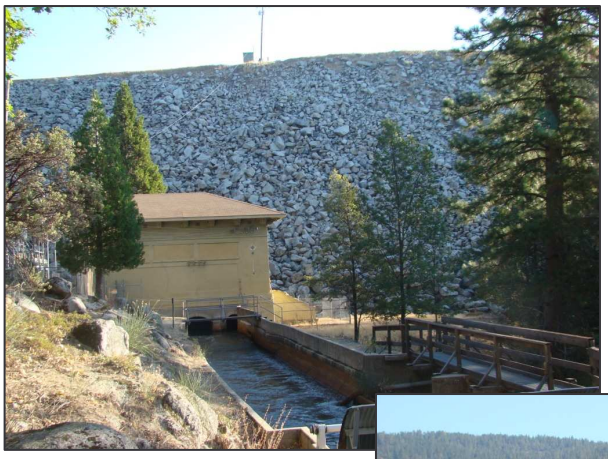
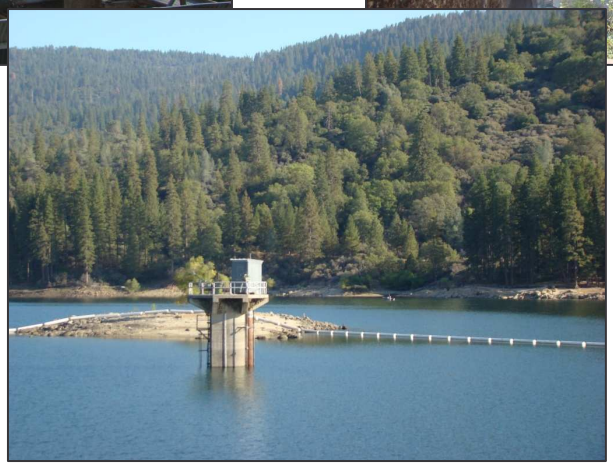
Crane Valley Hydroelectric Project, FERC No. 1354

Crane Valley Water Temperature Monitoring Results – 2008

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





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Crane Valley Hydroelectric Project, FERC No. 1354
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1. 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. Data collected during 2008 represent the fourth 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, the U.S. Fish and Wildlife Service, 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.

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

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[1] 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. 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.

[1] Instream flows are required by the license, but at the present time PG&E does not have an approved flow management plan. The Flow Management Plan is currently in draft form and will be submitted for agency review in 2009. In the meantime, approximate releases are being made with the intent of meeting the required flows until the final flow management plan is approved.

2.0 METHODS

2.1 Sample Locations

Water temperature was measured at 13 stream locations from May 1 to October 31, 2008 (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 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 2008) 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, 2008 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 monthly to a laboratory computer and stored. Data downloads occurred on May 20 and 21, June 24 and 25, July 29 and 30, August 25 and 26, September 30 and October 1, and November 4 and 5, 2008. These data are provided in Appendix A.

During the monthly field visits to download data from the water temperature recorders, Bass Lake water temperature profiles were collected. 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 of approximately ±0.15°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 21 existing PG&E maintained gaging stations and two U.S. Geological Survey (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

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 2008 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 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 loss due to vandalism. 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.

Two sets of VEMCO MiniLog 12 TR digital temperature loggers were employed for the 2008 monitoring effort and each was calibrated in a laboratory setting prior to use. The first set was the same set used for the 2005, 2006, and 2007 monitoring seasons. This set was calibrated by PG&E in the off-season and was used from May 1 to 7 only, until the new units arrived to replace them. As shown in Appendix D, six of the total 24 older loggers that were calibrated failed. The second set deployed was a new set. The second set was calibrated by the Manufacturer and was placed in time for the June data acquisition. Calibration information for each set is provided in Appendix D.

Reservoir Temperature Profiles
The Bass Lake temperature profiles consisted of collection of 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.

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 instantaneous measurements did not vary by more than 1°C from corresponding hourly mean temperature collected by either the primary or redundant logger. The exception was a 5°C difference at T4 during the June site visit. This measurement was considered an anomaly, however, because for each month, at each site, primary and redundant logger data were also available. Water temperature recorded between the primary and redundant logger never varied by more than 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 2008, 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 but T9, the site upstream of the South Fork Diversion Dam. 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 one case 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 T5, a redundant logger, T5B, was reassigned to the role of primary logger in June because the original primary logger, T5A, was found out of the water during the June, July, and August downloads due to flow reductions or vandalism. Hence, the loss of 5A data did not affect the data set's completeness. However, in 2009 an additional effort will be made to hide each logger placed at this location.

At all 13 sites, the dataset was reduced by seven percent due to a brief early season error in each logger's programming. For 14 of the 184 days of data acquisition (May 7 through 20) the loggers did not collect data for any site. The loggers had reverted to their manufacturer-set acquisition frequency of every minute, instead of the Project-specific 20-minute collection intervals, and the logger memories became full by May 6th. During the May 20 and 21 site visit, each of the loggers was replaced with a new logger which was programmed to collect data at 20 minute intervals and there was enough memory to collect all subsequent measurements. In 2009, field staff will perform an additional check when replacing the loggers to ensure that all loggers are programmed to the proper acquisition frequency.

At site T9 data were lost for an additional 24 days in July, in addition to the 14 days of data lost in May. From July 6 through July 29, both the primary and the redundant recorders were stranded due to fluctuating water levels. This resulted in an additional reduction in the dataset size of 13 percent, for a total loss of 20 percent of the data. The completeness objective for T9 was not met.

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 2008 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, 2008. 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 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.

<u>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</u>

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 18.3°C at both sites during the monitoring period. On June 25, the temperature logger housing at T7B was found partially out of the water. Water temperature data were collected accurately, since the logger was fully submerged. Both water temperature recorders at T7 were moved to a deeper pool across the stream to avoid low water levels. The mean daily water temperatures for T7 and T8 resembled the same trend as the mean daily air temperatures throughout the monitoring period (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 5. 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 four meters of depth. Bass Lake became more stratified after the June profile and exhibited a thermocline at about seven meters on July 30, 2008. The thermocline remained through August, but dropped to a depth of approximately seven and a half meters. The September and November water temperature profiles were orthograde, indicating that fall turnover had occurred before the September 30 download.

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 August 14, the mean daily water temperature in the spill channel remained fairly constant, between 6.9 and 9.8°C (Figure 3.1-4). From August 15 through October 2, daily maximum water temperatures reached a high of 18.4°C and subsequently decreased until the recorders were removed. The mean daily water temperature never exceeded 18.1°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 29 through October 8 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 August 31, water temperatures fluctuated between a mean daily water temperature of 10.8°C up to a mean daily water temperature of 15.1°C (Figure 3.1-5; 3.1-18). From September 1 to October 1, the mean daily water temperature increased to a high of 17.4°C. After October 1, the temperatures slowly decreased until the temperature loggers were removed. The mean daily water temperature never exceeded 17.4°C for the entire duration of the monitoring period. The mean daily water temperatures did not correlate 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 July 10 when the mean daily temperature peaked at 20.3°C (Figure 3.1-6; 3.1-19). After July 10, the mean daily temperature showed an overall decrease until the recorders were removed. The mean daily water temperature never exceeded 20.3°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).

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. During the June 24 and 25 visit, the logger at T5A was out of the water and subsequently moved to the middle of the stream channel to ensure that water temperatures would be captured during low flow situations. During the July 29 and 30 visit, the logger at T5A was found out of the water due to vandalism and was relocated downstream to the same site as T5B. During the August 25 and 26 visit, the logger at T5A was found out of the water again due to vandalism. The logger was put back into the water at the same location and was not vandalized for the remainder of the monitoring period.

Daily mean water temperatures at T5 had an overall increasing trend from May 1 until July 16, with a maximum mean temperature of 25.8°C. After July 16, the mean temperatures decreased steadily with a dramatic decrease occurring from August 5 (23.6°C) to August 15 (12.8°C). After August 15 the mean temperatures increased until September 30 and then decreased steadily until the loggers were removed. The mean daily water temperatures at T5 never exceeded 25.8°C throughout the monitoring period.

The mean daily water temperatures at T4 increased steadily from May 1 until August 7, with a maximum mean temperature of 19.8°C. Maintenance activities occurred at this station from August 7 to August 11. Data points from August 8 through 11 were removed from the data set because the daily mean water temperatures matched the daily mean air temperatures. After August 11, the mean temperatures sharply declined until August 19, with a mean daily temperature of 11.9°C. After August 19, the mean temperatures increased with the same trend as T5 until temperatures peaked on October 2, then decreased until the loggers were removed. The mean daily water temperatures at T4 did not exceed 19.8°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, were mostly constant (below 10 cfs) except for short peaks beginning mid September through the end of the monitoring period.

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 10, when the mean temperature peaked at 23.6°C (Figure 3.1-9). In August and September, the mean daily water temperature decreased and never exceeded 21.7°C. The mean daily water temperature continued to decrease until October 13 at 10.4°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 flow value at spill gage W15 below North Fork Diversion Dam remained at zero

for the entire monitoring period with the exception of July 13 through July 31, when the values were 2 cfs.

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 June, the daily water temperatures did not exceed 18.5°C (Figure 3.1-10). In August, the mean daily water temperatures did not exceed 20.0°C. Mean daily water temperatures decreased throughout August and September until a low of 8.7°C was reached on October 14. After October 14, 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 (Figure 3.1-23).

Some data loss occurred at this site. Data from July 6 through July 29 were removed due to both recorders being displaced from the water (Figure 3.1-10; 3.1-23). During the July 29 and 30 visit, both of the recorders were found out of the water and moved downstream to the face of South Fork Diversion Dam in an effort to decrease the likelihood of stranding due to fluctuating water levels and for continued safe access. Unfortunately, by August both recorders became trapped in the dam valve, but data were still recorded for that time period. Data were also removed from August 26 at 11 a.m. until August 27 at 5 a.m. due to both loggers being out of the water when water levels were drawn down to remove the loggers from the South Fork Diversion Dam valve. Subsequently, in September, both recorders were relocated back upstream to the previous site 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 increased steadily from May 1 to July 16 to a mean high of 23.0°C. After July 16, the daily mean water temperatures decreased overall until the loggers were removed (Figure 3.1-11). The mean daily water temperatures never exceeded 23.0°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).

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 20.8°C in June. In July, the daily mean water temperature increased and did not exceed 23.5°C. Daily mean water temperatures decreased in August to a high of 22.6°C. In September, the daily mean water temperature continued to decrease to a maximum of 18.8°C (Figure 3.1-12). The lowest daily maximum mean water temperature occurred in October with a value of 17.9°C. The water temperatures noted at T10 generally corresponded to fluctuations in air temperatures (Figure 3.1-25).

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 21.8°C in June. In July and August, the daily mean water temperature peaked at 25.0°C and 25.3°C, respectively. The daily mean maximum water temperature in September decreased to 22.2°C. The daily mean water temperature continued to decrease in October with a high of 20.2°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).

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. The mean daily water temperature at site T12 exceeded 20.6°C for 92 consecutive days between June 15 and September 14, 2008 (Figure 3.1-14). However, the highest mean daily water temperature was not recorded at T12 (25.6°C), but rather at T5 (25.8°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). 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, 2008. All stream flow and reservoir storage raw data files are all located in Appendix B.

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 gage W26 (located on Willow Creek below confluence of North and South forks) with a maximum flow of 1248.2 cfs for July. The highest monthly mean flows were also recorded at gage W26 and averaged 224.4 cfs for the month of June. Of the eight gages located within NFWC, SFWC and Willow Creek (this does not include flows through Project canals), two recorded the spill over Project diversion dams and not actual stream flow. The two gages are W15 and W13. Gage W15 recorded zero spills for the entire monitoring period other than July 13 through July 31 when it recorded 2 cfs. Gage W13 recorded zero spills throughout the entire monitoring period other than July 27 when it recorded 1 cfs. It must be noted that while the spill gages 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 specifies 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 2008 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 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. In May, flows measured at W33 were greater than 3 cfs for most of the month except May 7 and 8. The flows remained above 3 cfs until August 4 (at 3.0 cfs) and continued to decrease to a minimum of 0.7 cfs on October 3. In October, the flow values were below 3 cfs at W33 from October 7 to 11 and again from October 14 to 30. 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. Flow data on August 16 were not available for gage W26.

With respect to the conduits, there are consistent flows through conduits W1 (Browns Ditch), W12 (South Fork Ditch) and W14 (Upper San Joaquin #1 Ditch) except during maintenance and when needed to support instream flow release requirements. Annual maintenance for Browns Ditch occurred from August 25 through October 30. Annual maintenance for South Fork and San Joaquin #1 ditches occurred from July 7 through August 14. Flows in conduits 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 2008 monitoring period, W4, W9 and W25 had flow during May 27 through 29, June 10 through 21, and August 14 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 1 through June 9, storage increased in Bass Lake from 36,508 to 45,117 AF of water. After June 9, storage in Bass Lake was no longer increasing. By October 31, storage had been reduced to 24,916 AF.

Water storage levels varied in Corrine Lake between a low of 32.7 AF (on August 1) and a high of 64.7 AF (on July 6) between May 1 and October 31.

3.3 Discussion of Results

The fourth year of the Crane Valley Water Temperature Monitoring Program occurred in 2008. 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 fourth year, 2008 was a Critically Dry 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). Critically Dry water years represent extremely dry conditions, which understandably result in increased occurrences of stranding of temperature recorders and warmer stream temperature conditions due to the decreased volume and velocity of the stream flows.

In general, July was, on average the warmest month with a monthly mean air temperature of 26.5°C at the A.G. Wishon Powerhouse and a monthly mean air temperature of 25.0°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.

4.0 REFERENCES

Federal Energy Regulatory Commission (FERC). 2002. Supplemental Environmental Assessment for Hydropower License, Crane Valley Project, FERC No. 1354.

FERC. 2003. Pacific Gas and Electric Company Project No. 1354-005, Order Issuing New License.

FERC. 2005. Pacific Gas and Electric Company Project No. 1354-041, Order Approving Water Temperature Monitoring Plan, January 18.

Pacific Gas and Electric Company (PG&E). 2002. Crane Valley Hydroelectric Project (FERC No. 1354), Amended Application for new License. PG&E. San Francisco, California.

PG&E. 2004. Crane Valley Project, FERC No. 1354, Article 405 and Condition No. 5, Water Temperature Monitoring Plan. PG&E. San Ramon, California.

PG&E. Environmental Services, Water Resources. 2007. Quality Assurance Program Plan (QAPP) for Projects Requiring Water Quality and/or Water Temperature Monitoring. Revised on April 18, 2007. San Ramon, CA.

Studley, T.K., J.E. Baldrige, L.M. Wise, A.P. Spina, S.F. Railsback, E. McElravy, L. Travanti, T.D.F. Yuen, R.B. Lindahl, S.D. Chase, and R.W. Smith. 1995. Responses of Fish Populations to Altered Flows Project, Volume 1: Predicting Fish Populations from Stream Flow and Habitat Variables. Report 009.4-94.3. Prepared for Pacific Gas and Electric Company, Electric Power Research Institute, and Southern California Edison Company. Pacific Gas and Electric Company. San Ramon, CA.

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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

Table 3.1-1 Monthly mean, minimum and maximum water temperatures observed during the monitoring program (May 1 to October 31, 2008) by station.

