Characterize ambient conditions within the Project near Crane Valley PH
T1	NFWC downstream of Bass Lake at the Crane Valley PH Tailrace	TR	Determine water temperature of water released through Crane Valley PH
T2	NFWC River Mile 7.13, below Bass Lake	TR	Determine stream water temperature at the start of the stream reach
T3	NFWC River Mile 4.39, upstream of Manzanita Lake	TR	Determine stream water temperature entering a Project reservoir
T4	Manzanita Lake at the Project Diversion	TR	Determine the water temperature of water in Manzanita Lake
T5	NFWC River Mile 3.0, downstream of Manzanita Lake	TR	Determine water temperature of water released from Manzanita Lake
T6	NFWC River Mile 0.25, upstream of NFWC Diversion Dam	TR	Determine water temperature of stream above Project diversion
T7	SFWC River Mile 6.59, upstream of Browns Creek Diversion Dam	TR	Determine water temperature of stream above Project Diversion
T8	SFWC River Mile 6.5, downstream of the Browns Creek Diversion Dam	TR	Determine water temperature of stream below Project diversion at the start of the stream reach
T9	SFWC River Mile 0.1, upstream of SFWC Diversion Dam	TR	Determine water temperature of stream above Project Diversion
T10	Willow Creek River Mile 4.3, at Gage W-26	TR	Determine water temperature below the confluence of NFWC and SFWC
T11	Willow Creek River Mile 1.8, at the mouth of Whiskey Creek	TR	Determine water temperature at the confluence of a major tributary
T12	Willow Creek River Mile 0.37, at USGS Gage 2465	TR	Determine water temperature at the end of the Project Reach
T13	Willow Creek downstream of the sand trap spill channel confluence	TR	Determine water temperature below the confluence of NFWC and SFWC
Meteorology	A.G. Wishon Powerhouse	Met	Characterize ambient conditions within the Project near A.G. Wishon PH

* TP = Water temperature profile of Bass Lake
Met = Meteorology monitoring (Air Temperature)
TR = Continuous recording of water temperature

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Table 3.1-1. Monthly mean, minimum and maximum water temperatures observed during the monitoring program (May 1 to October 31, 2009) by station.

Station ID	Month during 2009	Data Days	Water Temperature (°C)		
			Min	Mean	Max
T1	May	31	7.6	9.3	10.2
	June	30	7.2	8.0	10.4
	July	31	7.3	7.5	8.1
	August	31	7.5	8.1	10.2
	September	30	8.3	11.1	15.0
	October	31	14.2	15.5	16.7
T2	May	31	9.6	15.7	20.3
	June	30	16.9	20.1	22.5
	July	31	10.1	13.9	21.8
	August	31	9.2	10.1	11.8
	September	30	9.9	12.0	14.6
	October	31	12.9	14.4	15.2
T3	May	31	13.1	17.0	18.9
	June	30	16.4	19.6	22.5
	July	31	17.4	18.8	21.7
	August	31	13.2	15.9	18.1
	September	30	14.0	15.5	16.2
	October	31	8.8	12.3	14.9
T4	May	31	9.5	11.5	12.9
	June	30	12.1	17.6	23.4
	July	31	20.4	21.7	23.1
	August	31	14.4	19.2	22.9
	September	30	13.0	16.6	20.4
	October	31	14.0	15.3	16.2
T5	May	31	9.6	12.1	18.2
	June	30	12.2	19.6	24.0
	July	31	21.7	23.6	25.0
	August	31	15.7	21.0	25.0
	September	30	13.3	17.0	21.2
	October	31	13.9	15.3	16.2
T6	May	31	11.5	14.0	17.0
	June	30	13.4	18.9	22.3
	July	31	20.0	21.9	23.2
	August	31	17.8	19.8	22.7
	September	30	13.9	17.8	20.1
	October	31	9.2	12.6	15.4
T7	May	31	7.4	11.1	13.3
	June	30	9.0	12.3	16.0
	July	18	13.9	15.2	16.8
	August	0	--	--	--
	September	29	11.7	14.8	16.3
	October	31	6.0	9.9	12.5
T8	May	31	7.4	11.2	13.5
	June	30	8.8	12.4	16.2
	July	31	13.8	16.1	17.7
	August	31	13.7	15.6	17.7
	September	30	11.9	15.0	16.2
	October	31	6.1	10.0	12.5

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Table 3.1-1. (continued)

Station ID	Month during 2009	Data Days	Water Temperature (°C)		
			Min	Mean	Max
T9	May	31	8.9	13.4	16.4
	June	10	11.8	14.7	19.8
	July	31	16.8	19.4	21.2
	August	31	17.2	18.7	21.2
	September	30	14.2	16.9	18.6
	October	31	9.8	11.6	13.0
T10	May	31	10.0	12.9	17.2
	June	30	12.8	18.2	21.9
	July	31	18.6	21.1	22.9
	August	31	18.7	20.3	22.8
	September	30	13.9	18.1	21.0
	October	31	10.2	12.6	14.9
T11	May	31	10.8	13.9	18.1
	June	30	13.4	18.3	22.3
	July	31	19.3	22.0	23.9
	August	31	19.8	21.9	23.9
	September	30	15.1	20.0	23.0
	October	31	9.0	13.4	16.0
T12	May	31	11.2	14.5	18.6
	June	26	14.0	18.4	22.8
	July	31	19.8	22.5	24.3
	August	31	20.5	22.3	24.3
	September	30	15.7	20.1	22.8
	October	31	9.3	13.8	16.6
T13	May	31	9.7	13.7	16.7
	June	30	12.4	18.0	20.6
	July	31	18.5	20.7	22.4
	August	31	17.7	19.5	22.1
	September	30	13.7	17.8	20.0
	October	31	8.5	12.1	14.8

-- No data available for August at T7 due to temperature logger out of water.

Monthly values are based on daily mean data, and represent the maximum, minimum and mean of the daily mean water temperatures recorded in each month (Appendix A). The daily mean is based on hourly mean water temperatures recorded during each day.

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Table 3.2-1. Summary of 2009 stream flow (cfs) monitoring and reservoir storage (AF) at PG&E and USGS-SCE maintained stations. All flow data are preliminary and provisional.

Station ID	Month during 2009	Data Days	Daily Mean Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W24	May	31	44.0	85.1	264.0
	June	30	13.0	26.2	49.0
	July	21	4.4	8.2	13.0
	August	31	2.5	3.3	6.3
	September	30	2.0	2.2	2.9
	October	30	2.6	6.9	65.0
W33	May	31	5.2	22.5	>29.0
	June	30	4.5	11.1	21.0
	July	31	5.0	9.3	15.0
	August	31	2.2	3.8	5.8
	September	30	1.6	1.9	3.0
	October	31	2.1	6.7	>29.0
W1	May	31	1.5	15.3	43.0
	June	30	0.0	13.9	17.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	0.9	11.0
W2 Bass Lake Storage	May	31	34,100.0	34,354.8	34,900.0
	June	30	34,500.0	34,600.0	34,700.0
	July	31	34,100.0	34,261.3	34,500.0
	August	31	33,500.0	33,735.5	34,000.0
	September	30	29,300.0	32,160.0	33,500.0
	October	31	24,020.7	26,650.5	29,053.6
W19	May	31	0.0	112.4	135.5
	June	30	0.0	4.8	102.7
	July	31	0.0	0.0	0.0
	August	31	0.0	0.3	9.1
	September	30	0.0	57.8	148.9
	October	31	0.0	71.6	116.5
W3	May	31	3.5	29.2	187.0
	June	30	15.0	42.0	58.0
	July	31	3.9	6.1	17.0
	August	31	3.8	4.2	14.0
	September	30	3.2	3.5	3.9
	October	31	3.2	3.6	6.8
W4	May	31	1.8	126.2	150.0
	June	30	0.2	9.6	110.0
	July	31	0.0	0.4	4.1
	August	31	0.0	3.0	44.0
	September	30	2.3	67.9	122.0
	October	31	119.0	120.8	122.0
W6	May	31	0.0	100.4	125.1
	June	30	0.0	6.4	86.9
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	52.0	119.0
	October	31	81.0	93.4	111.6

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Table 3.2-1. (continued)

Station ID	Month during 2009	Data Days	Daily Mean Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W8	May	31	0.0	28.3	221.0
	June	30	0.0	27.7	80.0
	July	31	0.0	1.1	20.0
	August	31	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	0.0	0.0
W29	May	31	5.8	22.5	112.0
	June	30	5.7	20.8	37.0
	July	31	3.6	6.0	13.0
	August	31	2.5	4.3	8.4
	September	30	3.8	4.4	5.0
	October	31	3.9	5.3	33.0
W9	May	31	0.0	125.1	150.
	June	30	0.0	8.3	125.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	71.4	131.0
	October	31	118.0	124.4	131.0
WC3	May	31	1.8	126.2	150.0
	June	30	0.2	9.6	110.0
	July	31	0.0	0.4	4.1
	August	31	0.0	3.0	44.0
	September	30	2.3	67.9	122.0
	October	31	119.0	120.8	122.0
W11	May	31	0.0	112.0	137.4
	June	30	0.0	17.2	110.4
	July	31	0.0	0.8	25.0
	August	31	0.0	0.0	0.0
	September	30	0.0	57.7	117.5
	October	31	101.7	109.2	133.7
W12	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.9	3.0
	September	30	0.0	1.9	3.0
	October	31	1.0	0.5	3.0
W15	May	31	0.0	9.3	77.0
	June	30	0.0	11.0	47.0
	July	31	0.0	0.2	7.0
	August	31	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	2.9	17.0
W13	May	31	25.0	98.8	454.0
	June	30	0.0	10.6	81.0
	July	31	0.0	1.3	6.9
	August	31	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	7.0	59.0

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Table 3.2-1. (continued)

Station ID	Month during 2009	Data Days	Daily Mean Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W14	May	31	1.1	5.3	18.0
	June	30	0.0	6.0	34.0
	July	31	0.0	0.2	7.0
	August	31	0.0	4.8	14.0
	September	30	4.0	4.9	7.0
	October	31	0.0	1.5	6.0
W27	May	31	0.0	126.3	150.0
	June	30	0.0	8.3	125.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	13.0	130.0
	October	31	0.0	0.0	0.0
W26	May	31	23.0	254.5	807.0
	June	30	19.0	64.2	158.0
	July	31	8.2	15.4	52.0
	August	31	1.6	3.7	8.8
	September	30	1.4	15.7	131.0
	October	31	2.0	41.0	836.1
USGS Gage 2465	May	31	37.8	296.3	828.8
	June	30	29.1	79.8	169.4
	July	31	8.20	18.9	56.3
	August	31	1.62	4.55	8.0
	September	30	1.02	15.2	129.8
	October	31	1.8	43.6	943.4
W25	May	31	0.0	0.0	1.1
	June	30	0.0	0.0	0.2
	July	31	0.0	0.8	12.8
	August	31	0.0	4.0	22.4
	September	30	0.0	54.9	120.8
	October	31	116.8	118.4	120.7
W16	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	0.0	0.0
	September	30	0.0	48.8	129.3
	October	28	106.0	122.7	334.0
W17 Corrine Lake Storage	May	31	48.3	58.1	67.1
	June	30	33.1	40.3	47.8
	July	31	24.2	45.3	69.1
	August	31	0.9	36.6	61.0
	September	30	34.0	47.1	63.1
	October	29	44.5	48.2	52.8
W18	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	0.0
	August	31	0.0	2.9	28.7
	September	30	0.0	52.6	124.1
	October	30	109.2	114.1	125.0

Stream flow and storage data are provided in Appendix B.

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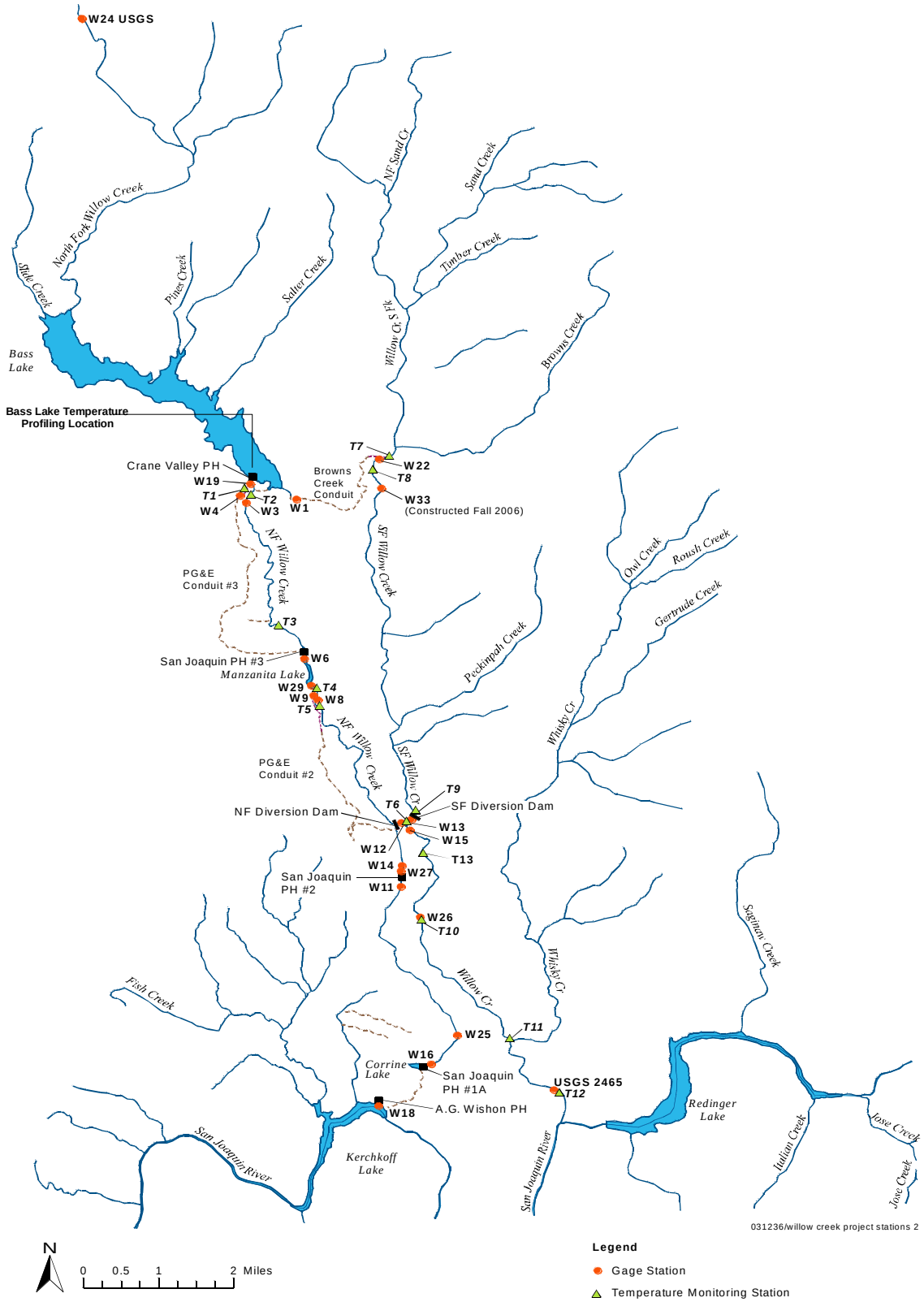

Figure 1.1-1. Crane Valley Project Area, Including Water Temperature Monitoring Station Locations and Gage Locations.