Station ID	Month during 2008	Data Days	Water Temperature (°C)		
			Min	Mean	Max
T1	May	19	6.9	7.9	8.9
	June	30	8.4	8.9	9.7
	July	31	7.5	7.7	8.5
	August	31	7.5	9.7	11.6
	September	30	11.6	14.2	17.9
	October	31	15.0	16.5	18.1
T2	May	18	10.8	12.3	14.5
	June	30	13.2	14.0	15.1
	July	31	12.2	12.7	13.3
	August	31	12.2	13.1	13.9
	September	30	12.6	14.5	17.1
	October	31	14.1	15.3	17.4
T3	May	19	11.9	13.8	18.9
	June	30	15.4	17.4	19.1
	July	31	17.6	18.7	20.3
	August	31	17.4	18.3	19.4
	September	30	14.7	15.9	17.2
	October	31	10.0	13.1	17.1
T4	May	18	9.4	11.7	14.6
	June	30	10.1	11.6	13.7
	July	31	12.4	15.6	19.4
	August	27	11.9	14.7	19.8
	September	30	12.5	14.8	18.0
	October	31	14.1	16.0	18.3
T5	May	18	10.3	14.7	21.5
	June	30	11.8	15.4	21.2
	July	31	21.3	23.7	25.8
	August	31	12.3	17.0	24.1
	September	30	12.7	15.0	18.2
	October	31	14.6	16.3	18.4
T6	May	19	9.3	12.9	18.7
	June	30	14.8	16.9	19.3
	July	31	19.2	21.3	23.6
	August	31	17.0	19.4	21.7
	September	30	15.0	15.9	17.1
	October	31	10.4	14.7	17.7
T7	May	18	6.1	8.0	10.2
	June	30	10.0	12.9	15.0
	July	31	14.9	16.6	18.3
	August	31	15.8	16.8	18.1
	September	30	13.4	14.8	16.2
	October	31	8.1	11.1	15.0
T8	May	18	6.0	7.9	10.3
	June	30	10.1	13.2	15.3
	July	31	14.9	16.6	18.3
	August	31	16.1	17.0	17.9
	September	30	13.3	14.9	16.1
	October	31	7.9	11.0	15.1

Table 3.1-1 (continued)

Station ID	Month during 2008	Data Days	Water Temperature (°C)		
			Min	Mean	Max
T9	May	19	8.7	11.9	17.3
	June	30	14.1	16.4	18.5
	July	7	18.4	18.8	19.4
	August	31	18.6	19.4	20.0
	September	30	14.7	16.4	18.9
	October	31	8.7	11.6	16.0
T10	May	19	12.6	14.9	21.3
	June	30	16.4	18.8	20.8
	July	31	20.5	21.6	23.5
	August	31	19.2	21.1	22.6
	September	30	15.6	17.2	18.8
	October	31	10.1	13.8	17.9
T11	May	18	9.1	12.4	16.2
	June	30	15.3	18.8	21.8
	July	31	21.5	23.1	25.0
	August	31	22.6	24.0	25.3
	September	30	17.8	20.0	22.2
	October	31	11.4	14.6	20.2
T12	May	18	10.1	13.5	17.6
	June	30	16.6	19.9	22.7
	July	31	22.5	23.6	25.6
	August	31	23.0	24.1	25.1
	September	30	18.3	20.1	21.9
	October	31	11.8	14.8	20.1
T13	May	19	9.4	12.9	18.5
	June	30	14.8	16.9	19.3
	July	31	19.2	21.1	23.0
	August	31	17.8	20.1	22.0
	September	30	15.3	16.3	17.5
	October	31	10.1	14.5	17.8

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. The daily mean is based on hourly mean water temperatures recorded during each day.

Table 3.2-1 Summary of 2008 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 2008	Data Days	Daily Mean Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W24	May	31	31.0	51.7	88.0
	June	30	8.8	17.8	32.0
	July	21	4.4	6.0	8.4
	August	31	1.9	2.4	3.0
	September	30	1.9	2.1	2.4
	October	31	2.4	3.5	7.1
W33	May	31	0.0	12.7	21.0
	June	30	5.8	12.6	23.0
	July	31	3.6	6.6	11.0
	August	31	1.0	2.0	3.4
	September	30	0.7	0.9	1.9
	October	31	0.7	2.3	6.6
W1	May	31	38.6	63.8	79.4
	June	30	0.0	11.0	35.9
	July	31	0.0	0.0	0.0
	August	30	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	0.0	0.1
W2 Bass Lake Storage	May	31	36,508	40,858	44,088
	June	30	43,195	44,081	45,117
	July	31	42,789	42,991	43,176
	August	31	38,434	41,307	42,777
	September	30	31,628	34,855	38,193
	October	31	24,916	28,247	31,413
W19	May	31	0.0	9.9	101.9
	June	30	0.0	40.7	112.6
	July	31	0.0	0.0	0.0
	August	31	0.0	53.8	109.0
	September	30	0.0	84.0	112.6
	October	31	0.0	87.2	117.2
W3	May	31	2.1	2.9	3.6
	June	30	3.0	3.4	4.0
	July	31	3.5	3.5	3.5
	August	31	2.7	3.1	3.5
	September	30	2.9	3.0	3.2
	October	31	2.9	2.9	3.2
W4	May	31	0.6	15.5	106.0
	June	30	4.4	49.1	109.0
	July	31	0.0	0.8	4.4
	August	31	0.0	62.2	109.0
	September	30	107.0	109.4	113.0
	October	31	108.0	115.1	126.0
W6	May	31	0.0	7.8	78.2
	June	30	0.0	36.3	86.2
	July	31	0.0	0.0	0.0
	August	31	0.0	45.8	95.3
	September	30	64.1	85.5	93.7
	October	31	0.0	65.5	149.0

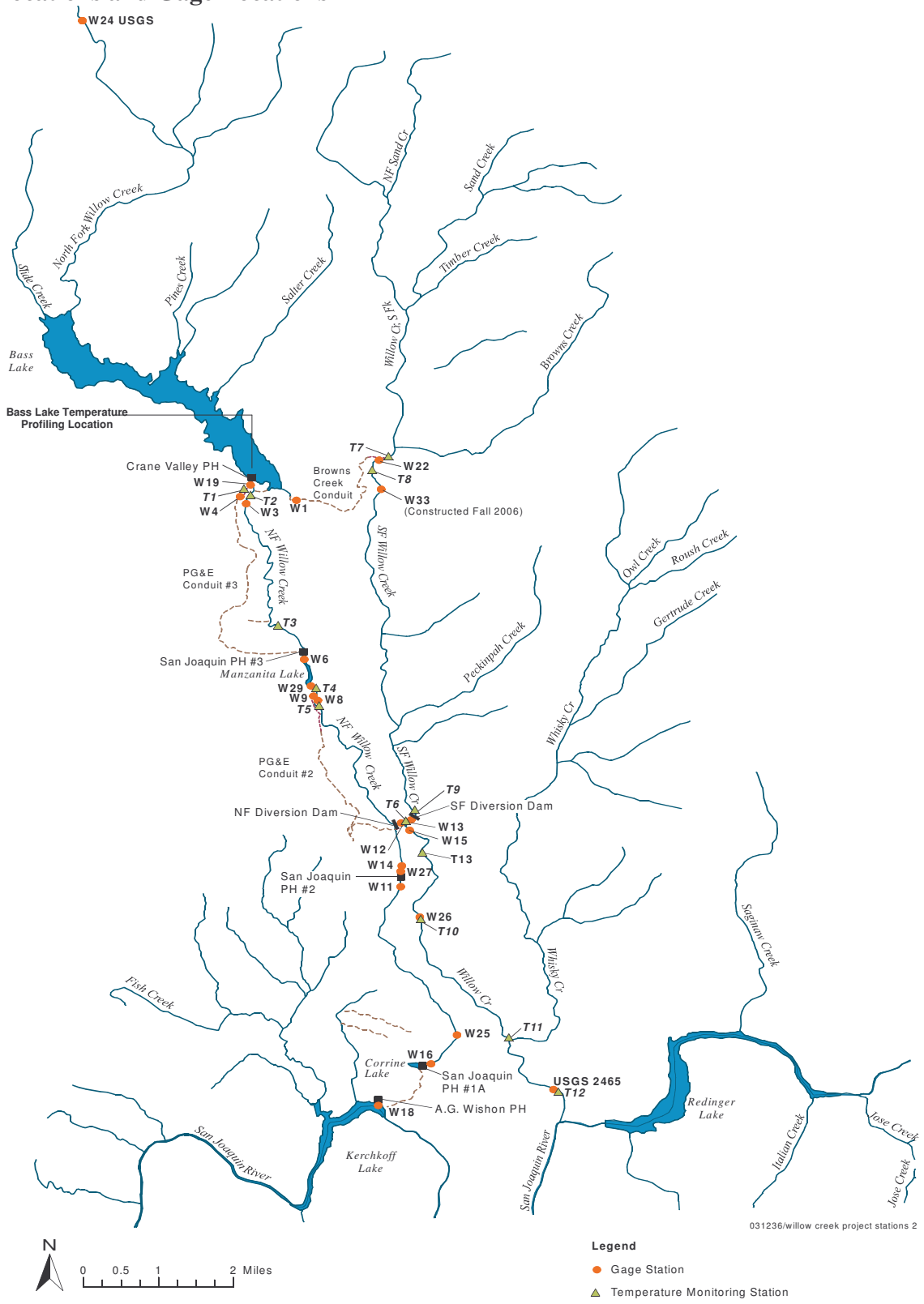
Table 3.2-1 (continued)

Station ID	Month during 2008	Data Days	Daily Mean Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W8	May	31	5.0	8.3	18.0
	June	30	4.5	8.2	15.0
	July	31	3.4	4.6	7.3
	August	31	3.4	5.1	9.7
	September	30	4.9	7.7	44.9
	October	31	4.3	34.6	68.0
W29	May	31	5.0	8.3	18.0
	June	30	4.5	8.2	15.0
	July	31	3.4	4.6	7.3
	August	31	3.4	5.1	9.7
	September	30	4.9	7.7	44.9
	October	31	4.3	34.6	68.0
W9	May	31	0.0	10.6	110.0
	June	30	0.0	46.3	150.0
	July	31	0.0	1.0	10.0
	August	31	0.0	66.4	115.0
	September	30	0.0	114.5	125.0
	October	31	0.0	70.8	149.0
WC3	May	31	3.5	18.5	109.4
	June	30	7.5	52.5	112.1
	July	31	3.5	4.3	7.9
	August	31	3.2	65.3	112.2
	September	30	110.0	112.5	115.9
	October	31	110.9	118.0	128.9
W11	May	31	0.0	9.4	98.3
	June	30	0.0	38.7	98.3
	July	31	0.0	0.0	0.0
	August	31	0.0	55.5	108.7
	September	30	28.5	92.6	112.2
	October	31	0.0	49.7	119.3
W12	May	31	10.0	24.7	42.0
	June	30	8.0	15.1	23.0
	July	31	0.0	1.4	12.0
	August	31	0.0	1.7	3.0
	September	30	0.0	0.0	0.0
	October	31	2.0	2.6	7.0
W15	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	1.2	2.0
	August	31	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	0.0	0.0
W13	May	31	0.0	0.0	0.0
	June	30	0.0	0.0	0.0
	July	31	0.0	0.0	1.0
	August	31	0.0	0.0	0.0
	September	30	0.0	0.0	0.0
	October	31	0.0	0.0	0.0

Table 3.2-1 (continued)

Station ID	Month during 2008	Data Days	Daily Mean Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W14	May	31	18.0	30.8	48.0
	June	30	11.0	21.0	29.0
	July	31	3.8	11.1	16.0
	August	31	0.6	5.3	11.0
	September	30	4.0	8.9	118.0
	October	31	5.0	66.0	156.0
W27	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	0.0	0.0
	October	31	0.0	0.0	0.0
W26	May	31	2.0	2.5	2.9
	June	30	2.6	224.4	1137.7
	July	31	2.5	66.3	1248.2
	August	30	1.1	2.0	6.4
	September	30	1.7	2.8	17.4
	October	31	1.0	3.8	9.5
USGS Gage 2465	May	31	15.0	25.0	36.0
	June	30	5.5	9.1	15.0
	July	31	3.6	8.2	15.0
	August	31	0.9	1.7	4.2
	September	30	1.4	2.5	11.0
	October	31	1.2	3.5	8.9
W25	May	31	20.0	44.9	130.0
	June	30	19.0	63.6	126.0
	July	31	0.0	3.2	18.0
	August	31	1.6	64.6	113.0
	September	30	94.0	112.1	160.0
	October	31	73.0	116.3	180.0
W16	May	31	0.0	6.3	141.9
	June	30	0.0	55.0	140.0
	July	31	0.0	0.0	0.0
	August	31	0.0	49.7	158.0
	September	30	0.0	102.0	154.2
	October	28	0.0	0.0	0.0
W17 Corrine Lake Storage	May	31	34.9	45.9	50.1
	June	30	39.5	47.3	49.2
	July	31	33.9	48.8	64.7
	August	31	32.7	49.1	61.4
	September	30	40.0	48.4	55.7
	October	29	33.7	47.2	50.0
W18	May	31	15.4	41.9	134.5
	June	30	14.5	61.2	129.1
	July	31	0.0	3.3	19.8
	August	31	0.0	63.3	115.0
	September	30	78.2	107.6	130.9
	October	30	0.0	104.4	140.4

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



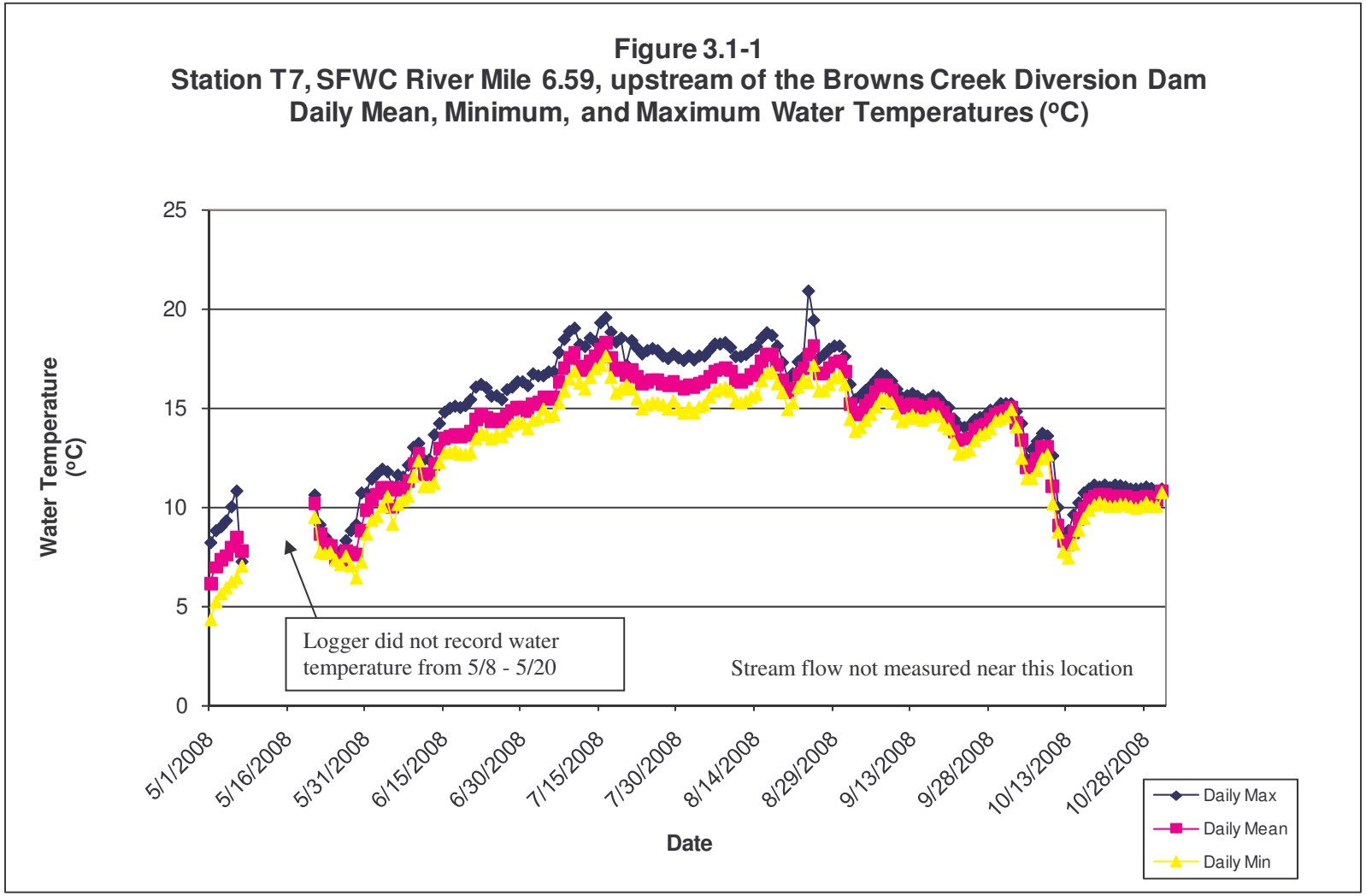
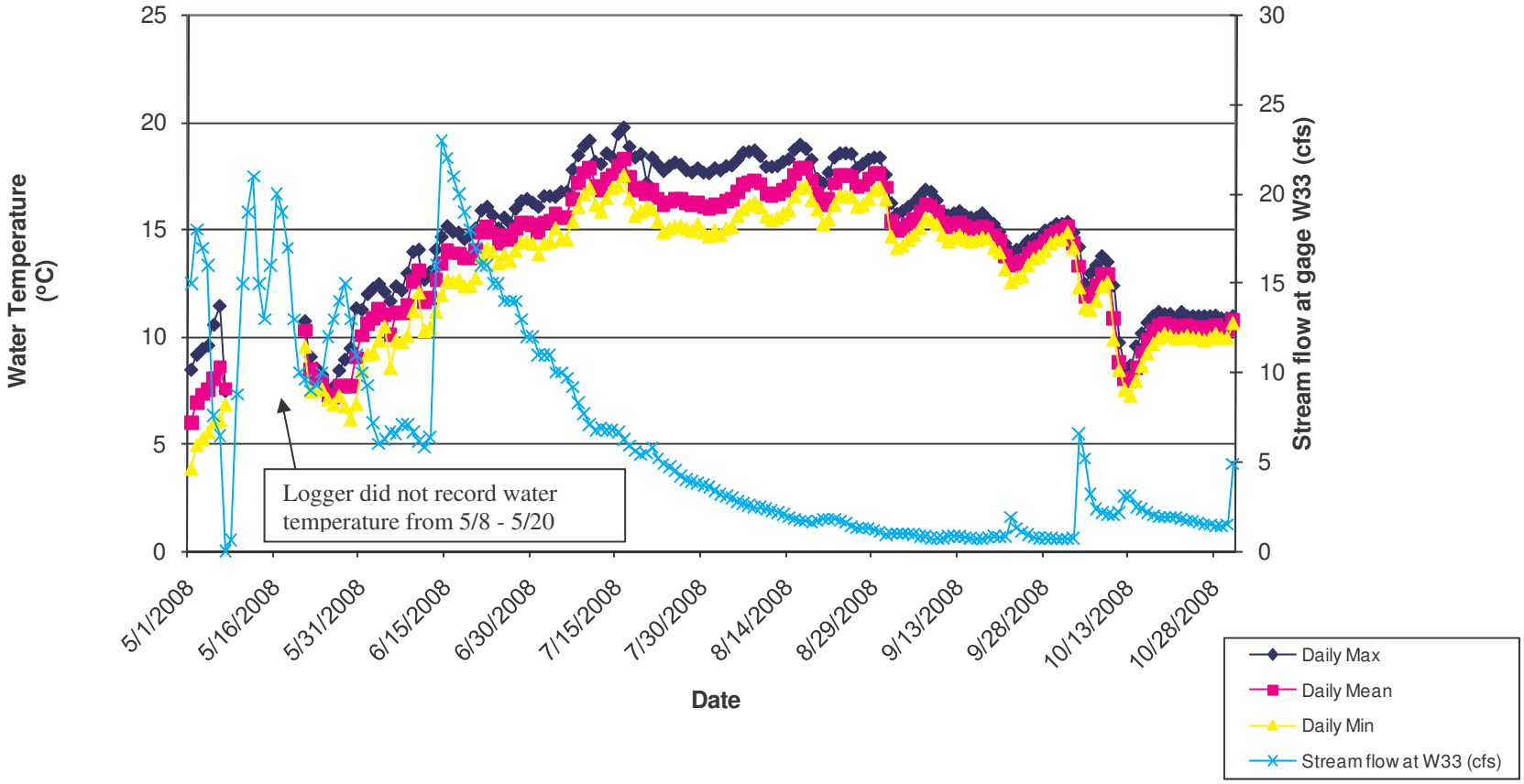


Figure 3.1-1
Station T7, SFWC River Mile 6.59, upstream of the Browns Creek Diversion Dam
Daily Mean, Minimum, and Maximum Water Temperatures (ºC)
Water Temperature (ºC)
25
20
15
10
5
0
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008
Date
Logger did not record water temperature from 5/8 - 5/20
Stream flow not measured near this location
Daily Max
Daily Mean
Daily Min

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)



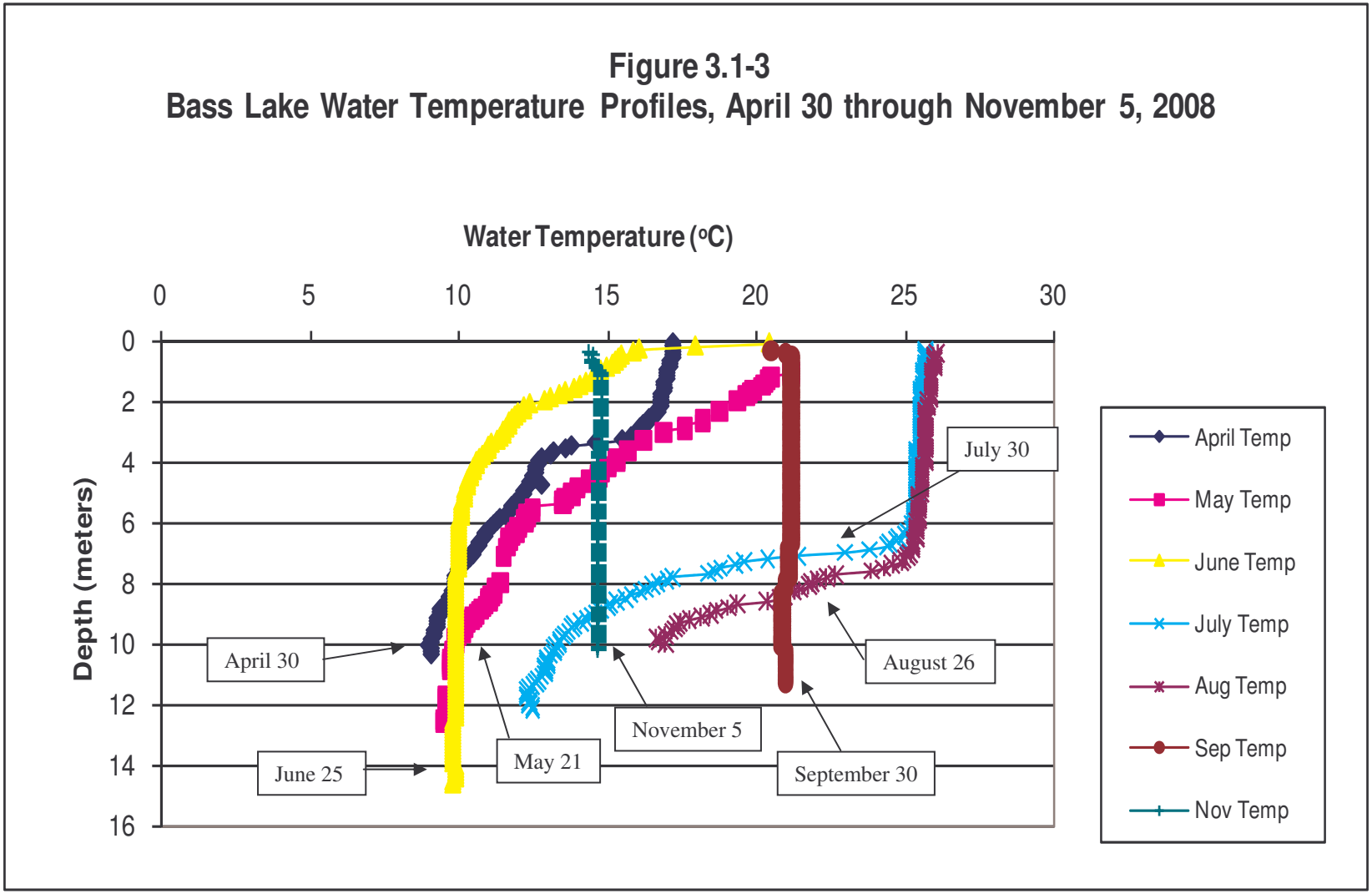


Figure 3.1-3
Bass Lake Water Temperature Profiles, April 30 through November 5, 2008
Water Temperature (°C)
0
5
10
15
20
25
30
Depth (meters)
0
2
4
6
8
10
12
14
16
April 30
June 25
May 21
November 5
September 30
August 26
July 30
April Temp
May Temp
June Temp
July Temp
Aug Temp
Sep Temp
Nov Temp

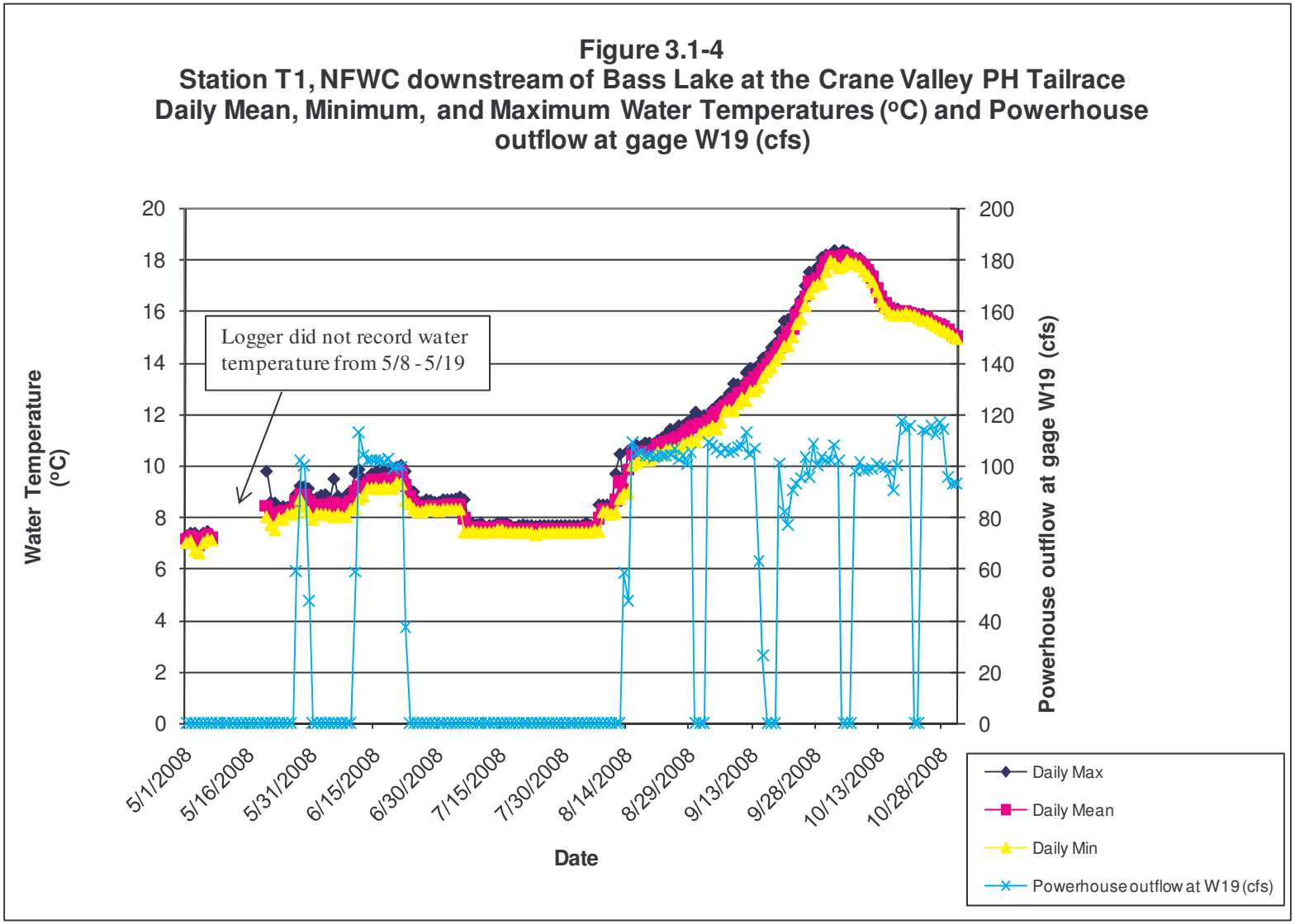
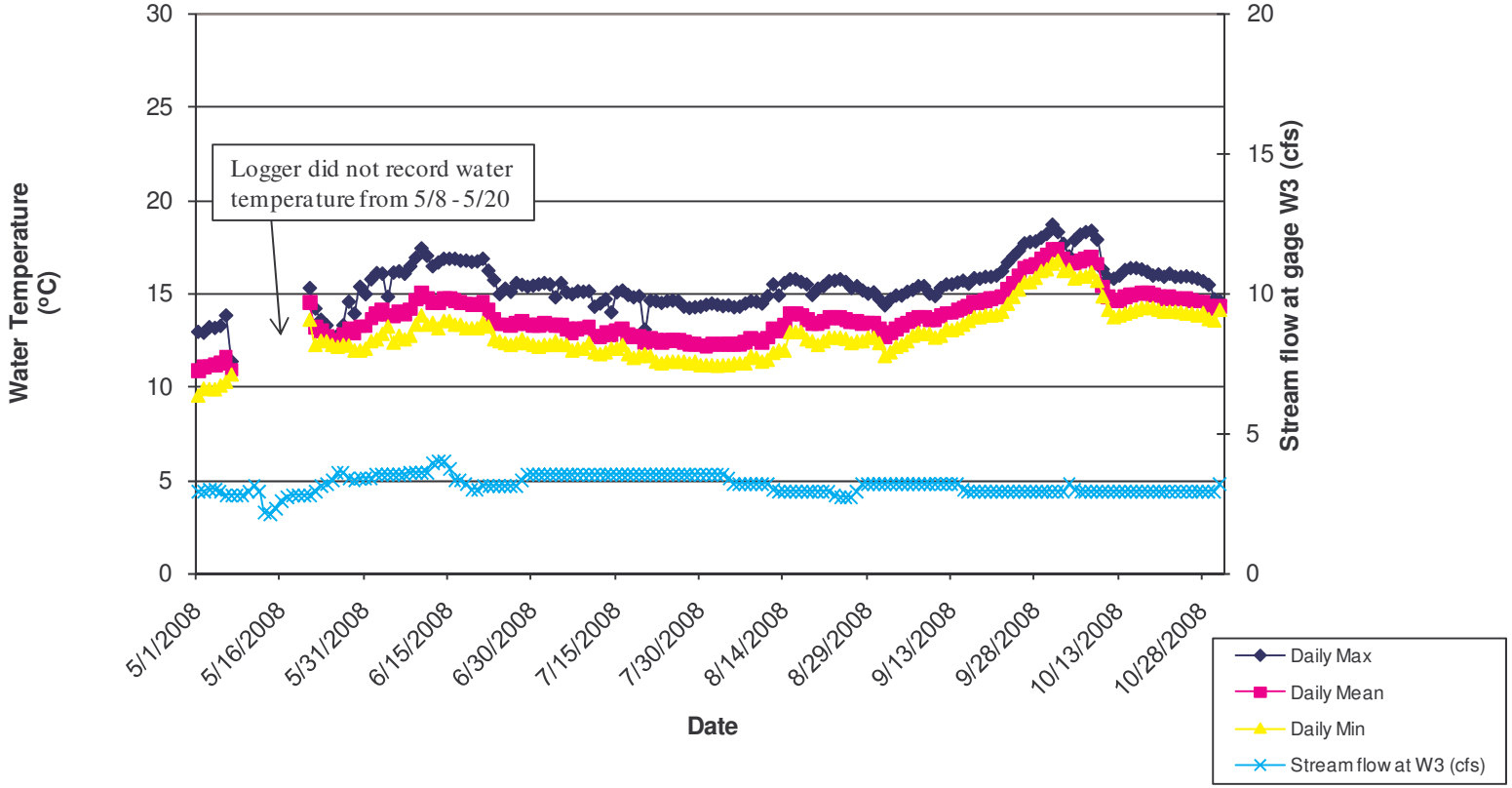


Figure 3.1-4
Station T1, NFWC downstream of Bass Lake at the Crane Valley PH Tailrace
Daily Mean, Minimum, and Maximum Water Temperatures (ºC) and Powerhouse outflow at gage W19 (cfs)
Logger did not record water temperature from 5/8 - 5/19
Water Temperature (ºC)
Powerhouse outflow at gage W19 (cfs)
Date
0
2
4
6
8
10
12
14
16
18
20
0
20
40
60
80
100
120
140
160
180
200
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008
Daily Max
Daily Mean
Daily Min
Powerhouse outflow at W19 (cfs)