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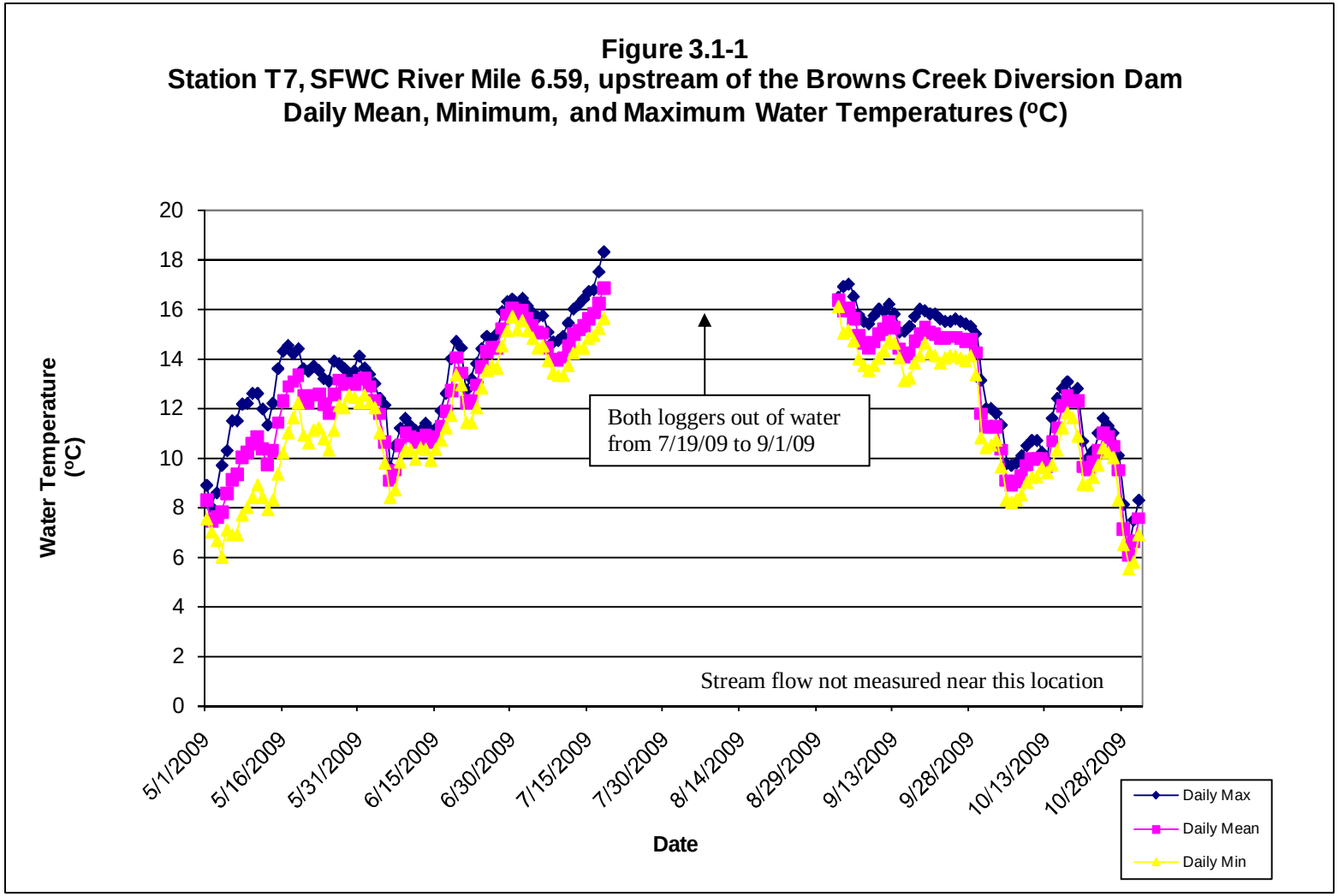

Figure 3.1-1. Station T7, SFWC River Mile 6.59, upstream of the Browns Creek Diversion Dam Daily Mean, Minimum, and Maximum Water Temperatures (°C).

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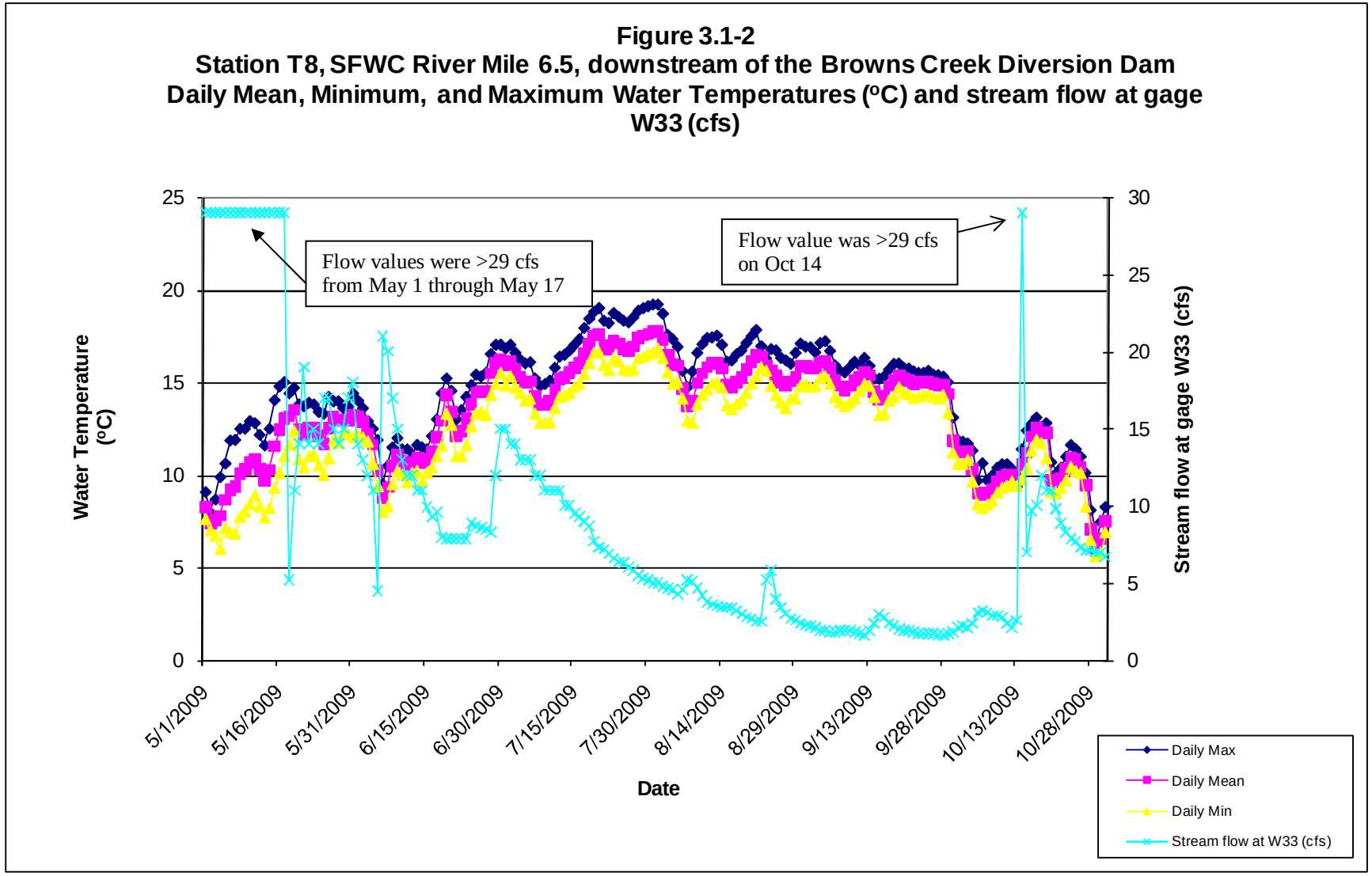

Figure 3.1-2. Station T8, SFWC River Mile 6.5, downstream of the Browns Creek Diversion Dam Daily Mean, Minimum, and Maximum Water Temperatures (°C) and stream flow at gage W33 (cfs).

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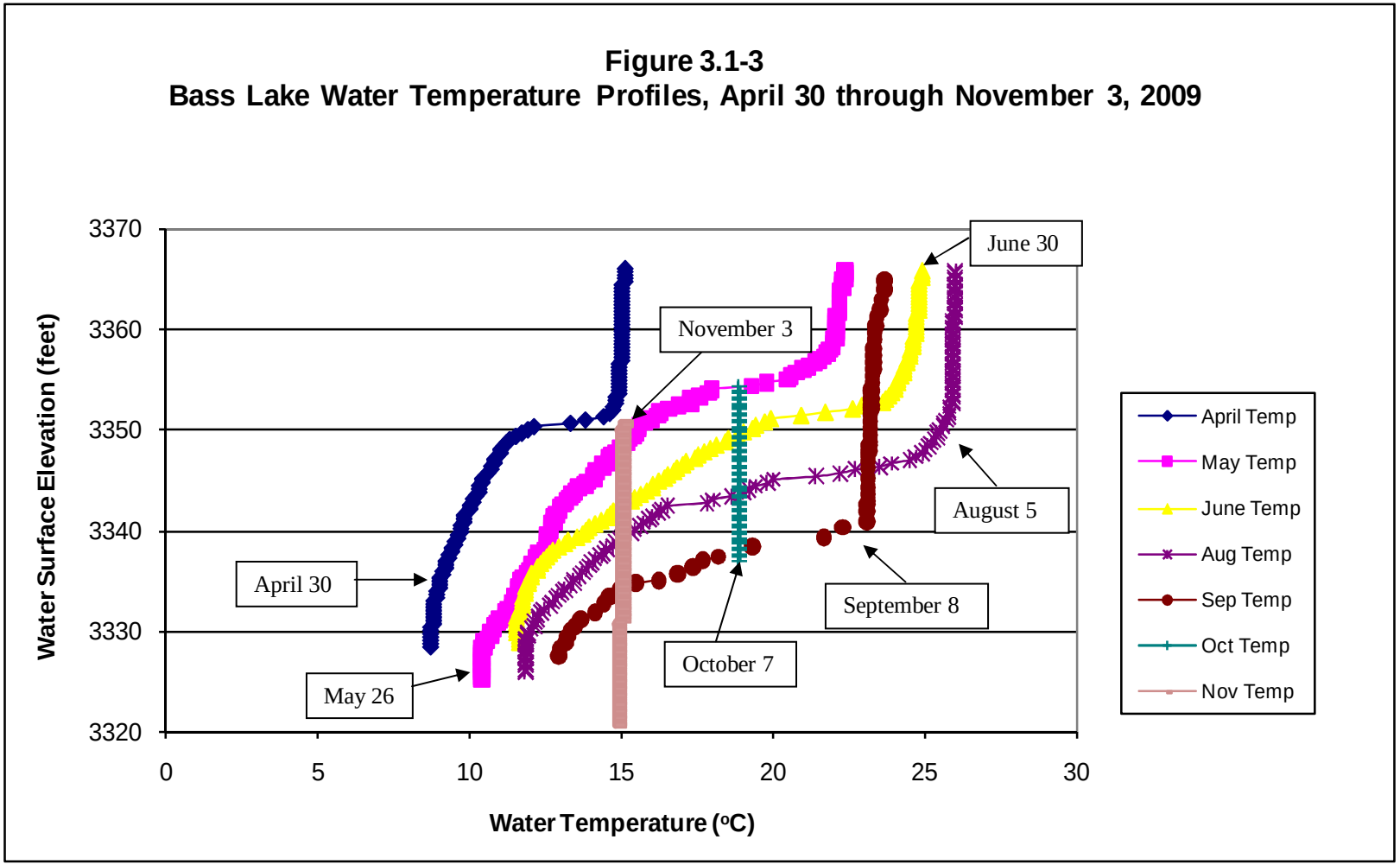

Figure 3.1-3. Bass Lake Water Temperature Profiles, April 30 through November 3, 2009.

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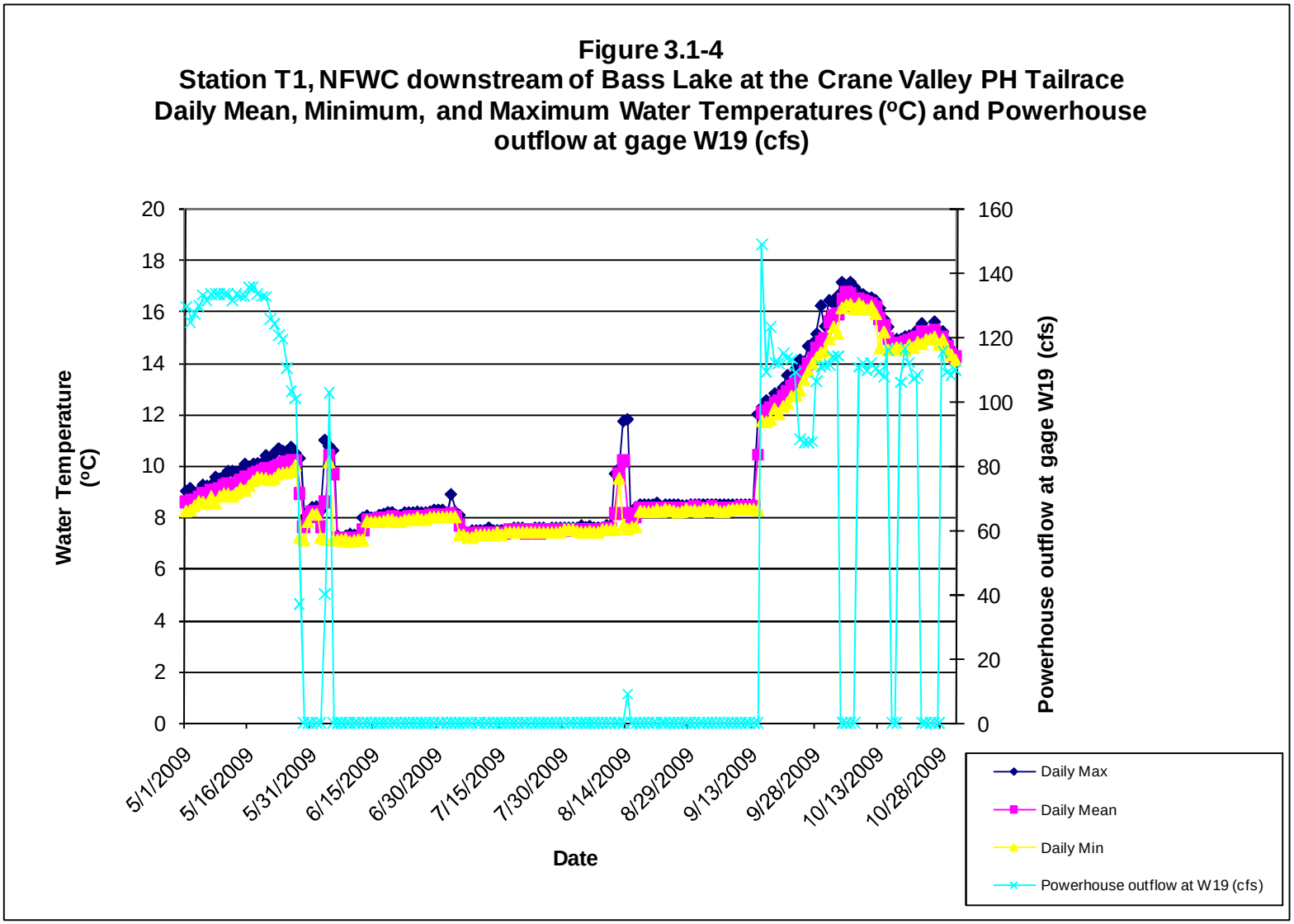

Figure 3.1-4. Station T1, NFWC downstream of Bass Lake at the Crane Valley PH Tailrace Daily Mean, Minimum, and Maximum Water Temperatures (°C) and Powerhouse outflow at gag W19 (cfs).

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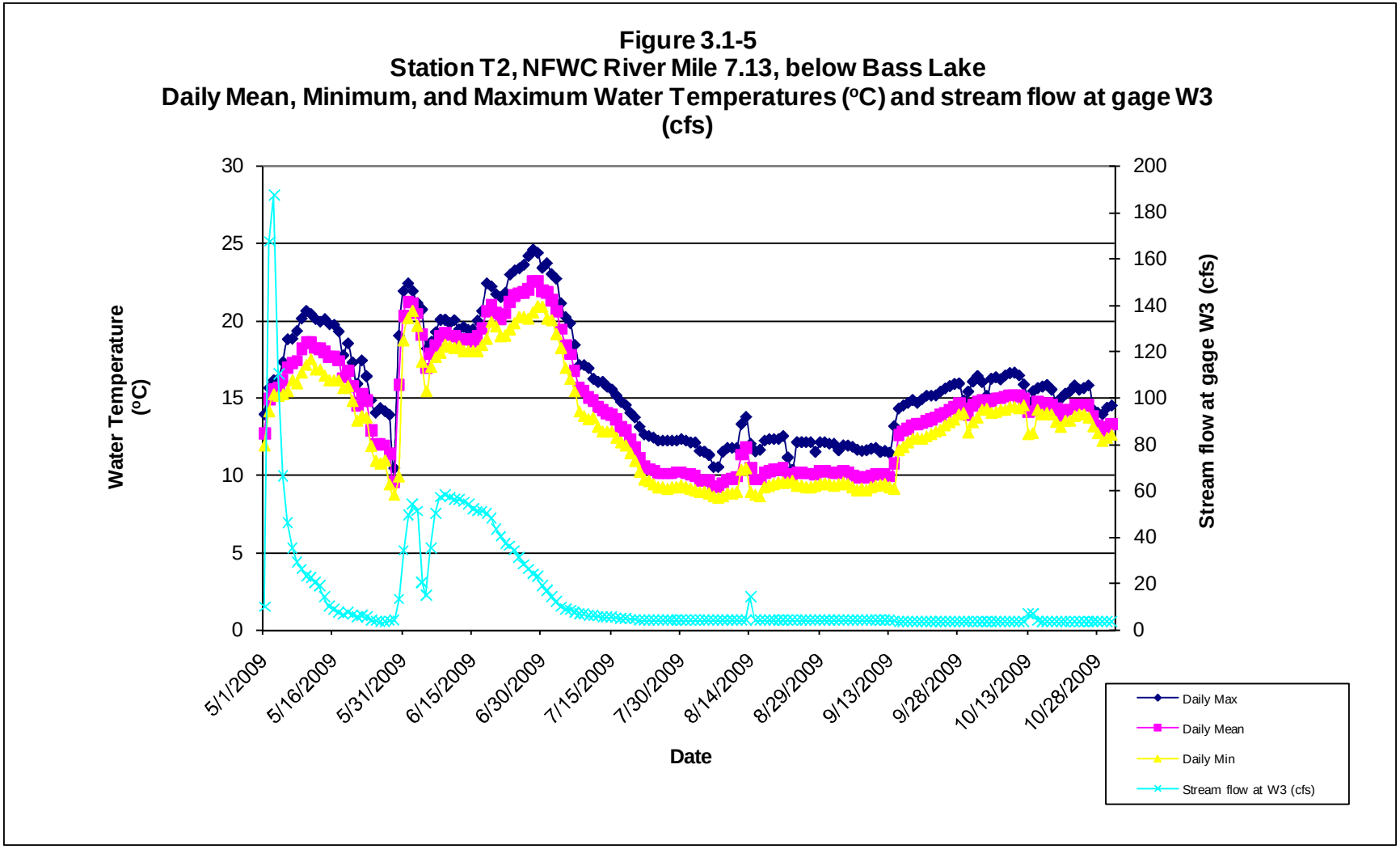

Figure 3.1-5. Station T2, NFWC River Mile 7.13, below Bass Lake Daily Mean, Minimum, and Maximum Water Temperatures (°C) and stream flow at gage W3 (cfs)

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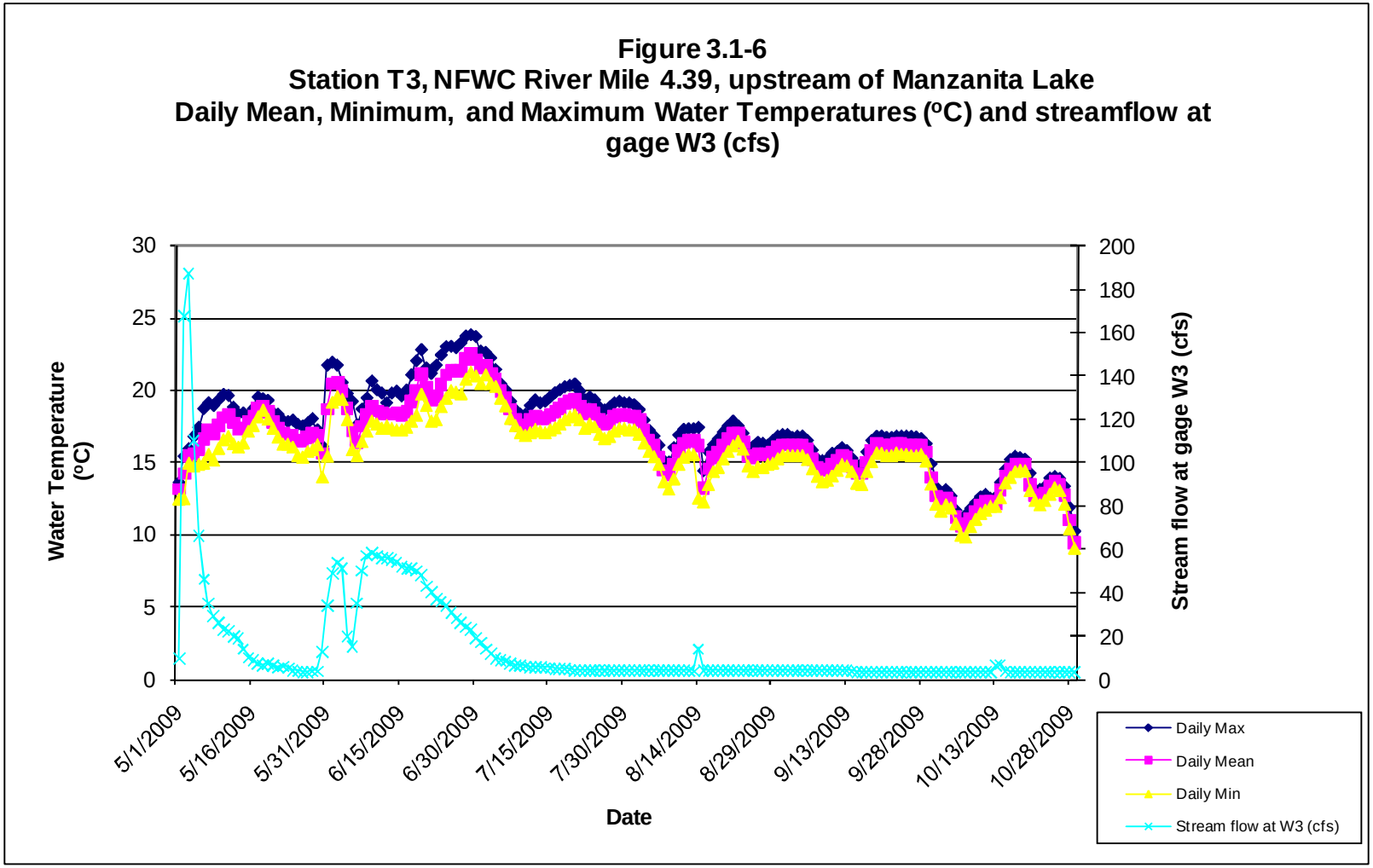

Figure 3.1-6. Station T3, NFWC River Mile 4.39, upstream of Manzanita Lake Daily Mean, Minimum, and Maximum Water Temperatures (°C) and streamflow at gage W3 (cfs).

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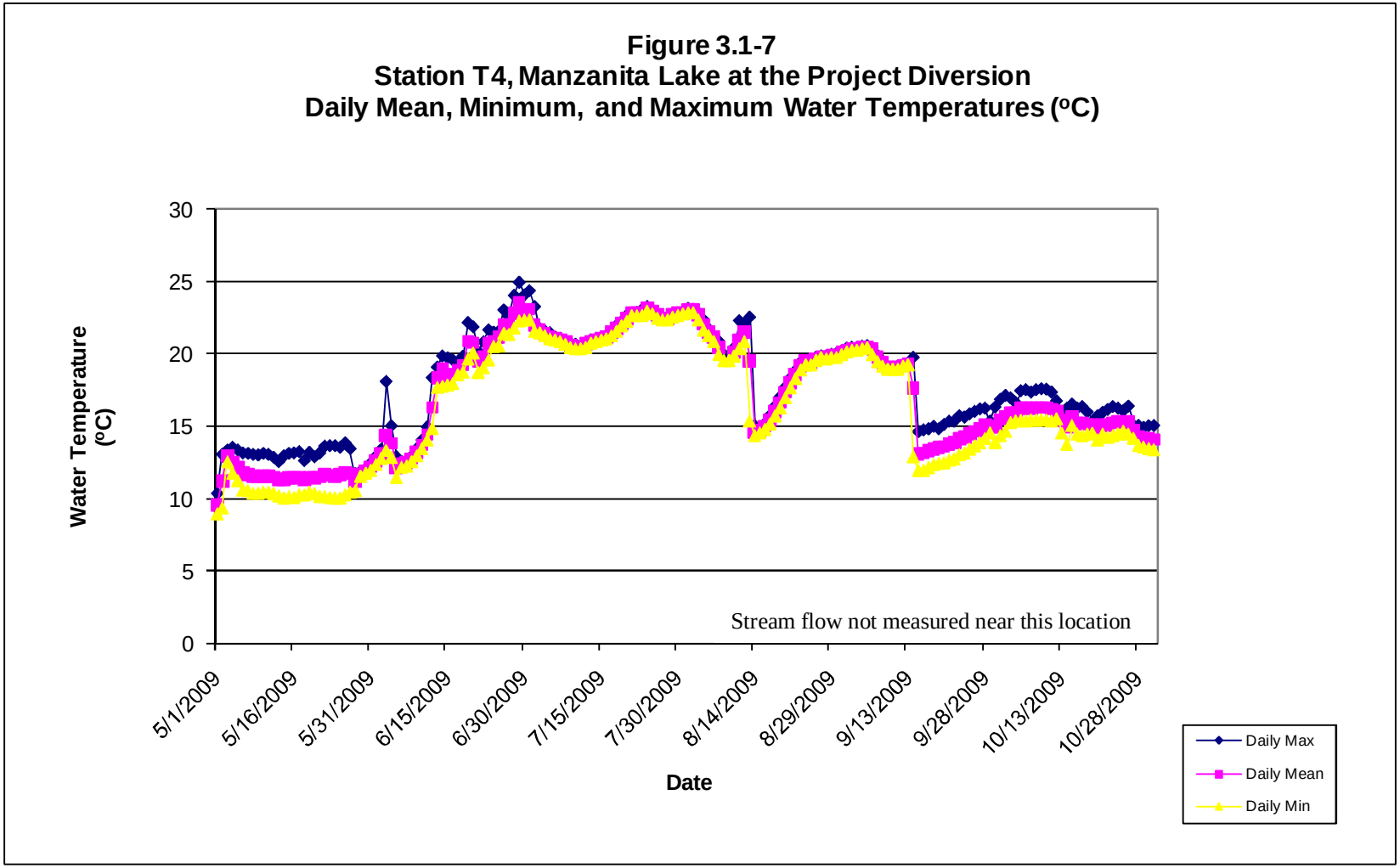

Figure 3.1-7. Station T4, Manzanita Lake at the Project Diversion Daily Mean, Minimum, and Maximum Water Temperatures (°C).

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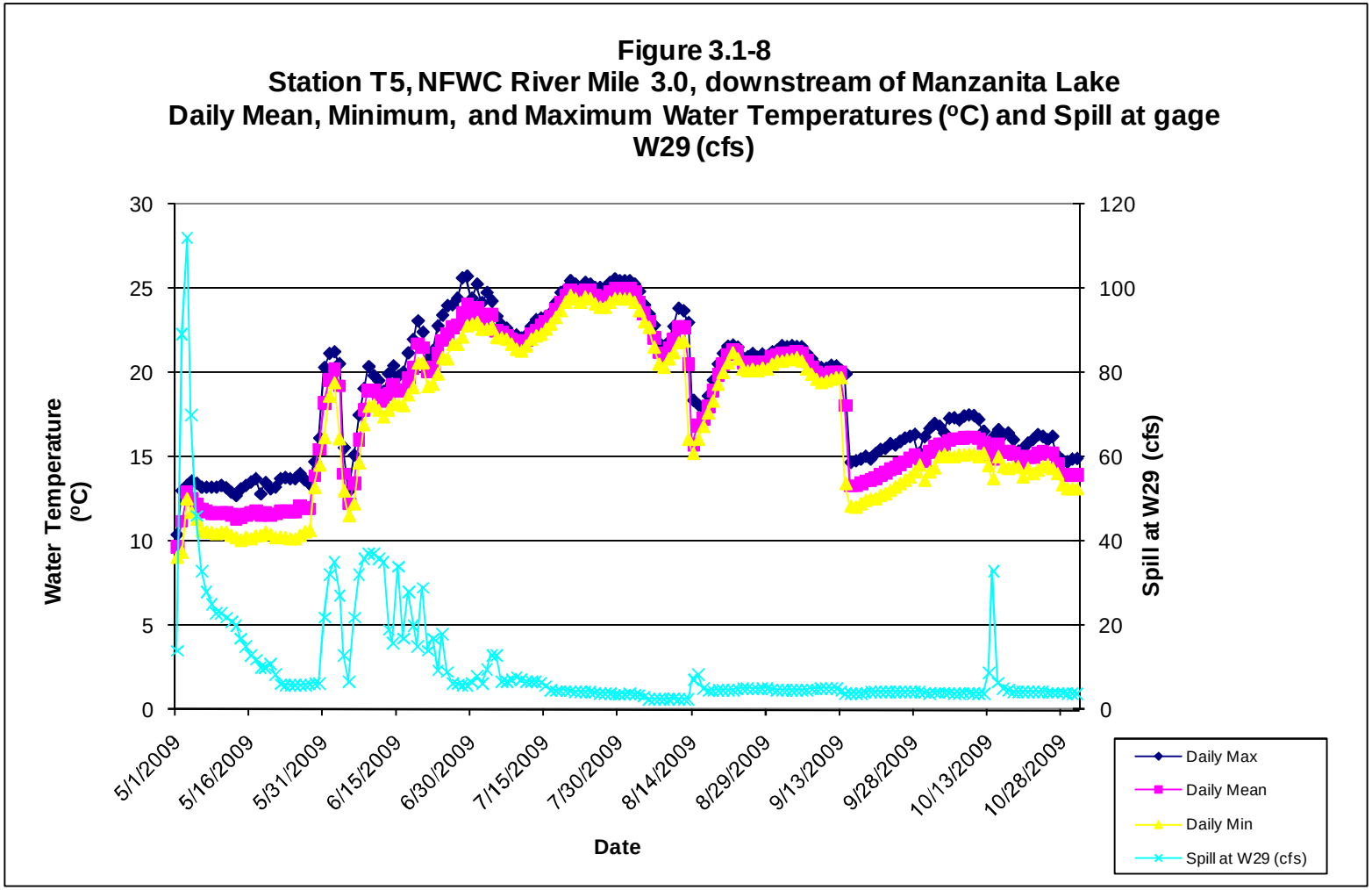

Figure 3.1-8. Station T5, NFWC River Mile 3.0, downstream of Manzanita Lake Daily Mean, Minimum, and Maximum Water Temperatures (°C) and Spill at gag W29 (cfs).