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)



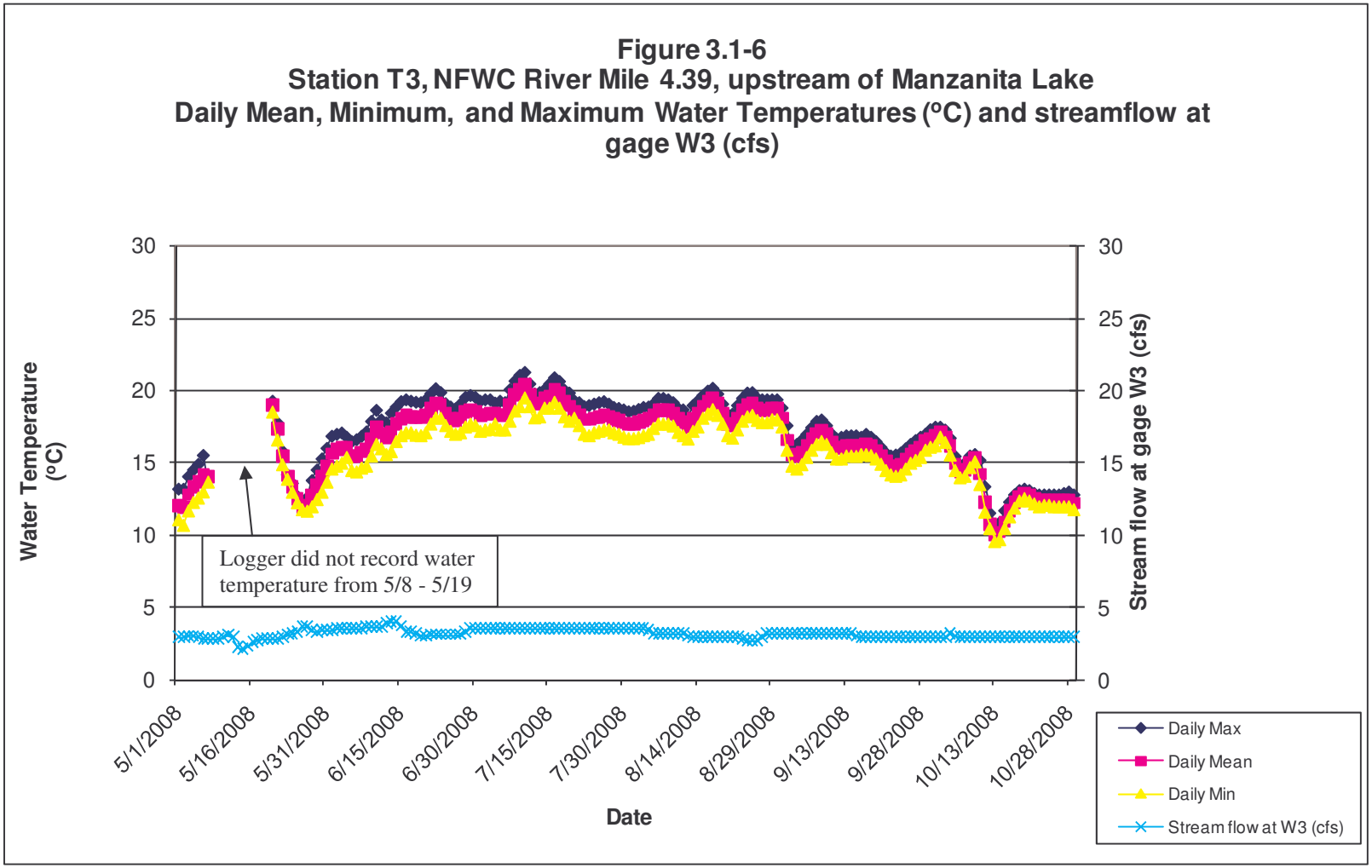


Figure 3.1-6
Station T3, NFWC River Mile 4.39, upstream of Manzanita Lake
Daily Mean, Minimum, and Maximum Water Temperatures (ºC) and streamflow at gage W3 (cfs)
Water Temperature (ºC)
Stream flow at gage W3 (cfs)
Date
Logger did not record water temperature from 5/8 - 5/19
Daily Max
Daily Mean
Daily Min
Stream flow at W3 (cfs)
0
5
10
15
20
25
30
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008

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

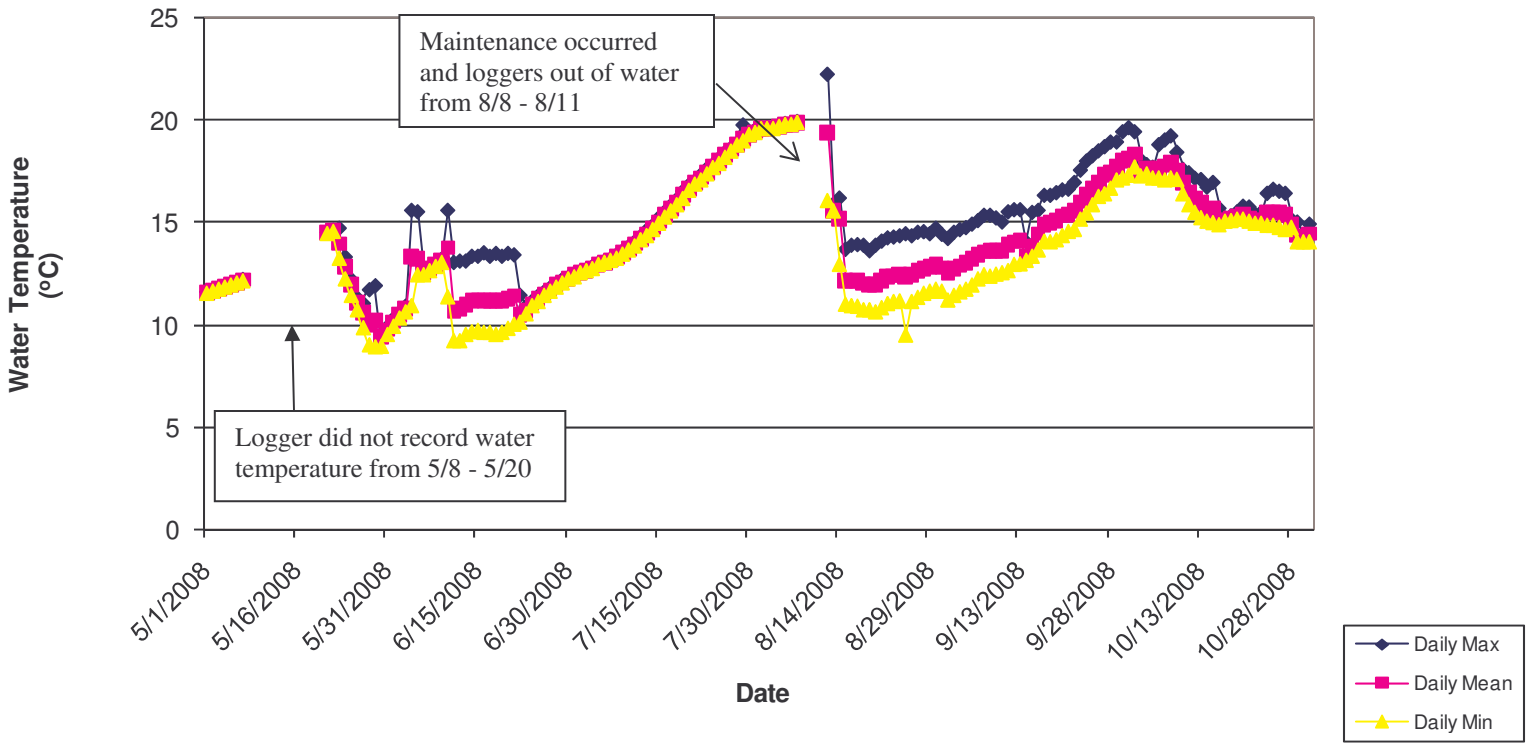
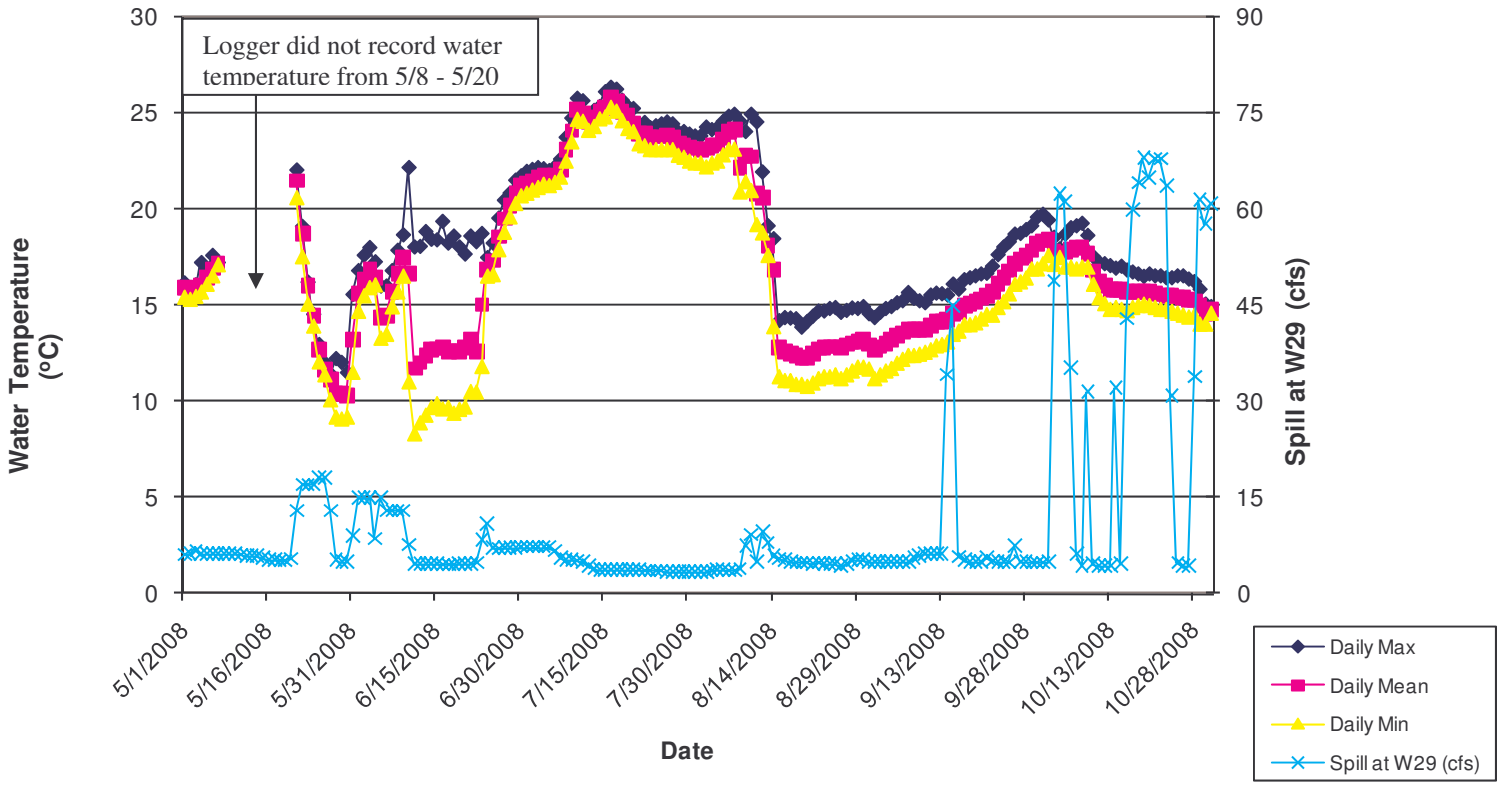


Figure 3.1-8
Station T5, NFWC River Mile 3.0, downstream of Manzanita Lake
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and Spill at gage W29 (cfs)



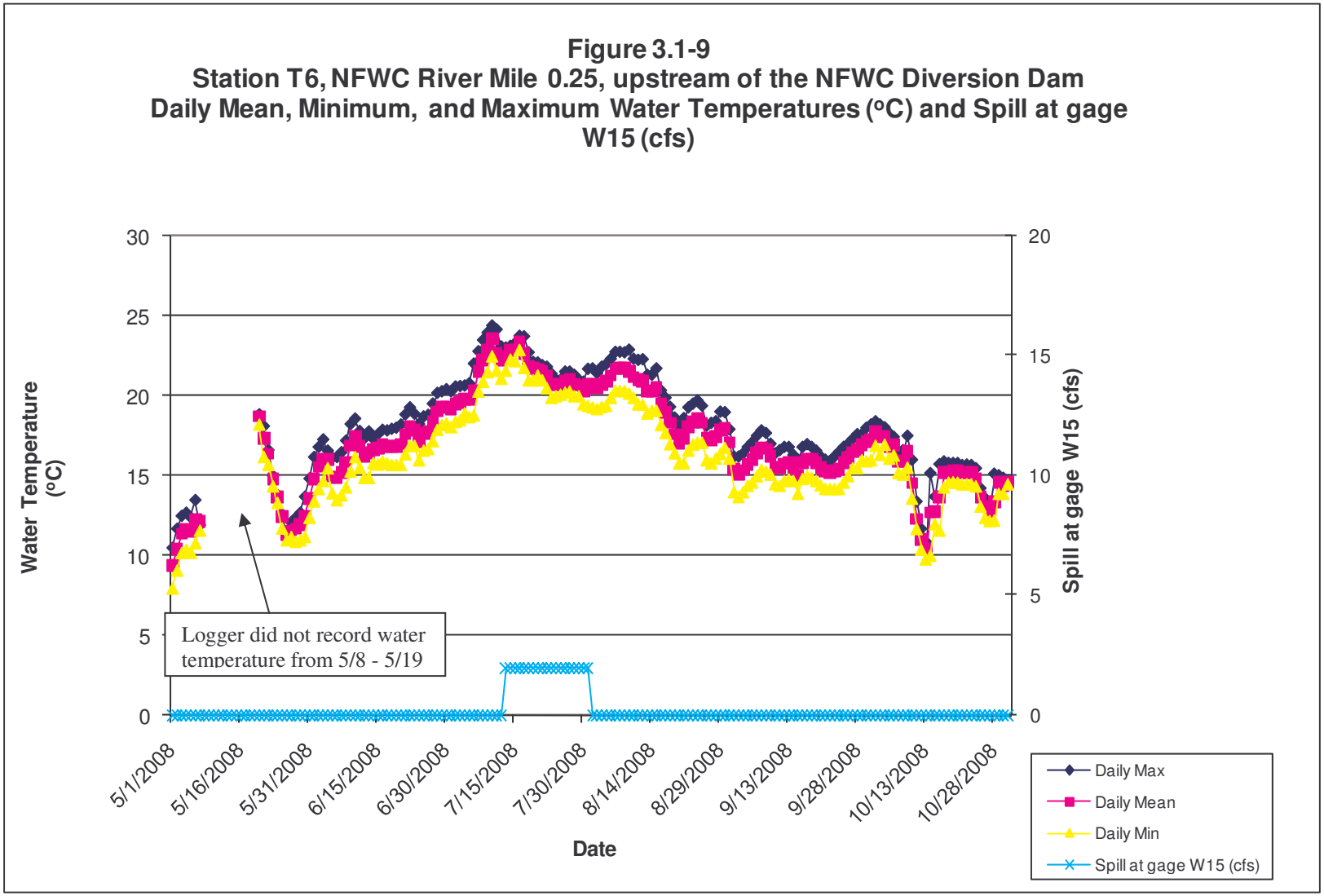
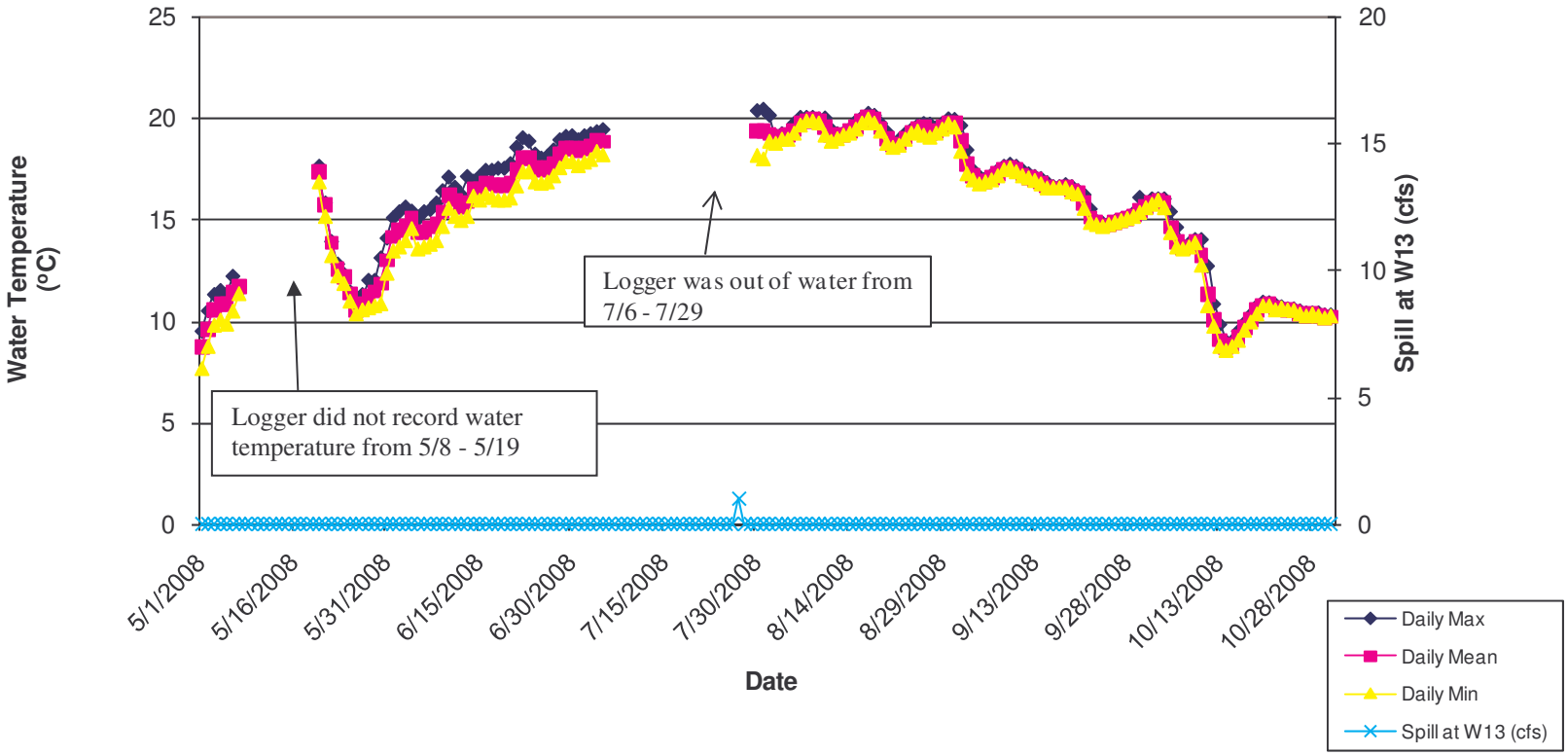