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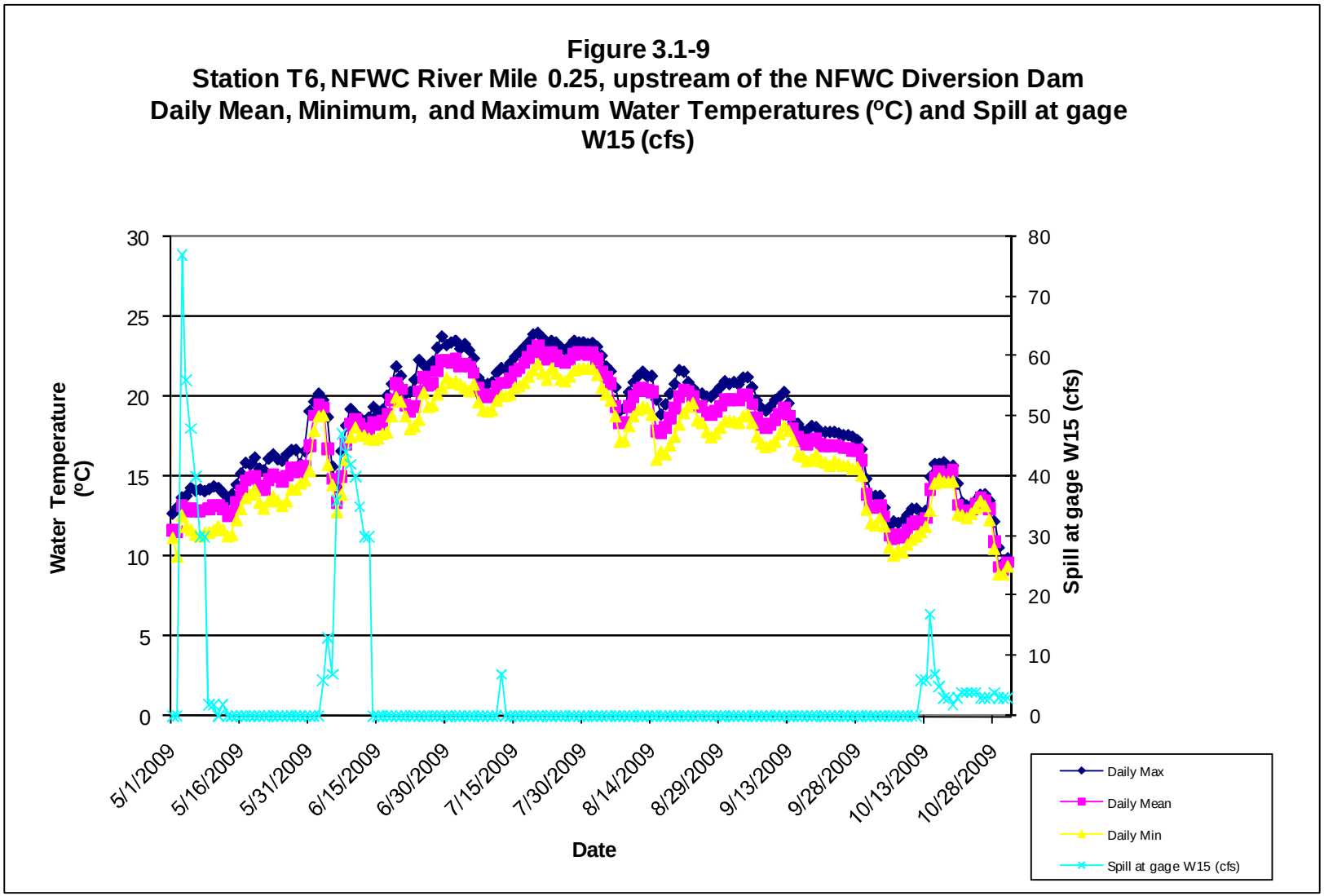

Figure 3.1-9. Station T6, NFWC river Mile 0.25, upstream of the NFWC Diversion Dam Daily Mean, Minimum, and Maximum Water Temperatures (°C) and Spill at gage W15 (cfs).

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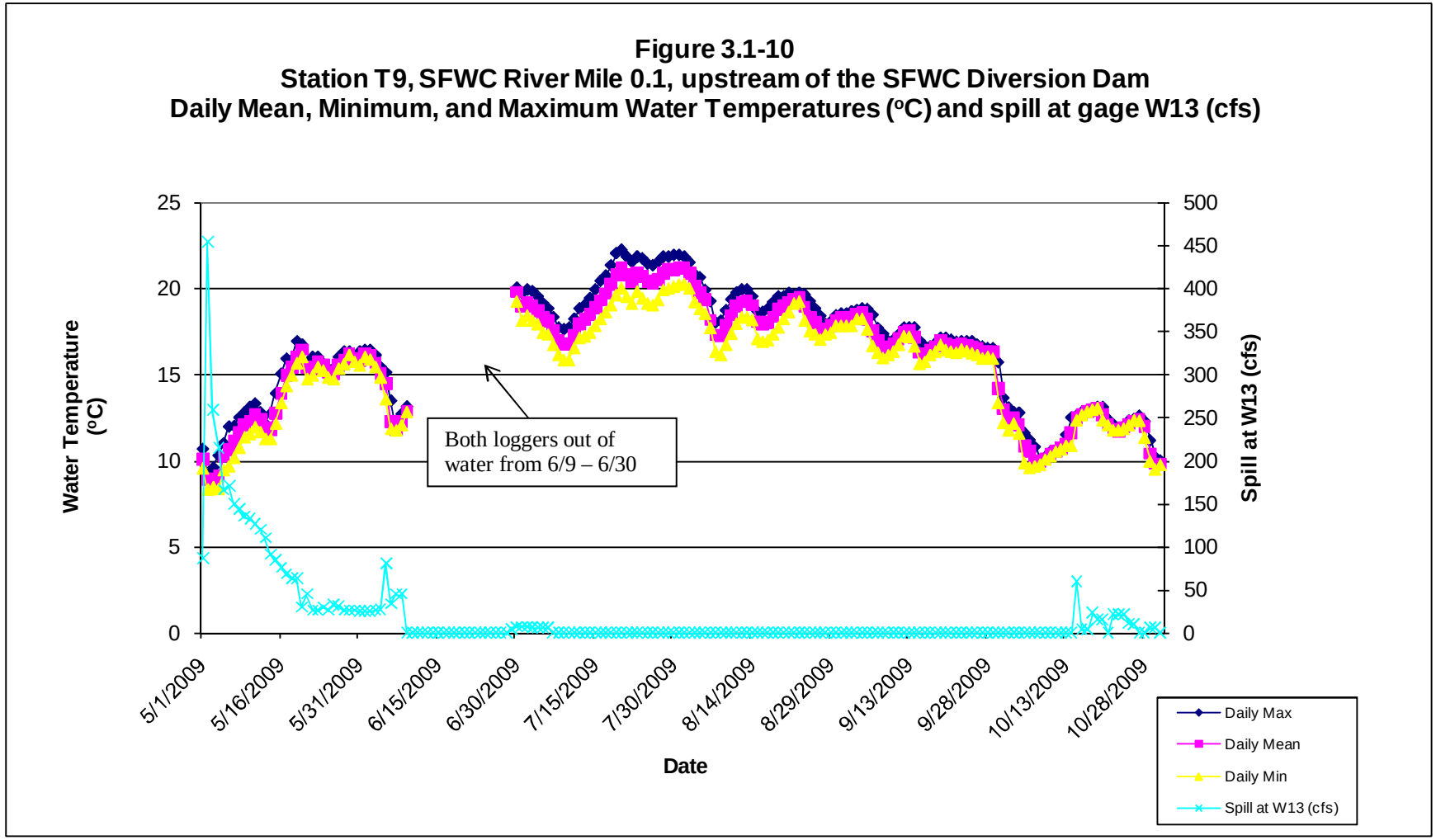

Figure 3.1-10. Station T9, SFWC River Mile 0.1, upstream of the SFWC Diversion Dam Daily Mean, Minimum, and Maximum Water Temperatures (°C) and spill at gage W13 (cfs).

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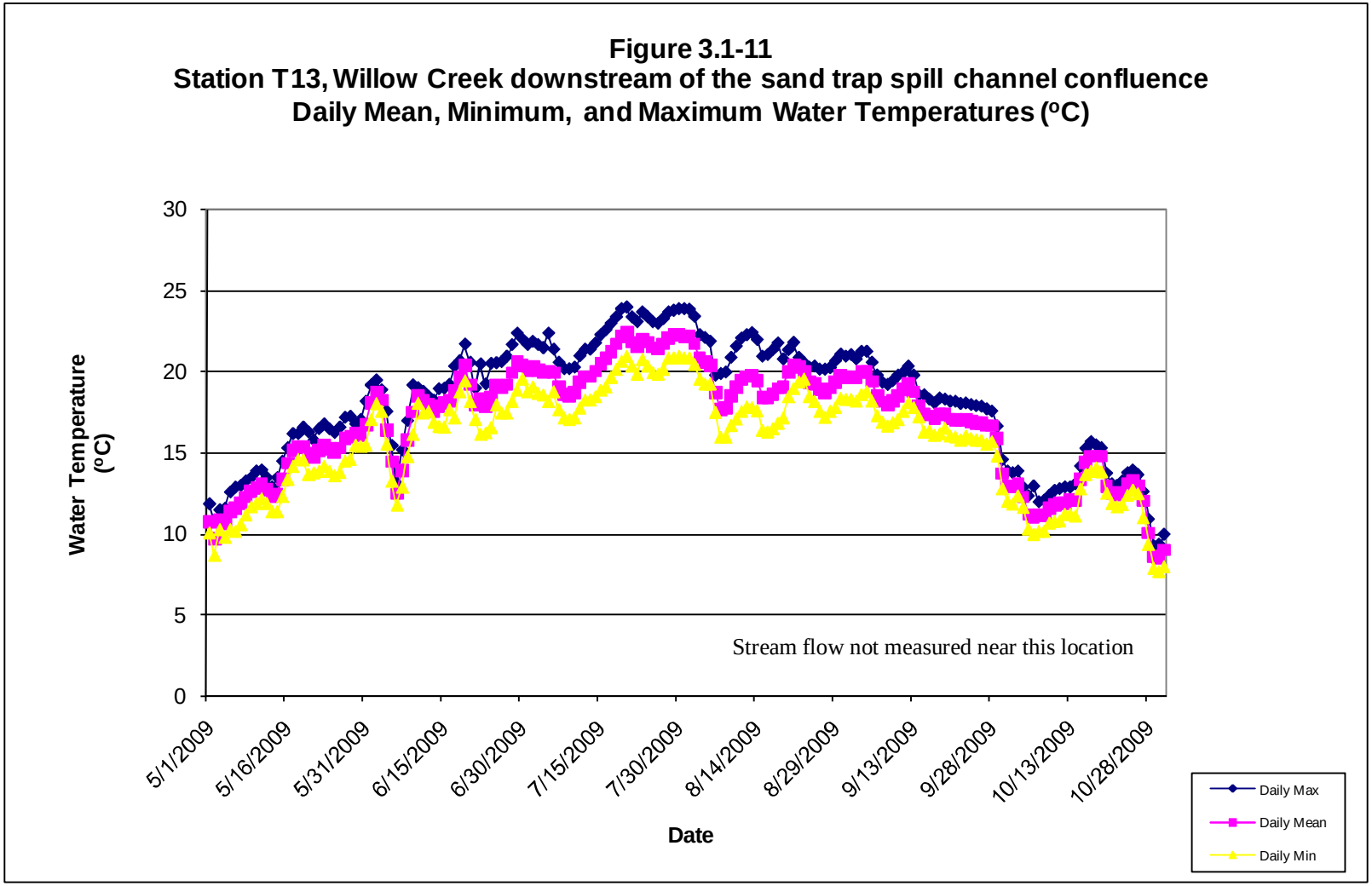

Figure 3.1-11. Station T13, Willow Creek downstream of the sand trap spill channel confluence Daily Mean, Minimum, and Maximum Water Temperatures (°C).

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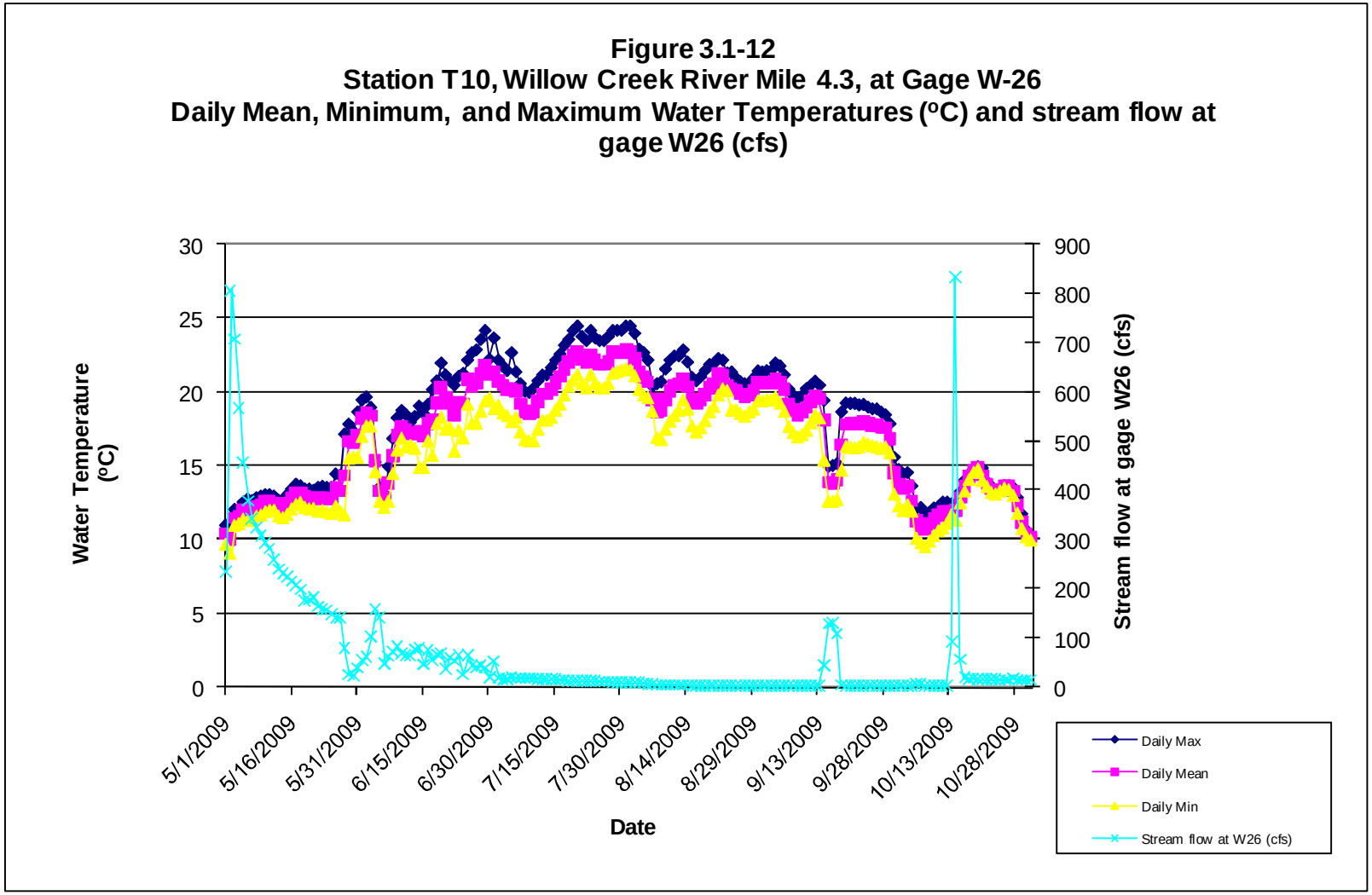

Figure 3.1-12. Station T10, Willow Creek River Mile 4.3, at Gage W-26 Daily Mean, Minimum, and Maximum Water Temperatures (°C) and stream flow at gage W26 (cfs).

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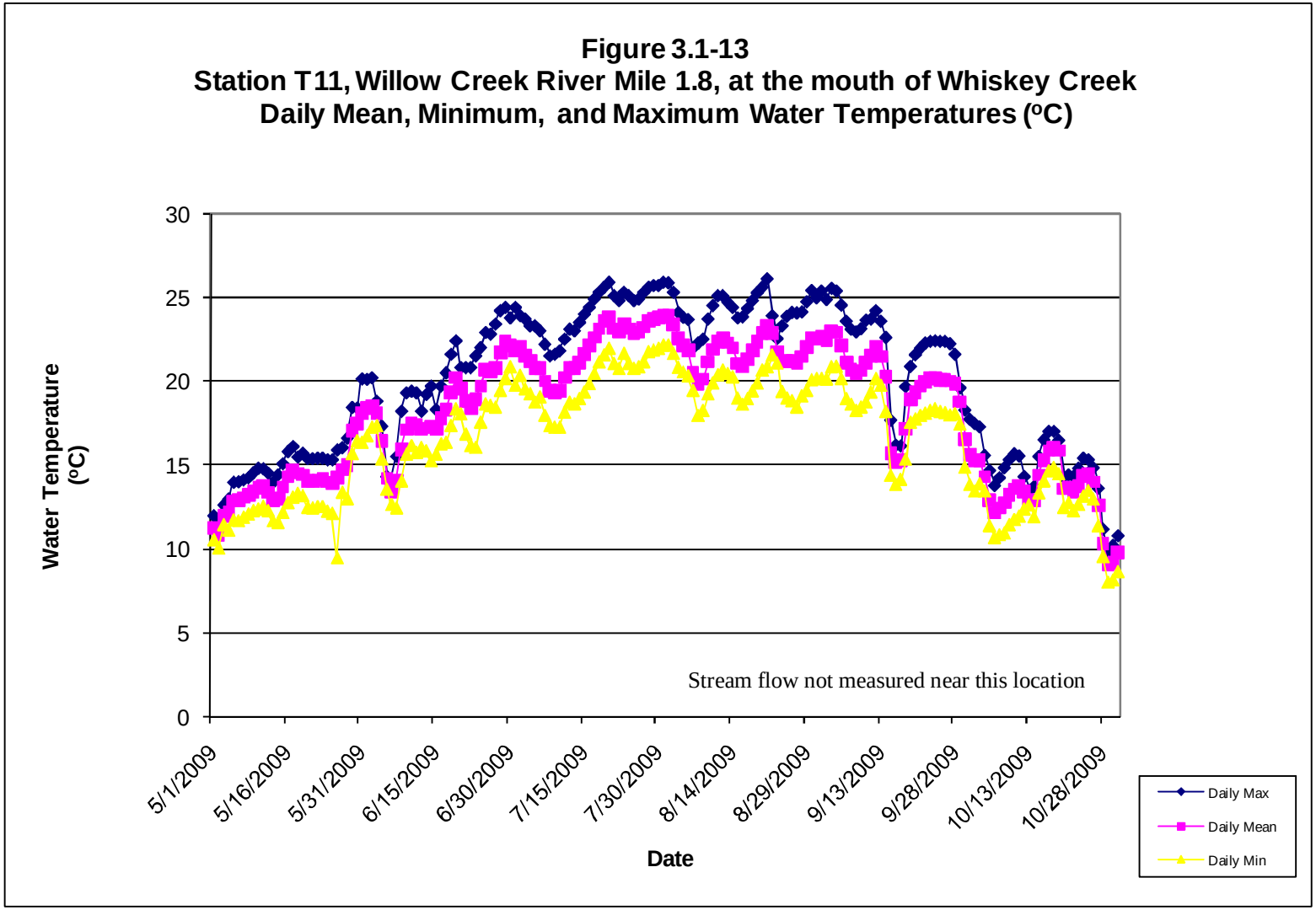

Figure 3.1-13. Station T11, Willow Creek River Mile 1.8, at the mouth of Whiskey Creek Daily Mean, Minimum, and Maximum Water Temperatures (°C).

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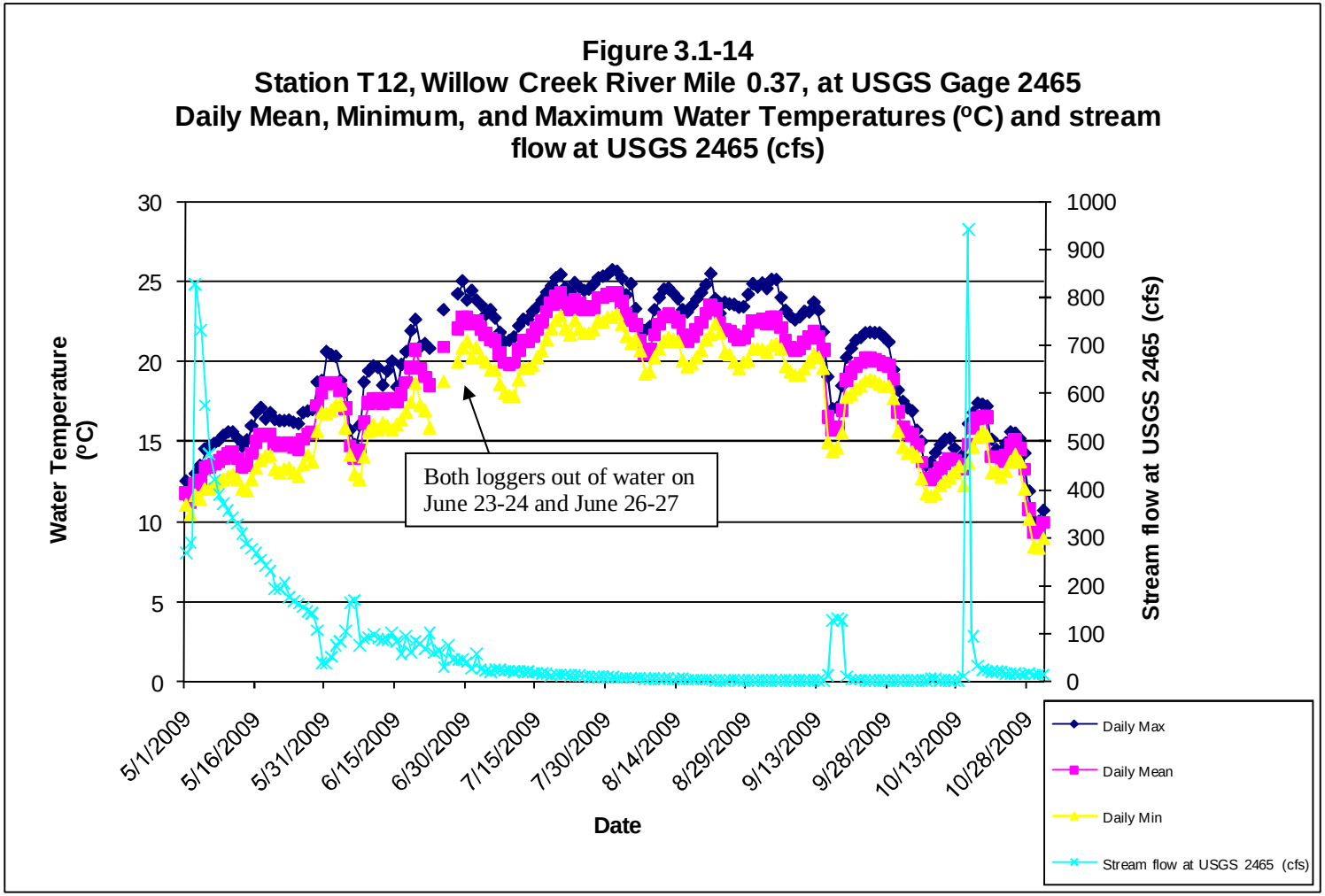

Figure 3.1-14. Station T12, Willow Creek River Mile 0.37, at USGS Gage 2465 Daily Mean, Minimum, and Maximum Water Temperatures (°C) and stream flow at USGS 2465 (cfs).

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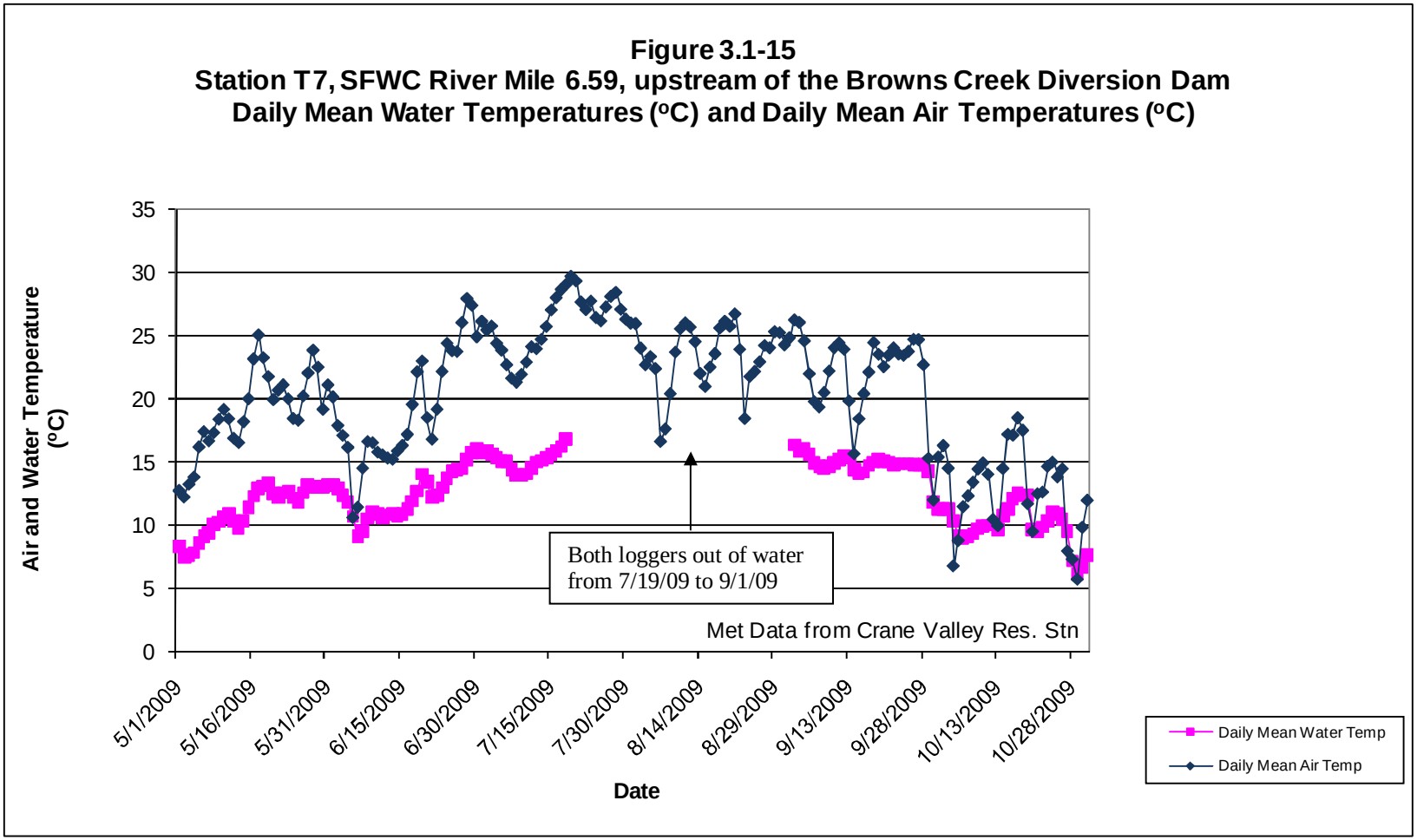

Figure 3.1-15. Station T7, SFWC River Mile 6.59, upstream of the Brownd Creek diversion Dam Daily Mean Water Temperatures (°C) and Daily Mean Air Temperatures (°C).