Figure 3.1-9
Station T6, NFWC River Mile 0.25, upstream of the NFWC Diversion Dam
Daily Mean, Minimum, and Maximum Water Temperatures (ºC) and Spill at gage W15 (cfs)
Water Temperature (ºC)
Spill at gage W15 (cfs)
Date
Logger did not record water temperature from 5/8 - 5/19
30
25
20
15
10
5
0
20
15
10
5
0
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008
Daily Max
Daily Mean
Daily Min
Spill at gage W15 (cfs)

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)



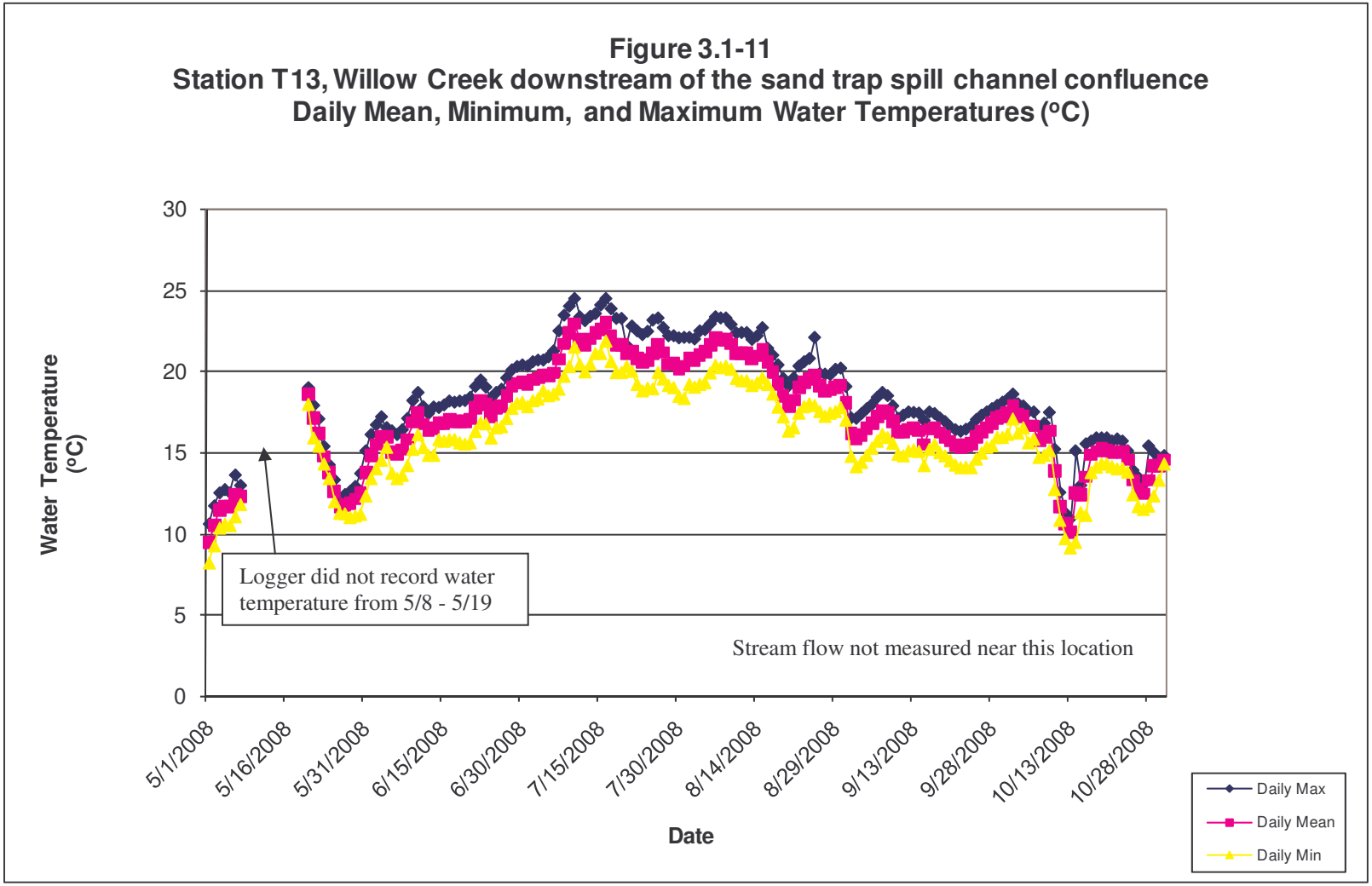
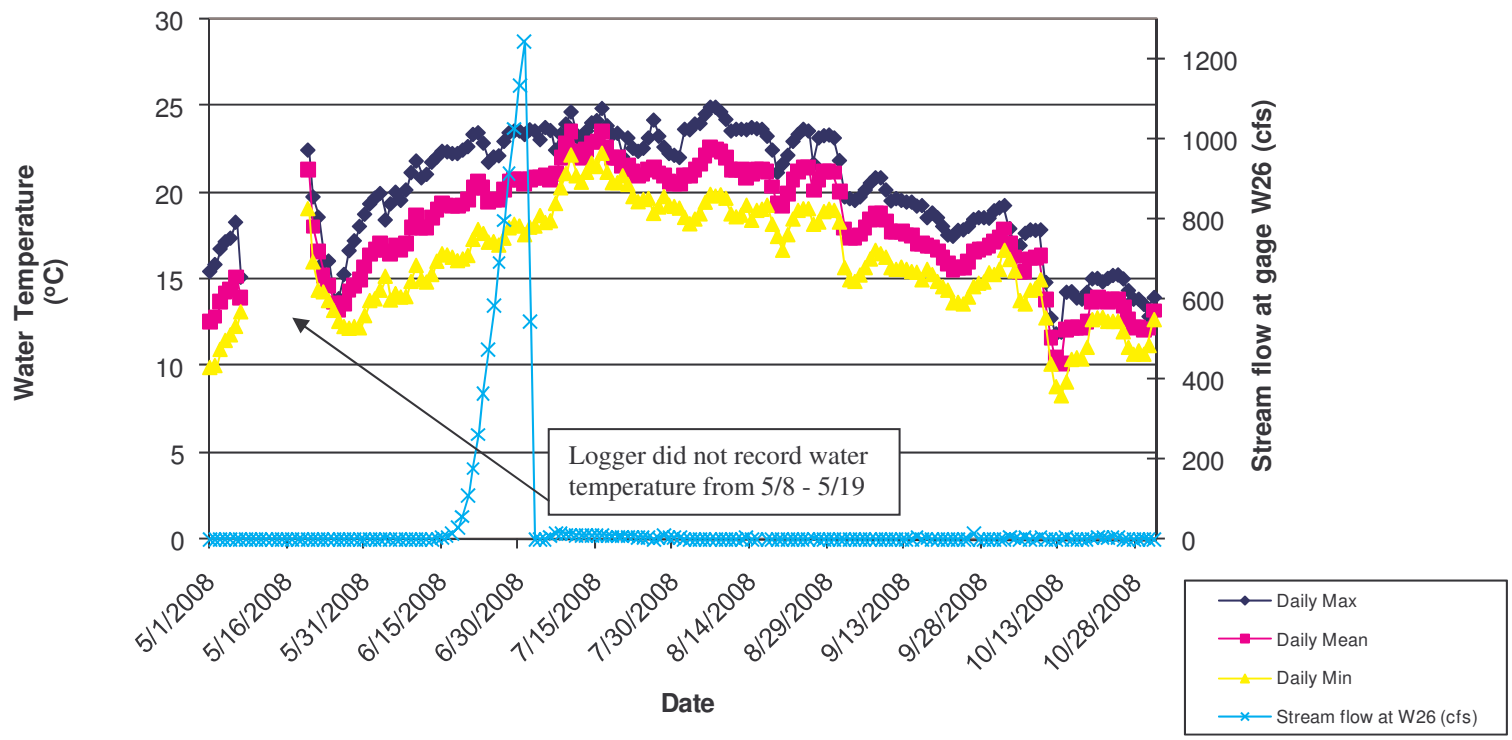


Figure 3.1-11
Station T13, Willow Creek downstream of the sand trap spill channel confluence
Daily Mean, Minimum, and Maximum Water Temperatures (°C)
Water Temperature (°C)
30
25
20
15
10
5
0
Logger did not record water temperature from 5/8 - 5/19
Stream flow not measured near this location
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008
Date
Daily Max
Daily Mean
Daily Min

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)



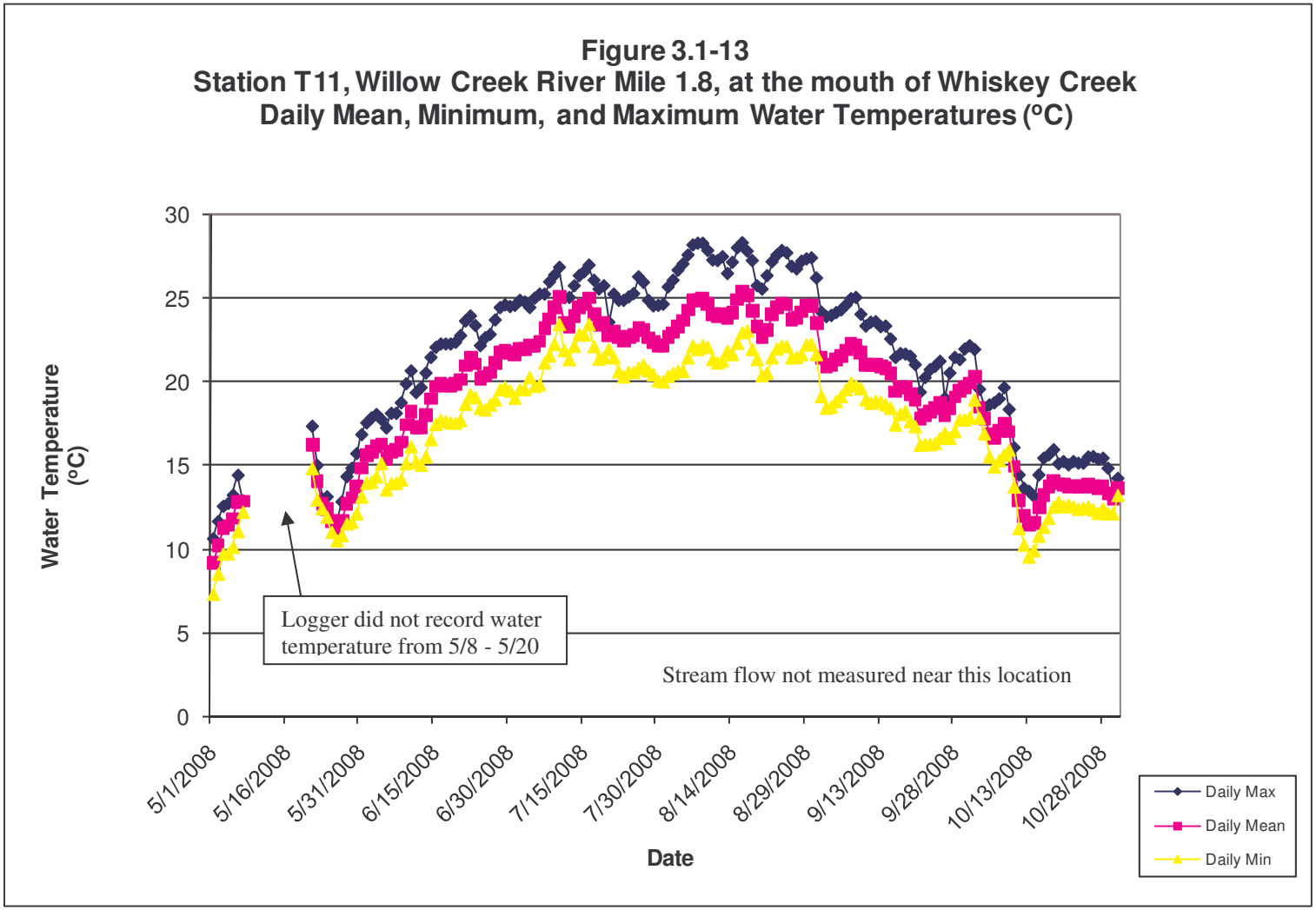


Figure 3.1-13
Station T11, Willow Creek River Mile 1.8, at the mouth of Whiskey Creek
Daily Mean, Minimum, and Maximum Water Temperatures (ºC)
Water Temperature (ºC)
30
25
20
15
10
5
0
Logger did not record water temperature from 5/8 - 5/20
Stream flow not measured near this location
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008
Date
Daily Max
Daily Mean
Daily Min