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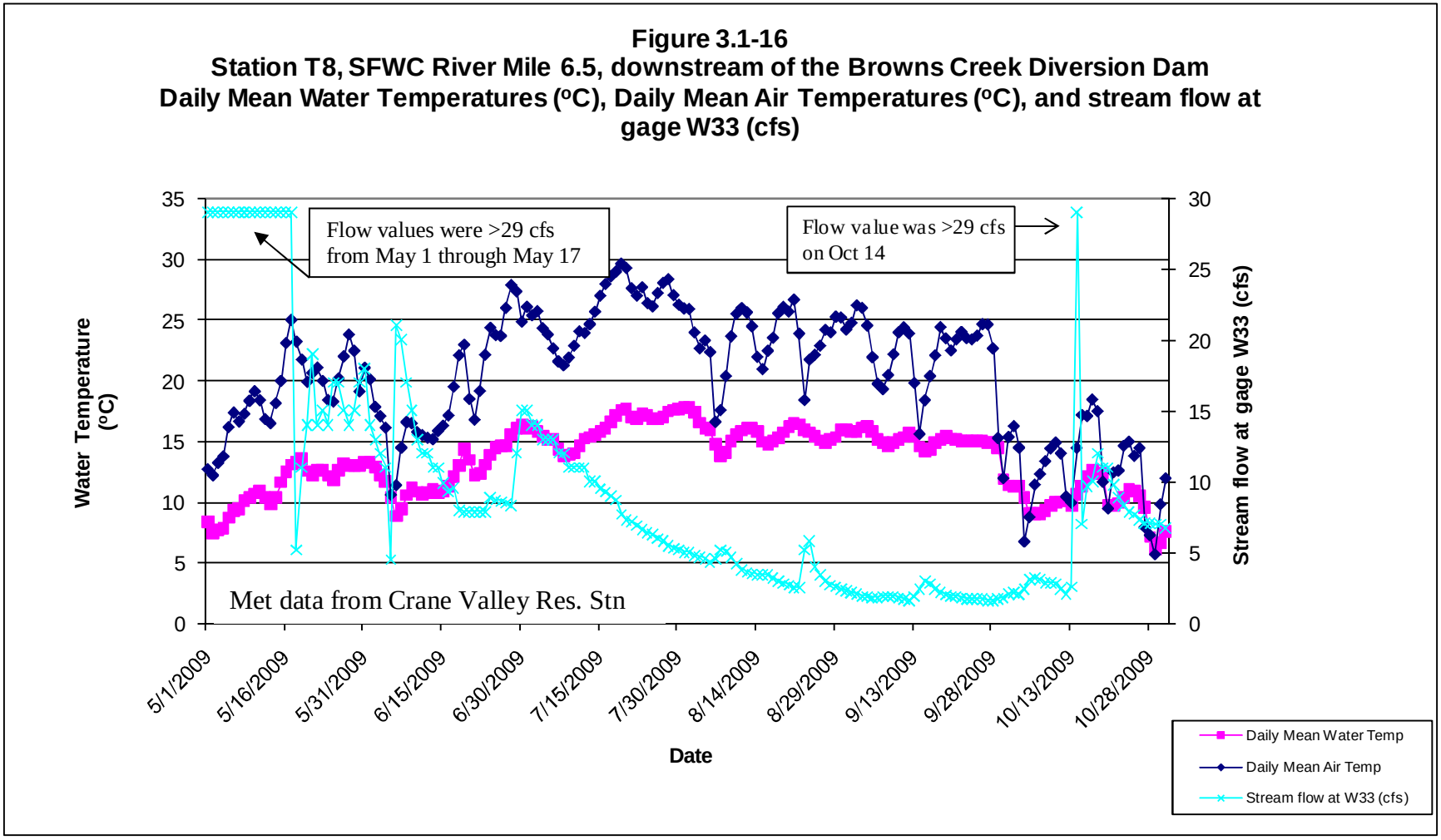

Figure 3.1-16. Station T8, SFWC River Mile 6.5, downstream of the Browns Creek Diversion dam Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at gage W33 (cfs).

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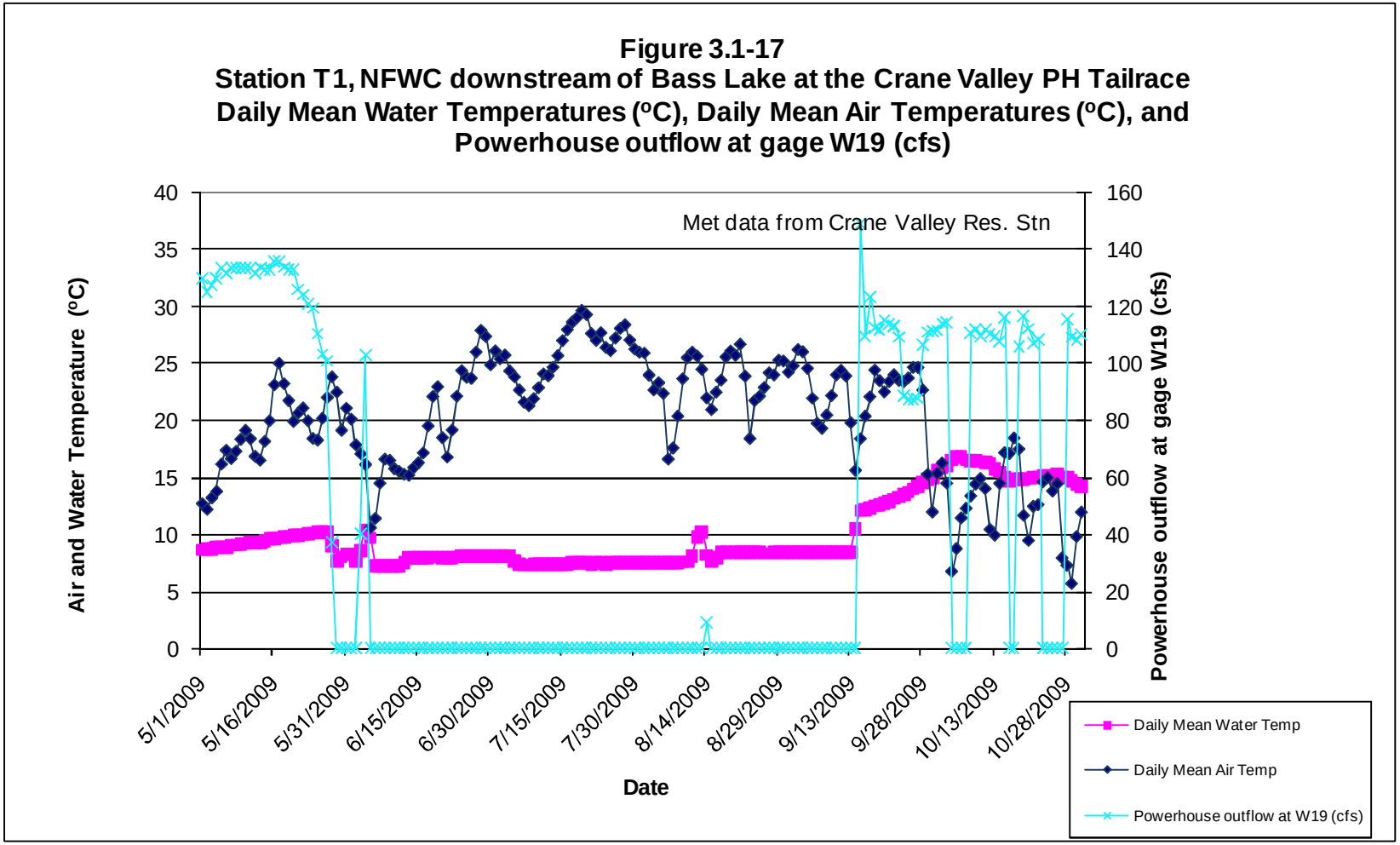

Figure 3.1-17. Station T1, NFWC downstream of Bass Lake at the Crane Valley PH Tailrace daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and Powerhouse outflow at gage W19 (cfs).

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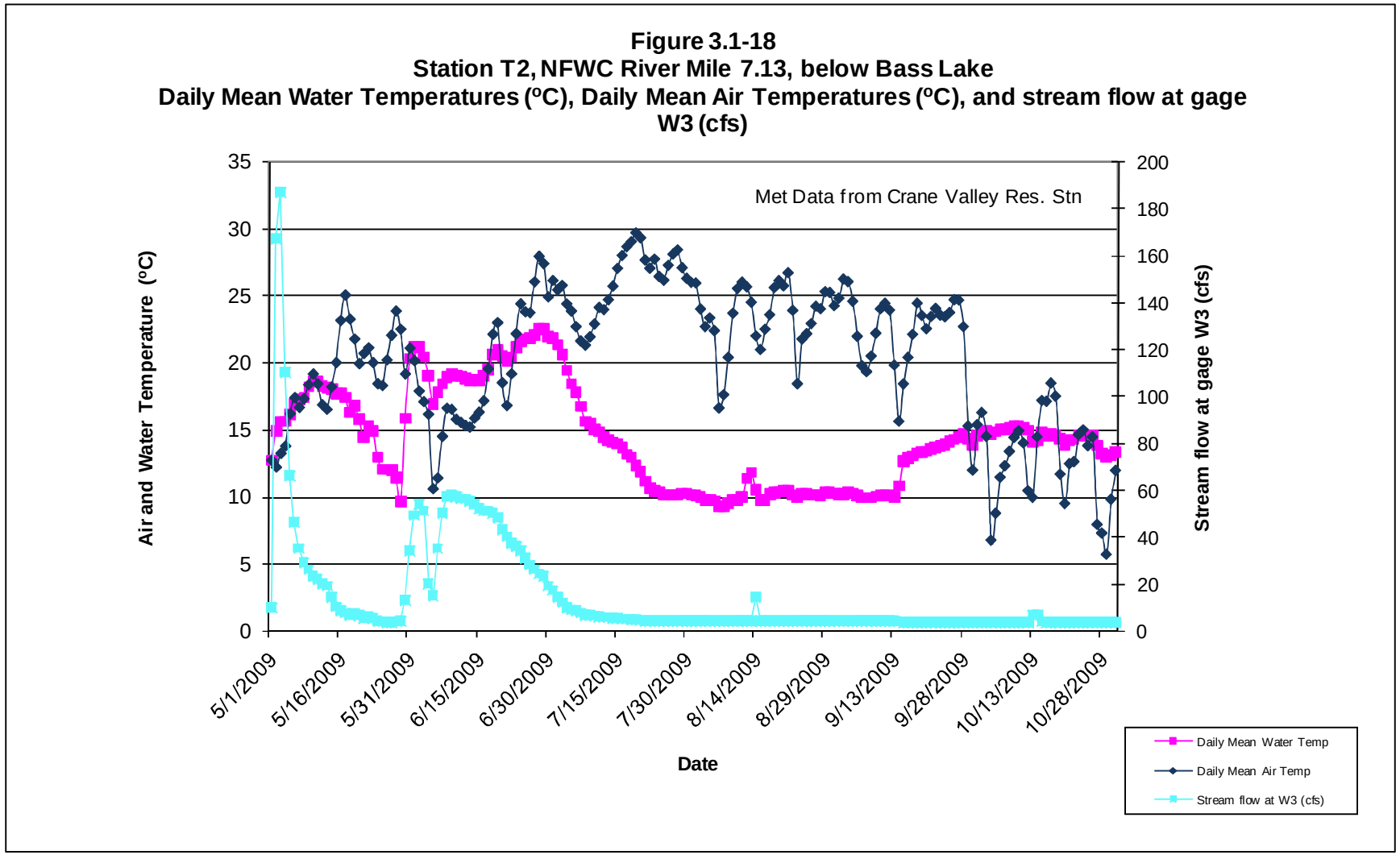

Figure 3.1-18. Station T2, NFWC River Mile 7.13, below Bass Lake Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at gage W3 (cfs).

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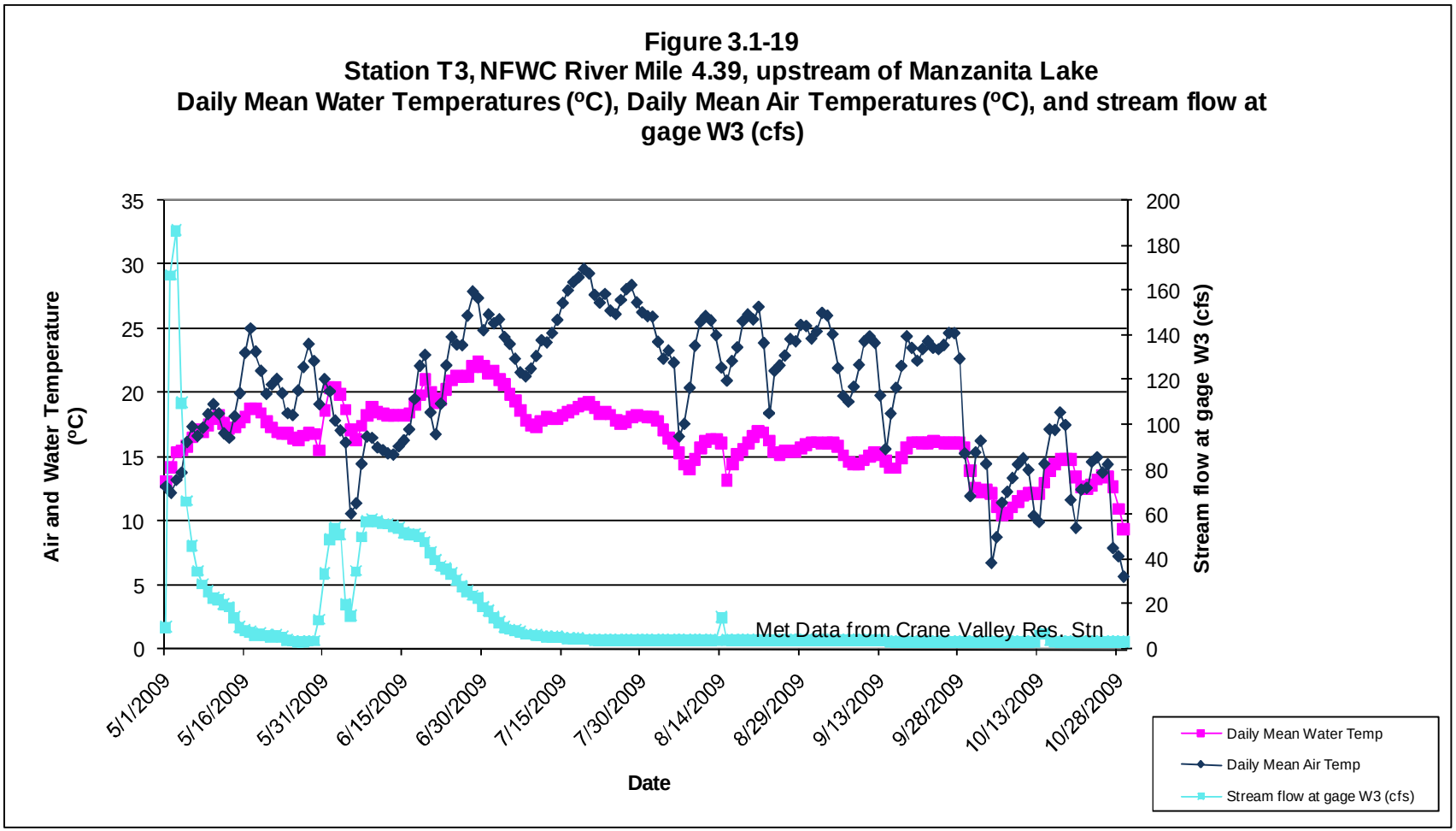

Figure 3.1-19. Station T3, NFWC River Mile 4.39, upstream of Manzanita lake Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at gage W3 (cfs).

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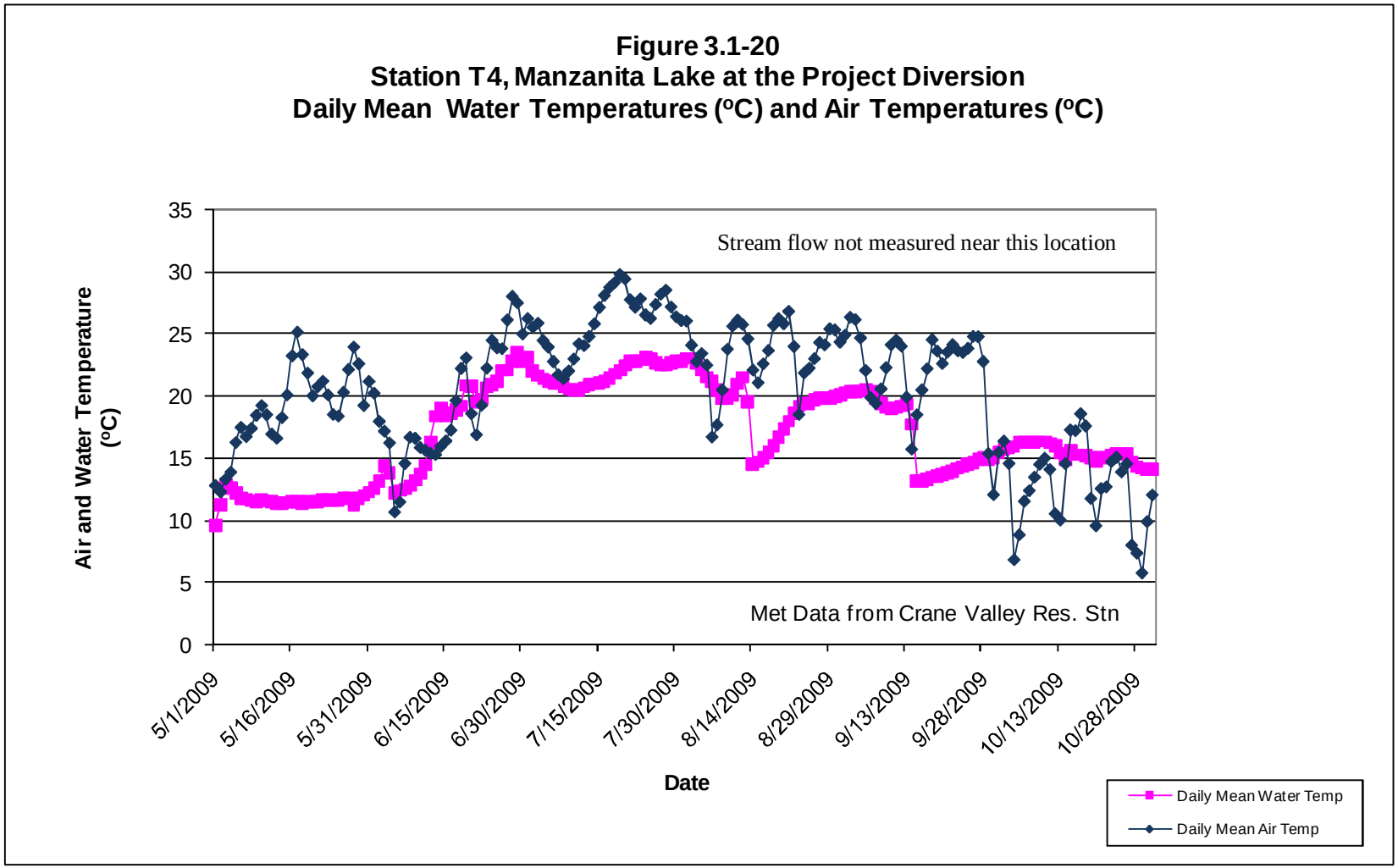

Figure 3.1-20. Station T4, Manzanita Lake at the Project Diversion Daily Mean Water Temperatures (°C), and Air Temperatures (°C).

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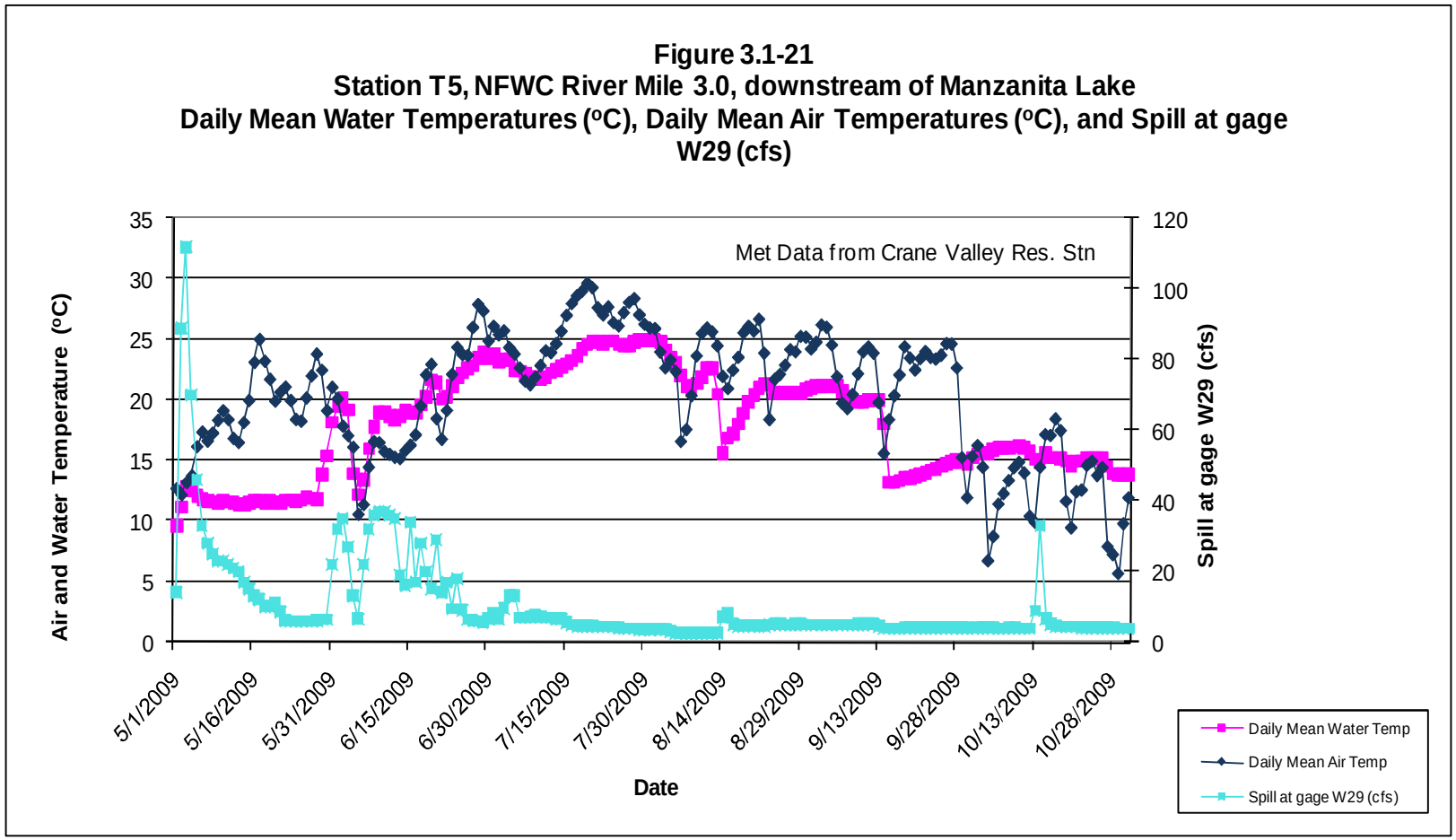

Figure 3.1-21. Station T5, NFWC River Mile 3.0, downstream of Manzanita Lake daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and Spill at gage W29 (cfs)

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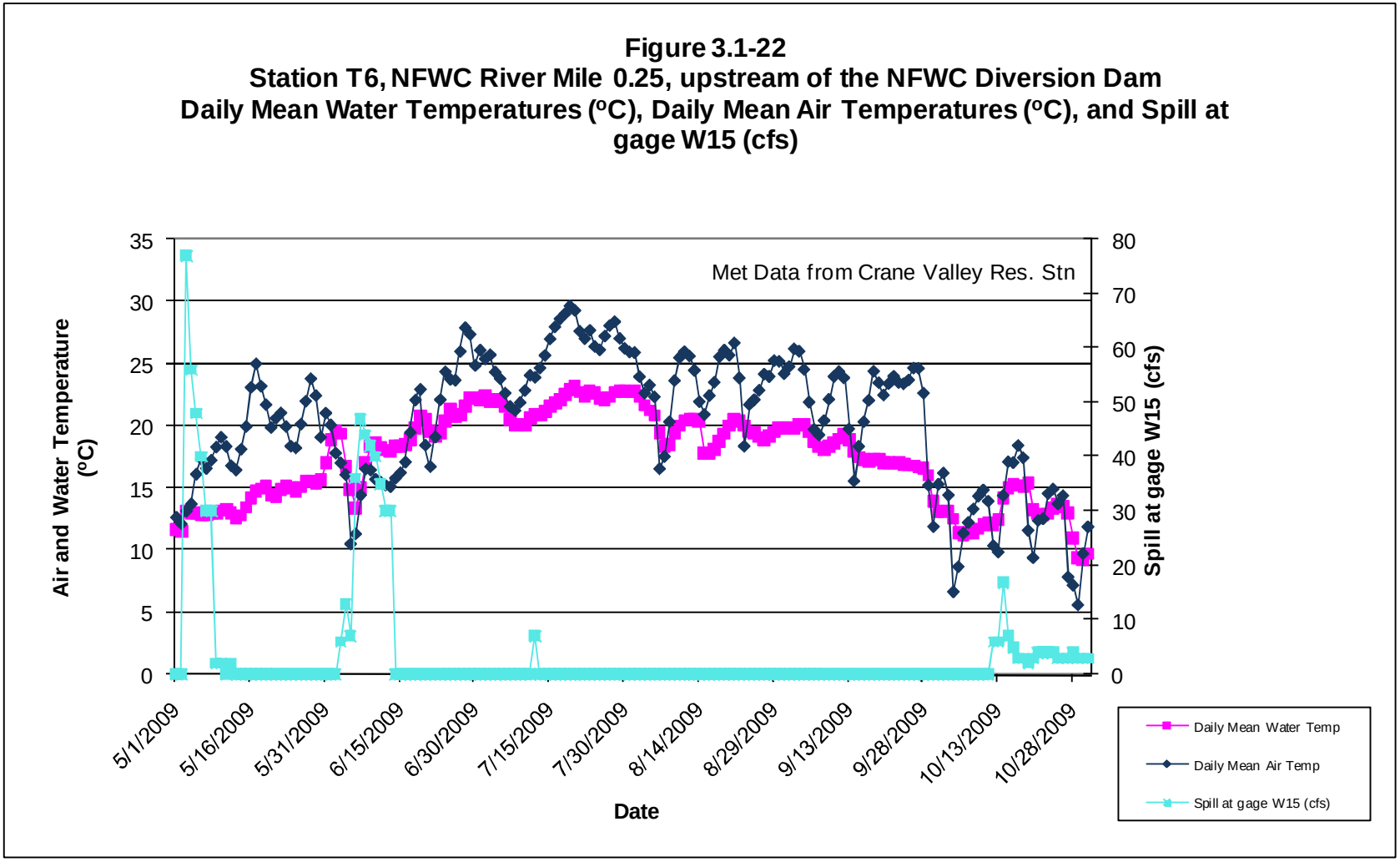

Figure 3.1-22. Station T6, NFWC River Mile 0.25, upstream of the NFWC Diversion Dam Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and Spill at gage W15 (cfs).

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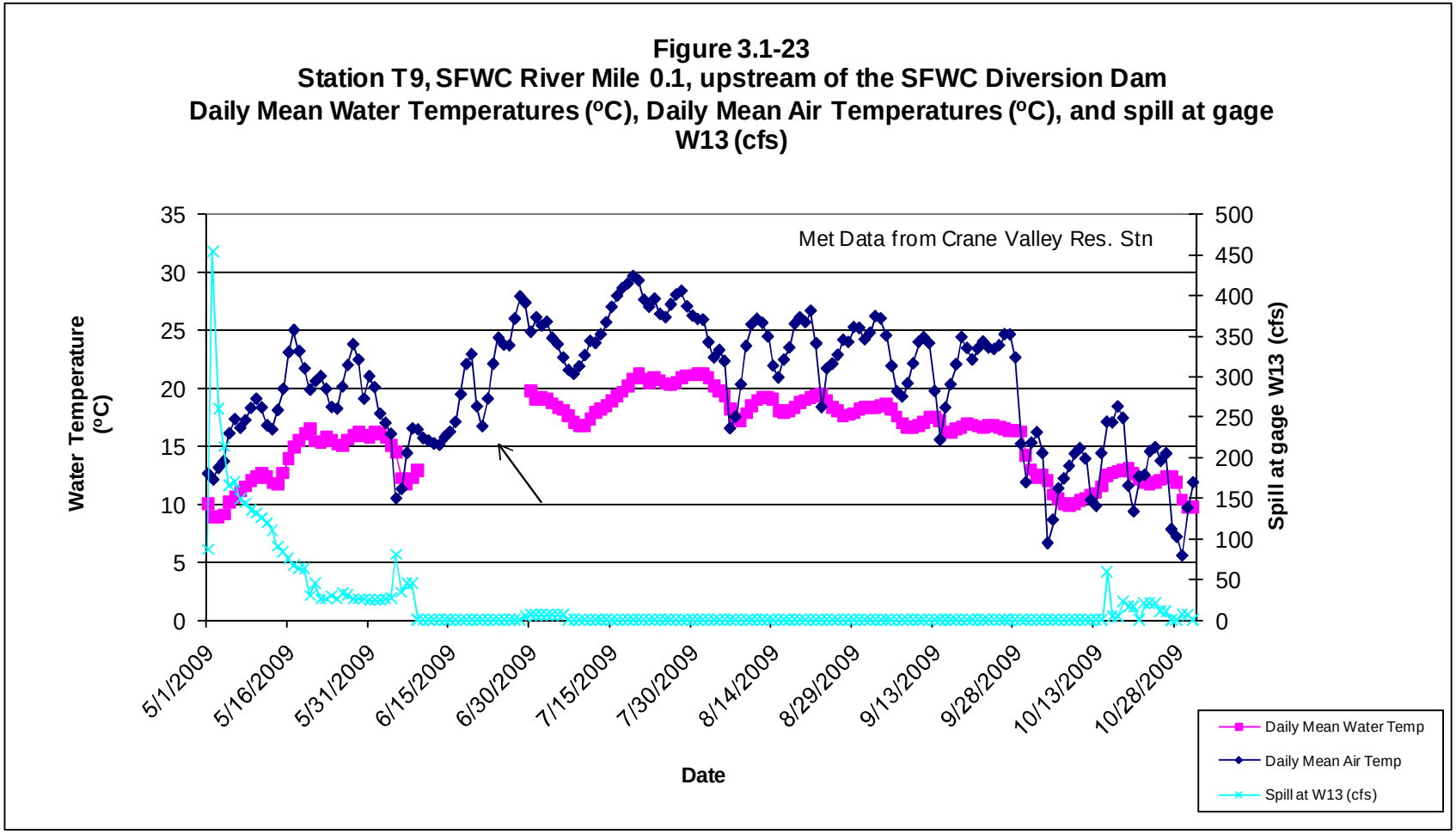

Figure 3.1-23. Station T9, SFWC River Mile 0.1, upstream of the SFWC Diversion Dam Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and Spill at gage W13 (cfs).