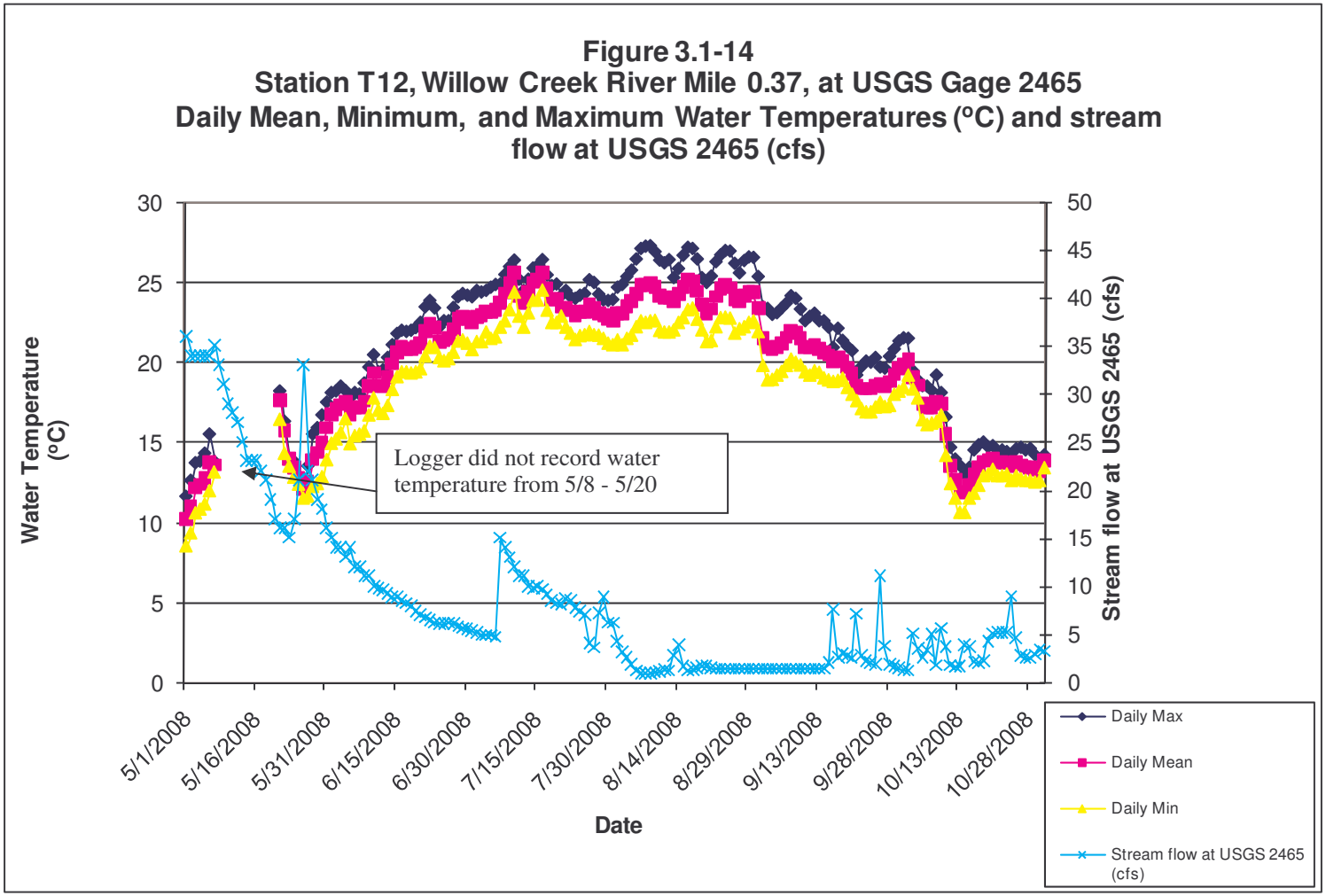


Figure 3.1-14
Station T12, Willow Creek River Mile 0.37, at USGS Gage 2465
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and stream flow at USGS 2465 (cfs)
Water Temperature (°C)
Stream flow at USGS 2465 (cfs)
Date
Logger did not record water temperature from 5/8 - 5/20
Daily Max
Daily Mean
Daily Min
Stream flow at USGS 2465 (cfs)
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008

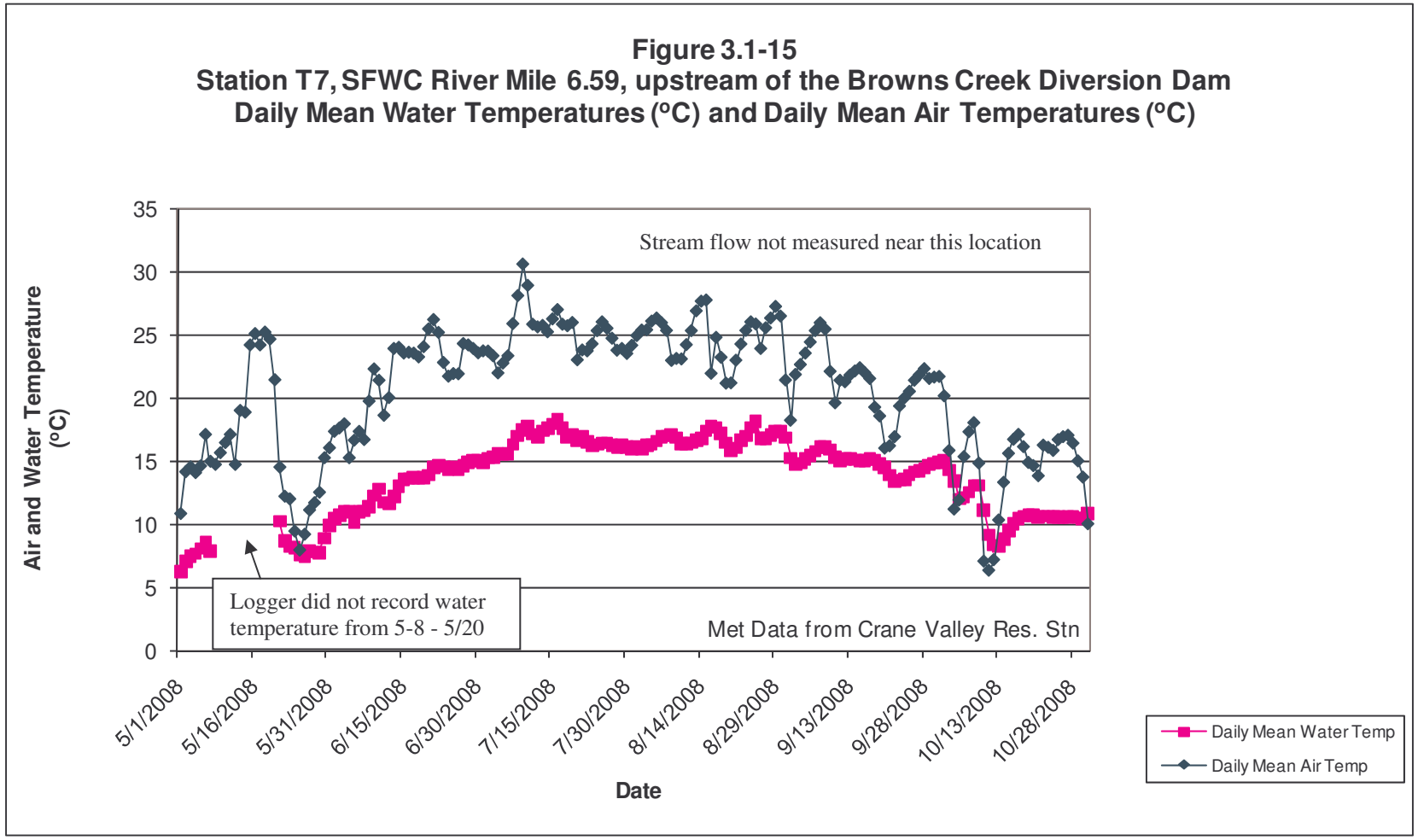
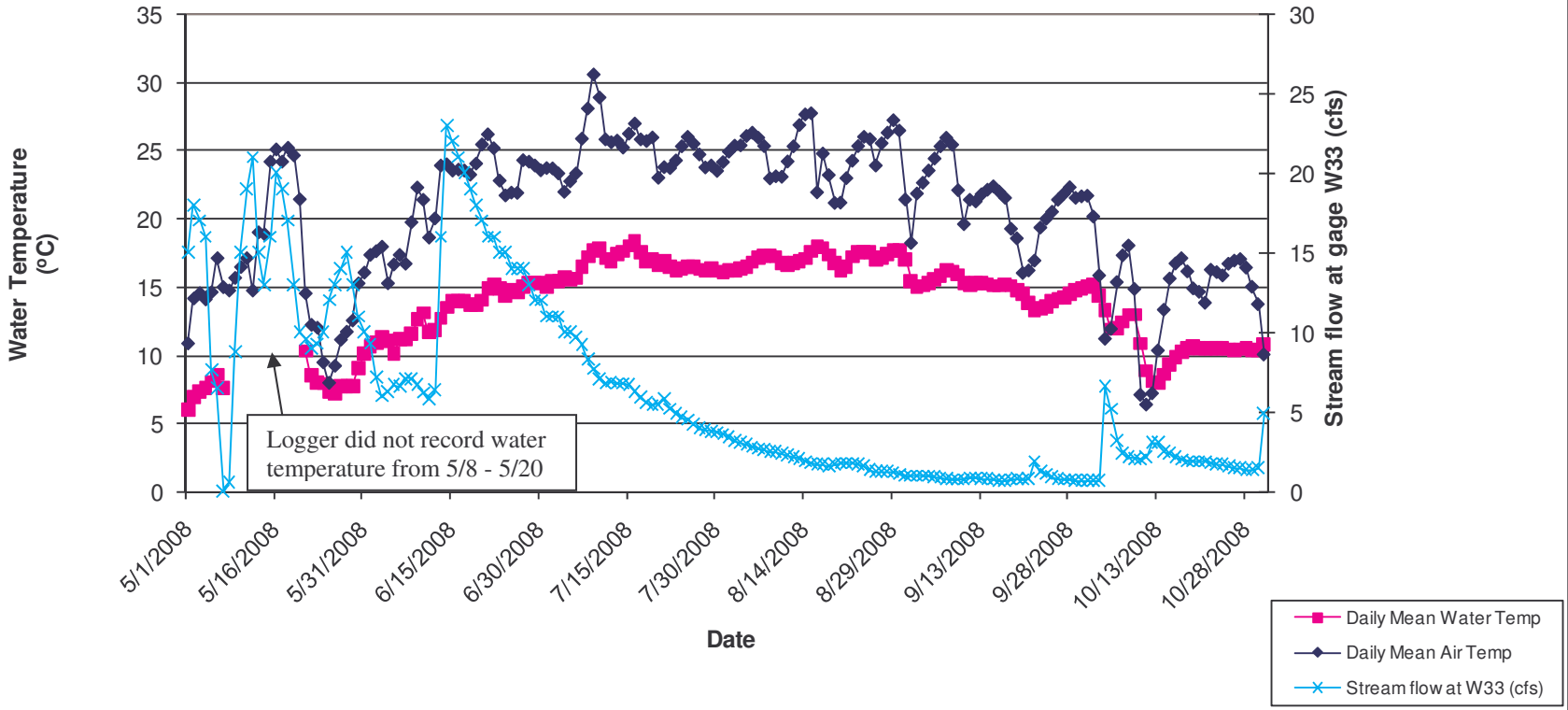


Figure 3.1-15
Station T7, SFWC River Mile 6.59, upstream of the Browns Creek Diversion Dam
Daily Mean Water Temperatures (°C) and Daily Mean Air Temperatures (°C)
Stream flow not measured near this location
Logger did not record water temperature from 5-8 - 5/20
Met Data from Crane Valley Res. Stn
Air and Water Temperature (°C)
35
30
25
20
15
10
5
0
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008
Date
Daily Mean Water Temp
Daily Mean Air Temp

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)



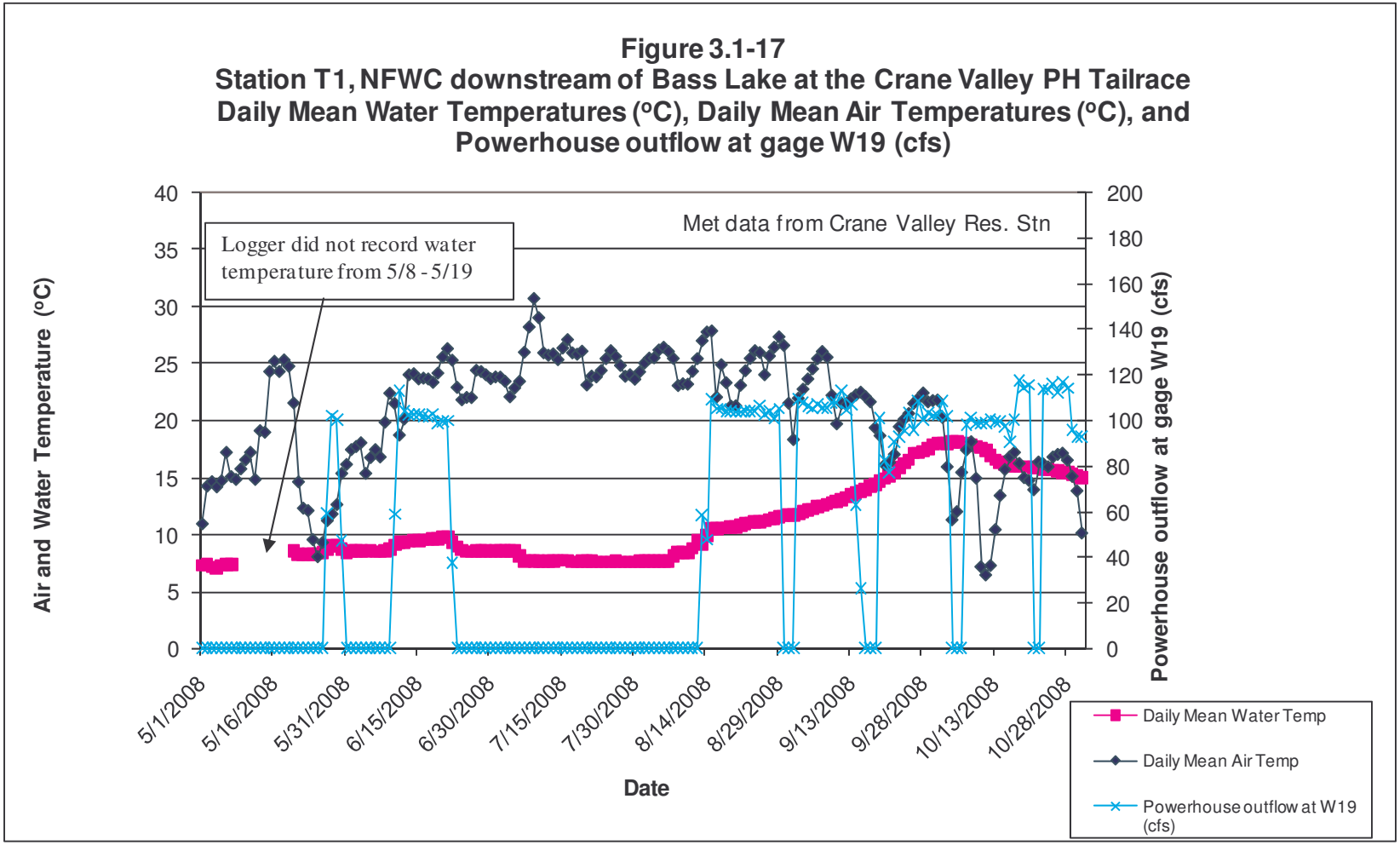


Figure 3.1-17
Station T1, NFWC downstream of Bass Lake at the Crane Valley PH Tailrace
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and
Powerhouse outflow at gage W19 (cfs)
Logger did not record water temperature from 5/8 - 5/19
Met data from Crane Valley Res. Stn
Air and Water Temperature (°C)
Powerhouse outflow at gage W19 (cfs)
Date
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100
120
140
160
180
200
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008
Daily Mean Water Temp
Daily Mean Air Temp
Powerhouse outflow at W19 (cfs)

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)

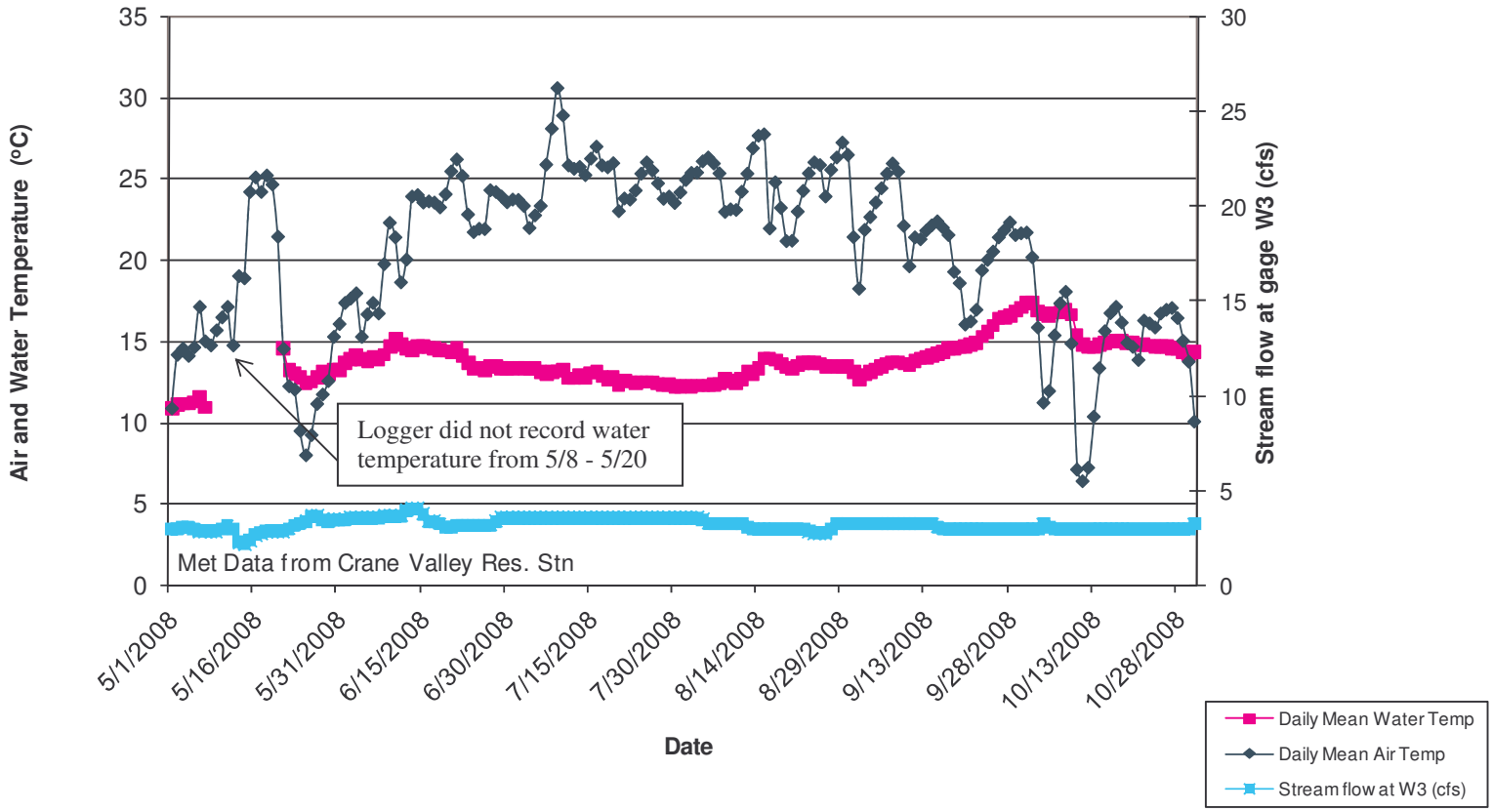
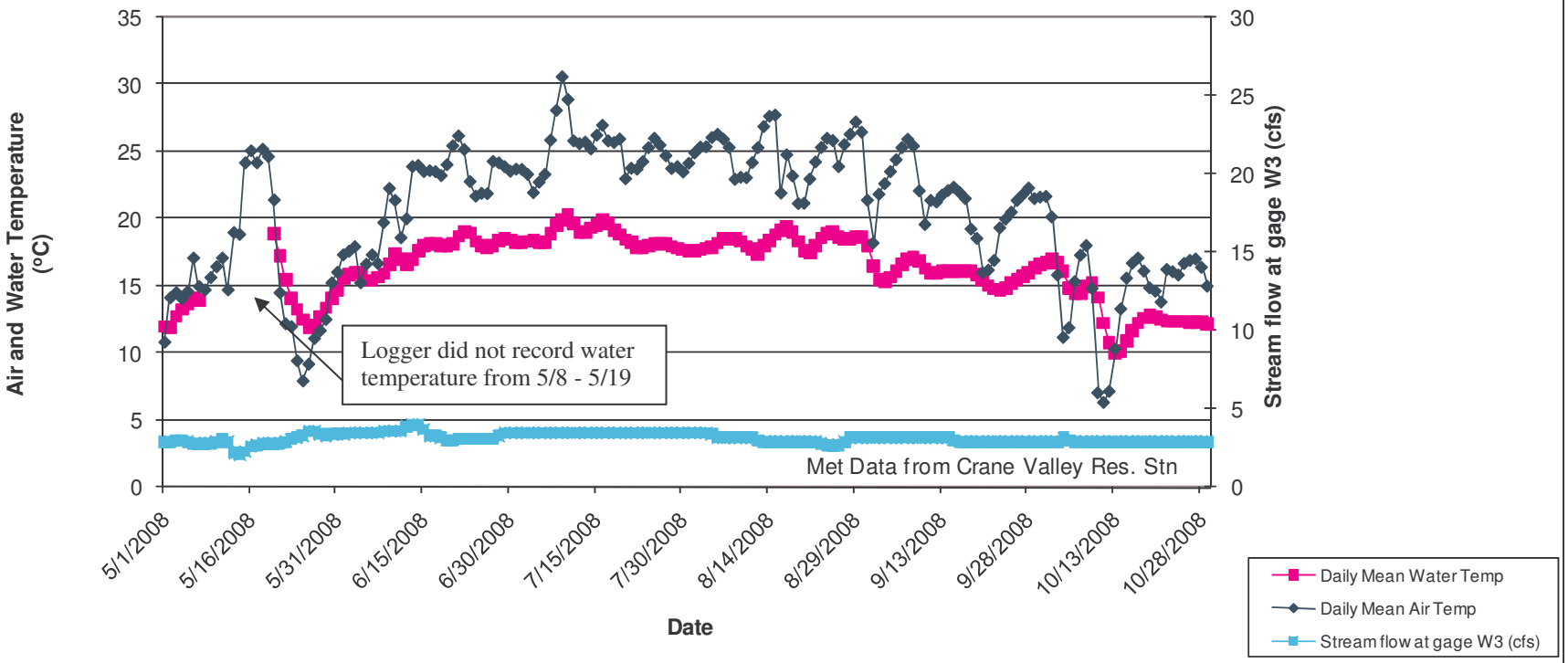


Figure 3.1-19
Station T3, NFWC River Mile 4.39, upstream of Manzanita Lake
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at gage W3 (cfs)



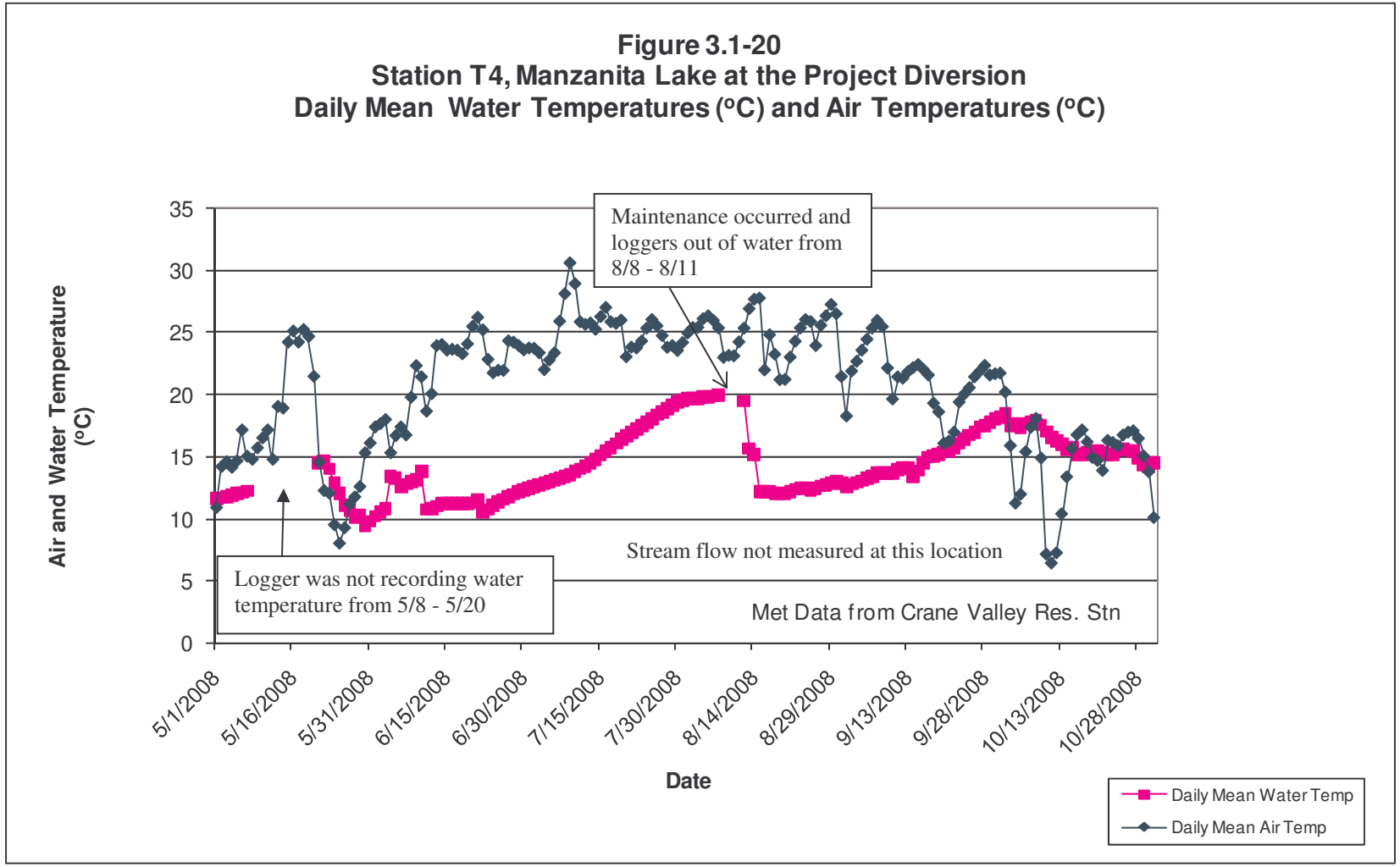


Figure 3.1-20
Station T4, Manzanita Lake at the Project Diversion
Daily Mean Water Temperatures (ºC) and Air Temperatures (ºC)
Maintenance occurred and loggers out of water from 8/8 - 8/11
Logger was not recording water temperature from 5/8 - 5/20
Stream flow not measured at this location
Met Data from Crane Valley Res. Stn
Air and Water Temperature (ºC)
35
30
25
20
15
10
5
0
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008
Date
Daily Mean Water Temp
Daily Mean Air Temp

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)

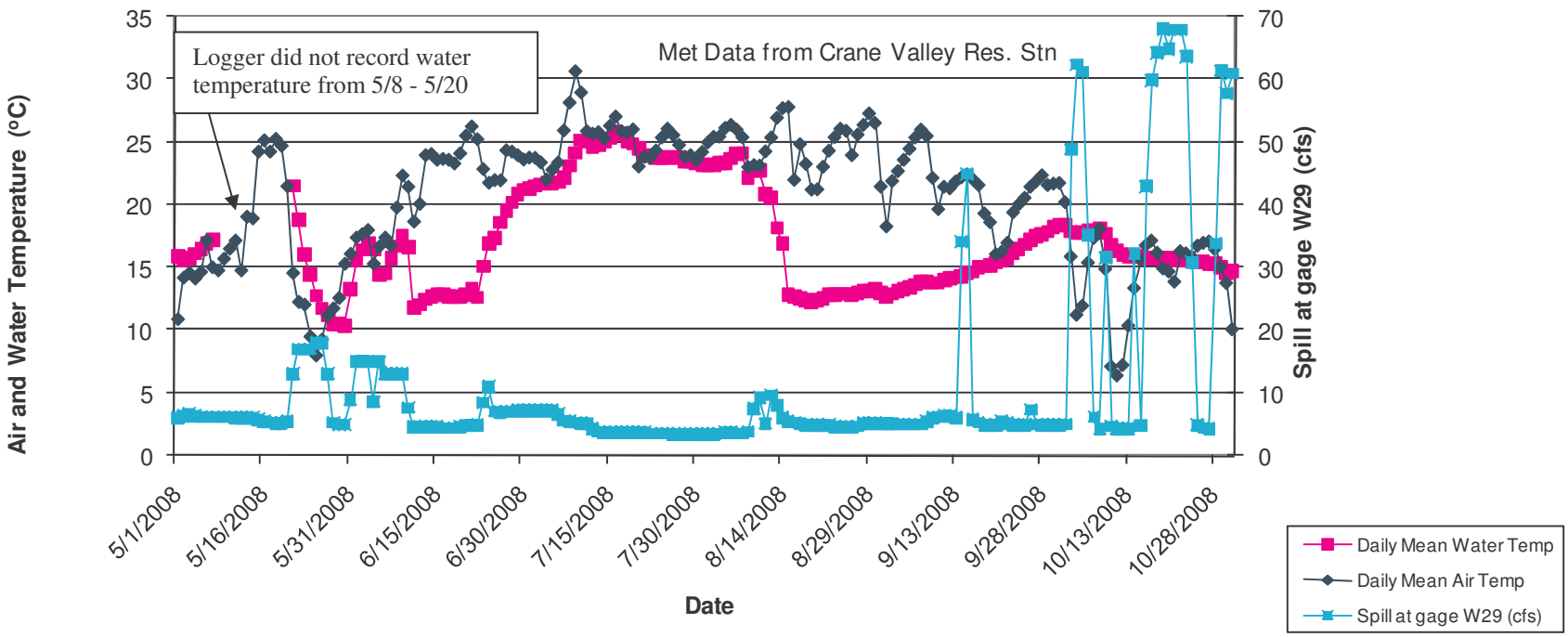


Figure 3.1-22
Station T6, NFWC River Mile 0.25, upstream of the NFWC Diversion Dam
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and Spill at gage W15 (cfs)