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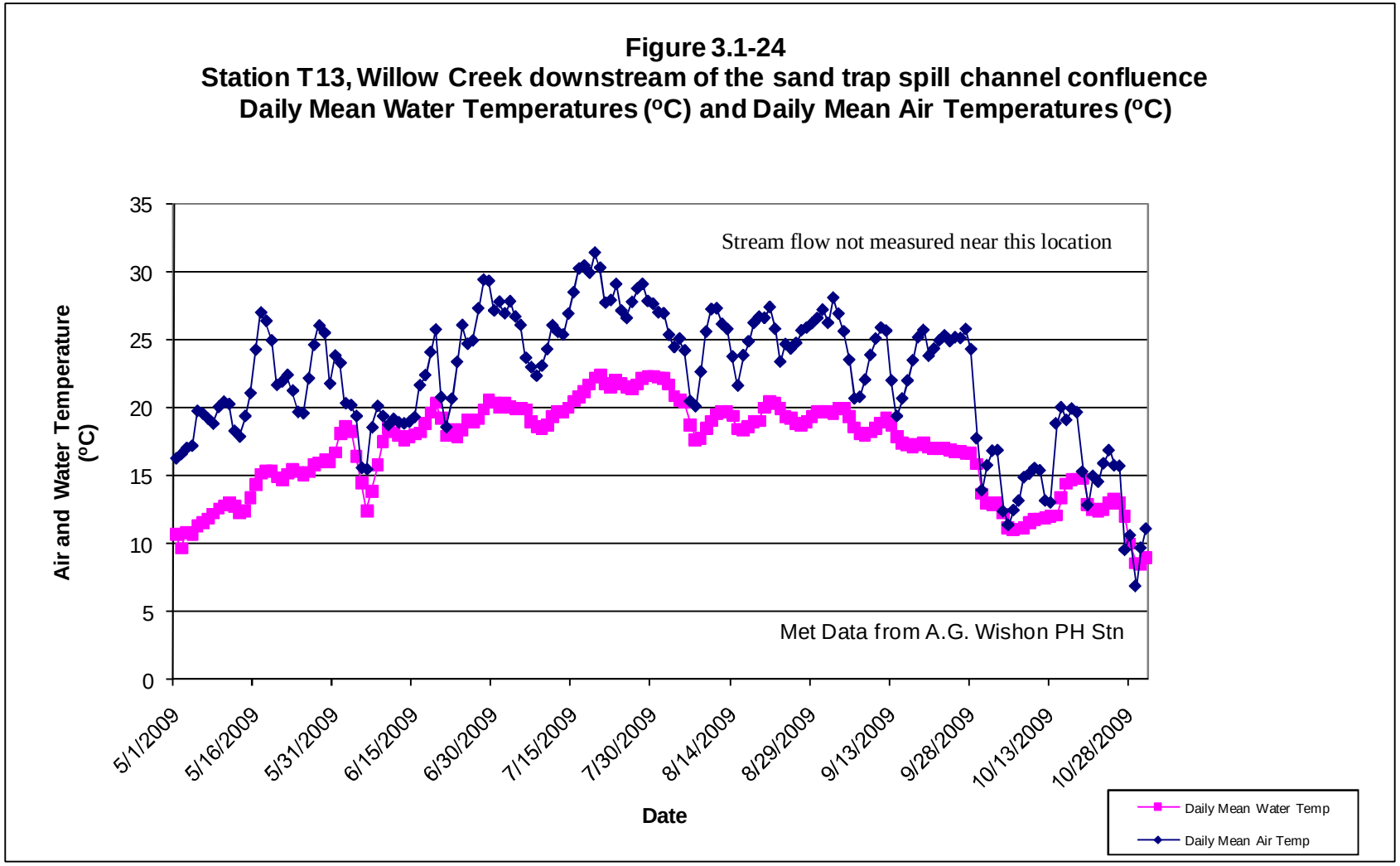

Figure 3.1-24. Station T13, Willow Creek downstream of the sand trap spill channel confluence Daily Mean Water Temperatures (°C) and Daily Mean Air Temperatures (°C).

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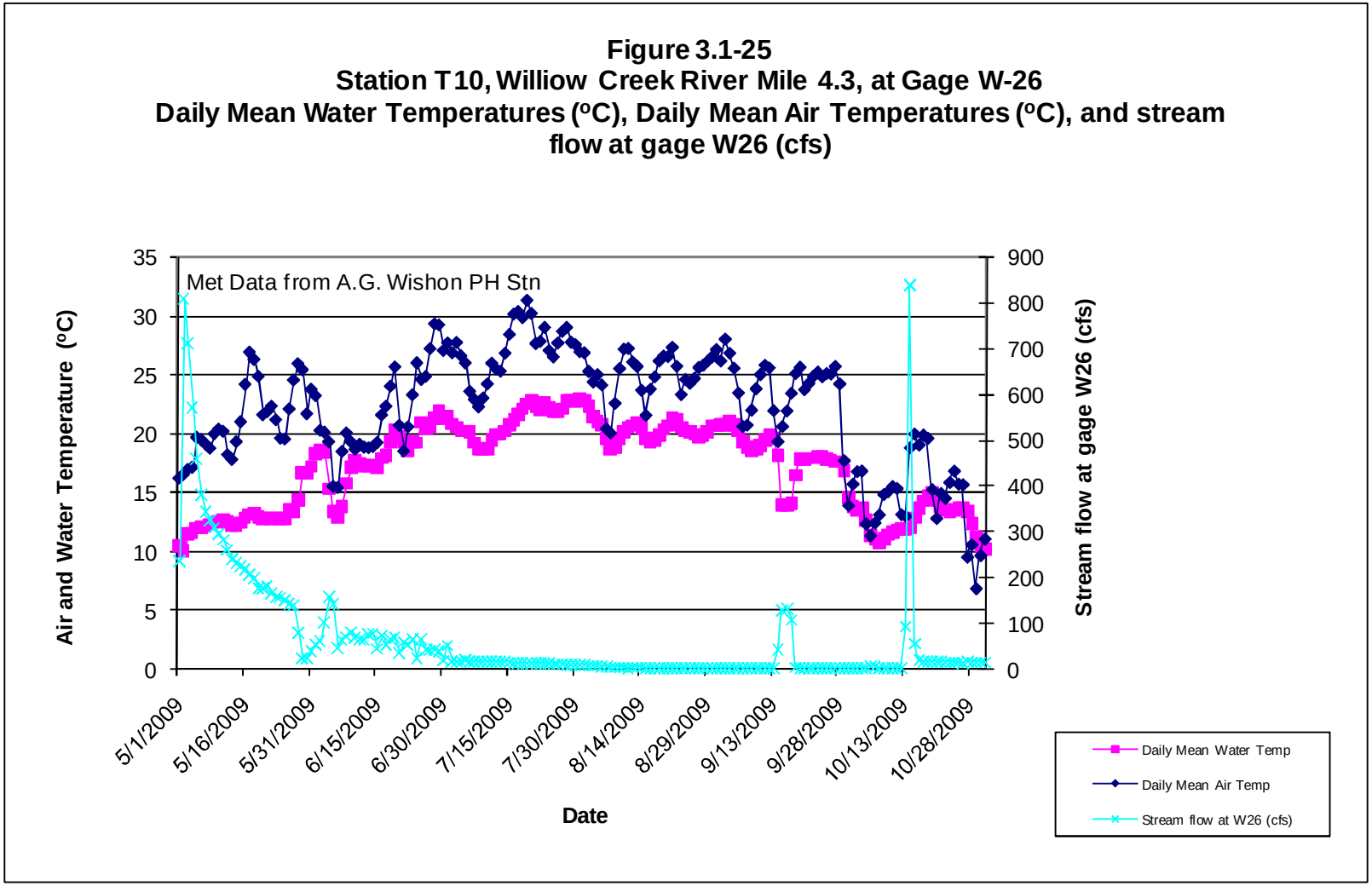

Figure 3.1-25. Station T10, Willow Creek River Mile 4.3, at Gage W-26 Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at gage W26 (cfs).

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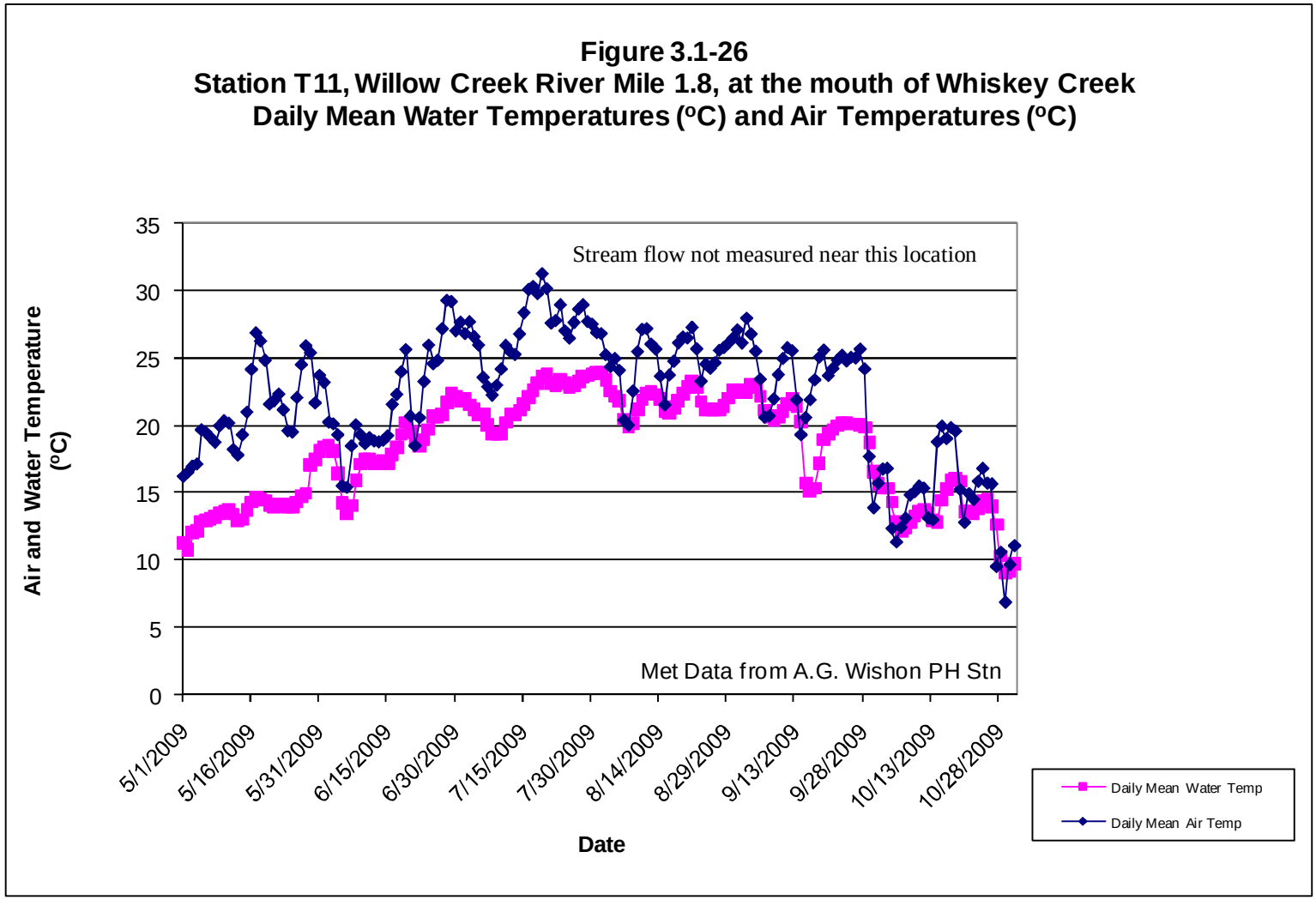

Figure 3.1-26. Station T11, Willow Creek River Mile 1.8, at the mouth of Whiskey Creek Daily Mean Water Temperatures (°C) and Air Temperatures (°C).

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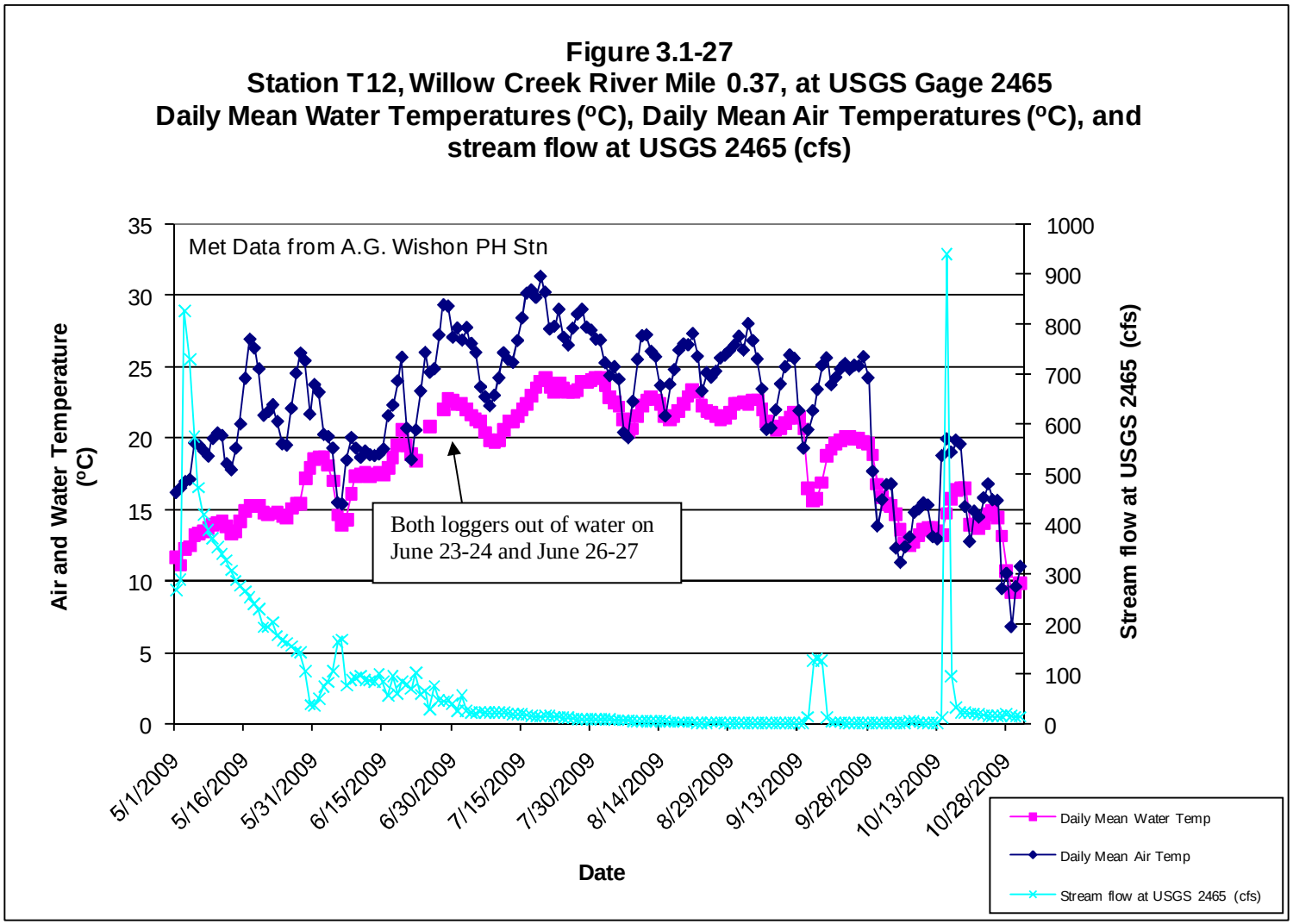

Figure 3.1-27. Station T12, Willow Creek River Mile 0.37, at USGS Gage 2465 Daily Mean Water Temperatures, Daily Mean Air Temperatures, and stream flow at USGS 2465 (cfs)

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