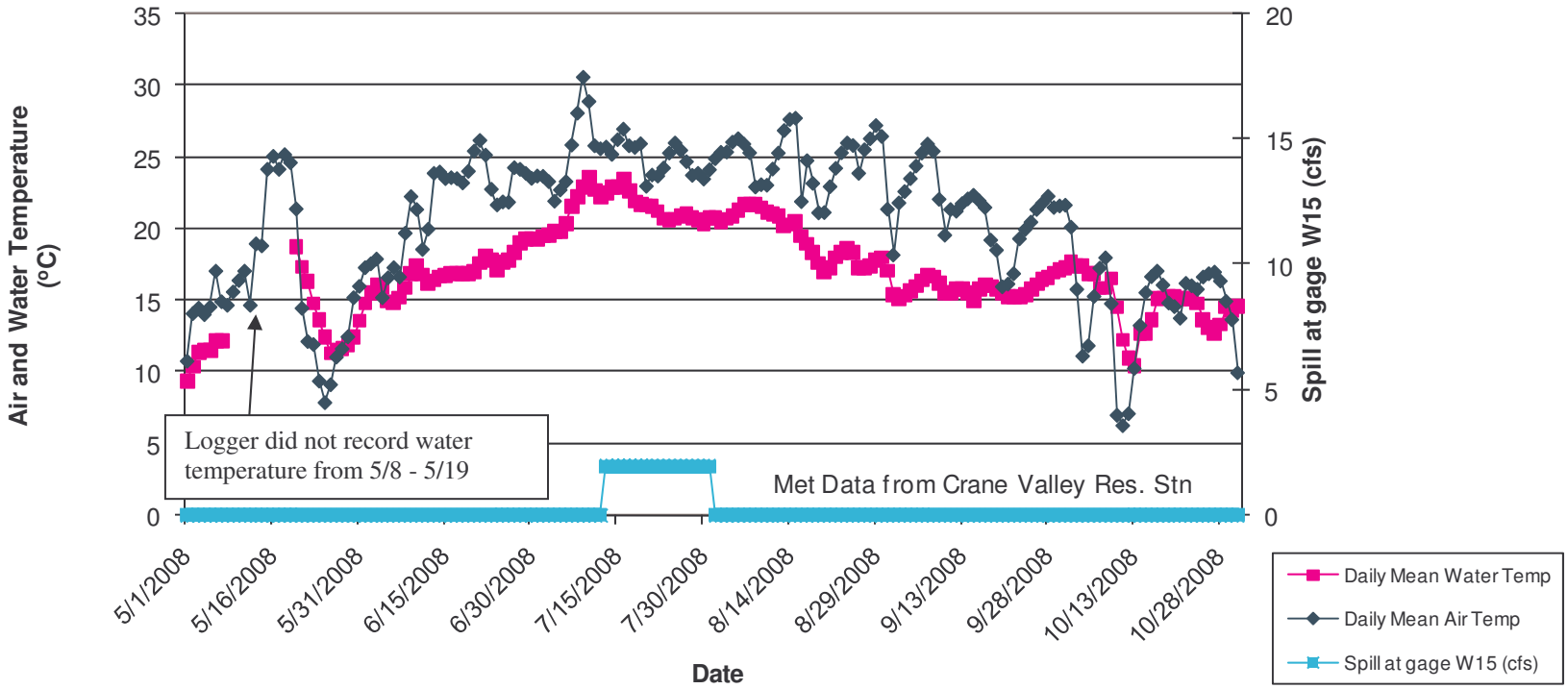
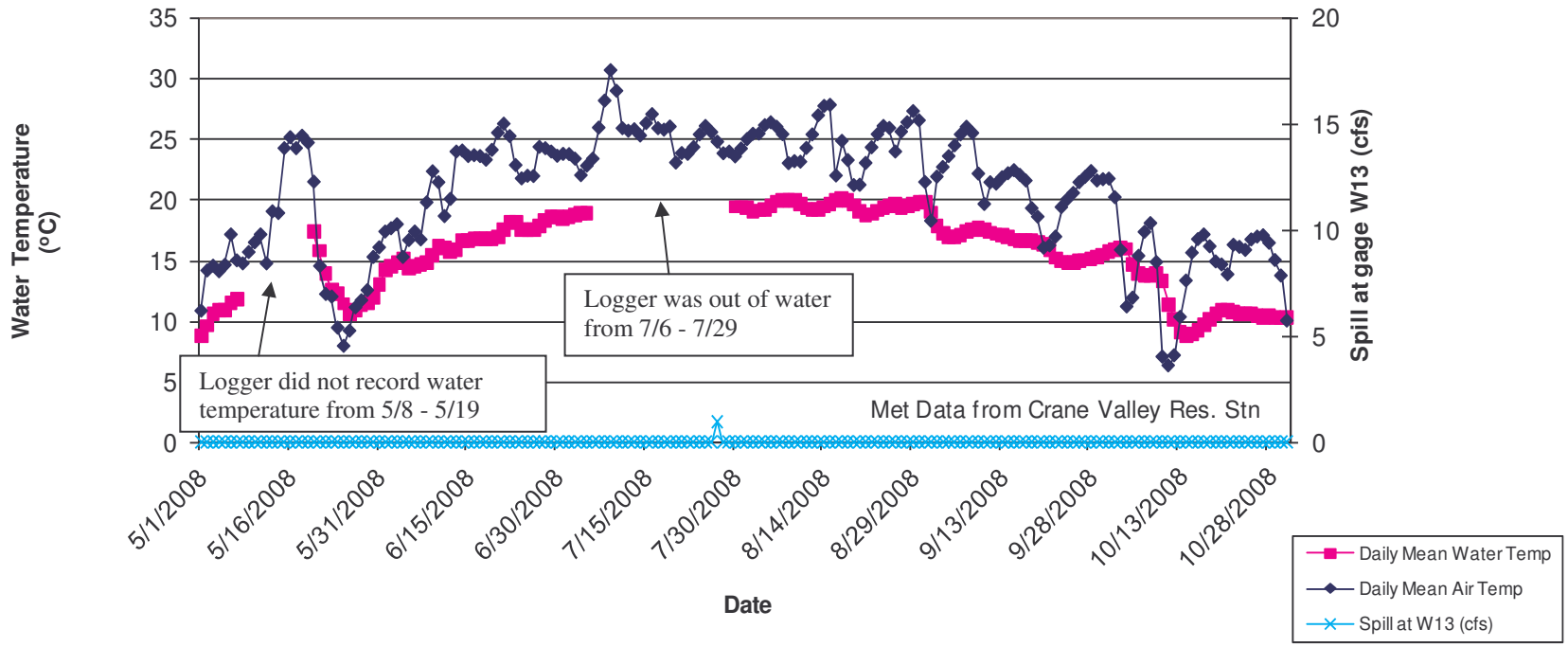


Figure 3.1-23
Station T9, SFWC River Mile 0.1, upstream of the SFWC Diversion Dam
Daily Mean Water Temperatures (ºC), Daily Mean Air Temperatures (ºC), and spill at gage W13 (cfs)



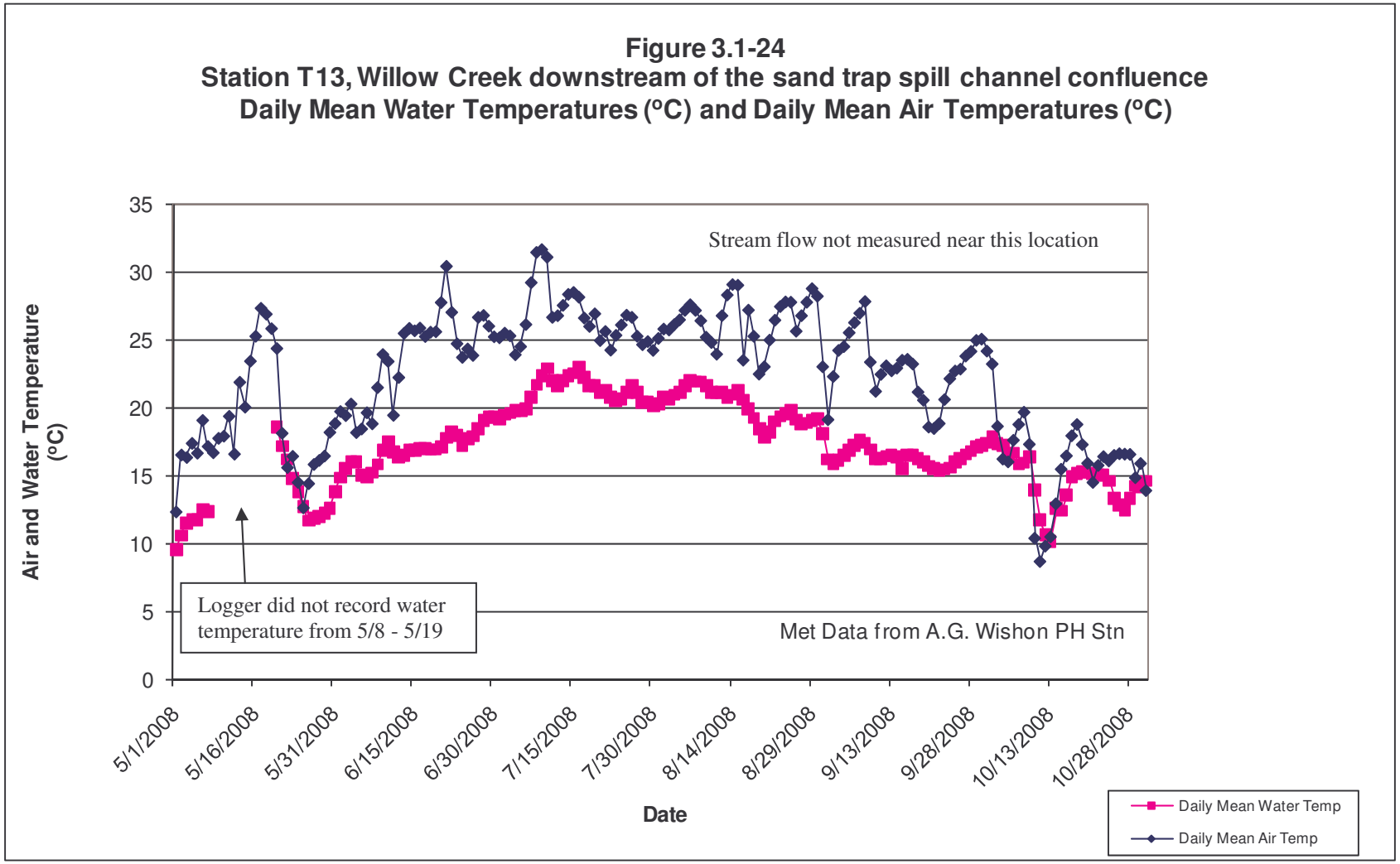
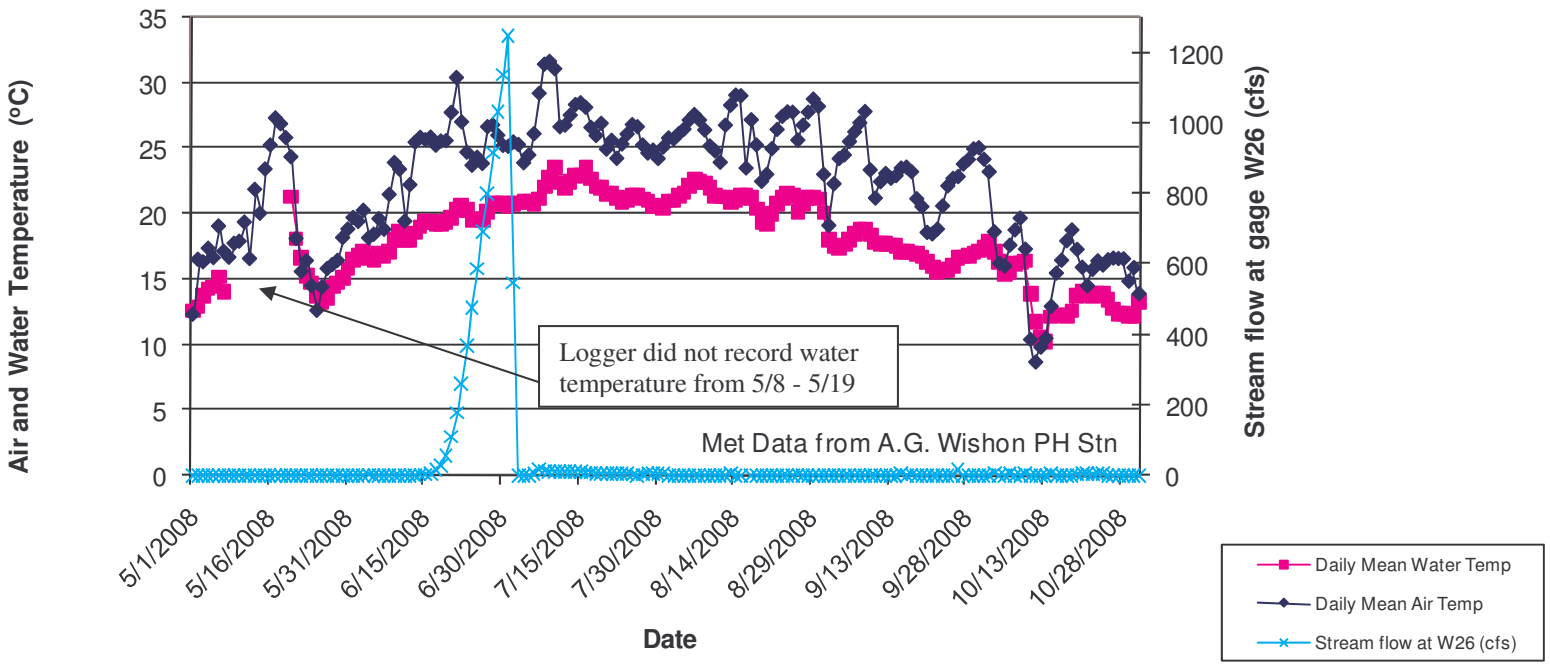


Figure 3.1-24
Station T13, Willow Creek downstream of the sand trap spill channel confluence
Daily Mean Water Temperatures (ºC) and Daily Mean Air Temperatures (ºC)
Stream flow not measured near this location
Logger did not record water temperature from 5/8 - 5/19
Met Data from A.G. Wishon PH Stn
Air and Water Temperature (ºC)
35
30
25
20
15
10
5
0
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008
Date
Daily Mean Water Temp
Daily Mean Air Temp

Figure 3.1-25
Station T10, Williow 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)



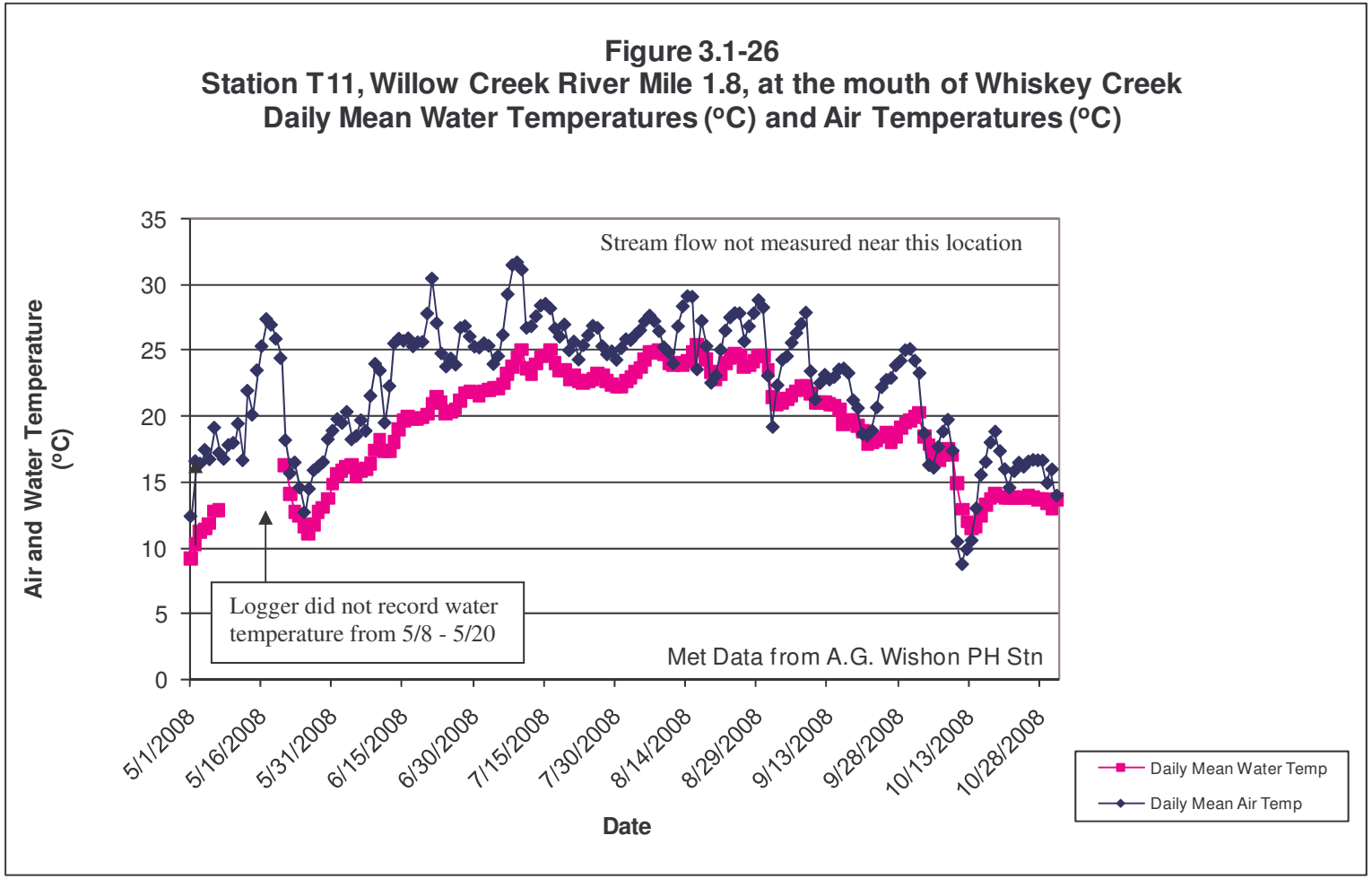


Figure 3.1-26
Station T11, Willow Creek River Mile 1.8, at the mouth of Whiskey Creek
Daily Mean Water Temperatures (°C) and Air Temperatures (°C)
Stream flow not measured near this location
Logger did not record water temperature from 5/8 - 5/20
Met Data from A.G. Wishon PH Stn
Air and Water Temperature (°C)
35
30
25
20
15
10
5
0
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008
Date
Daily Mean Water Temp
Daily Mean Air Temp

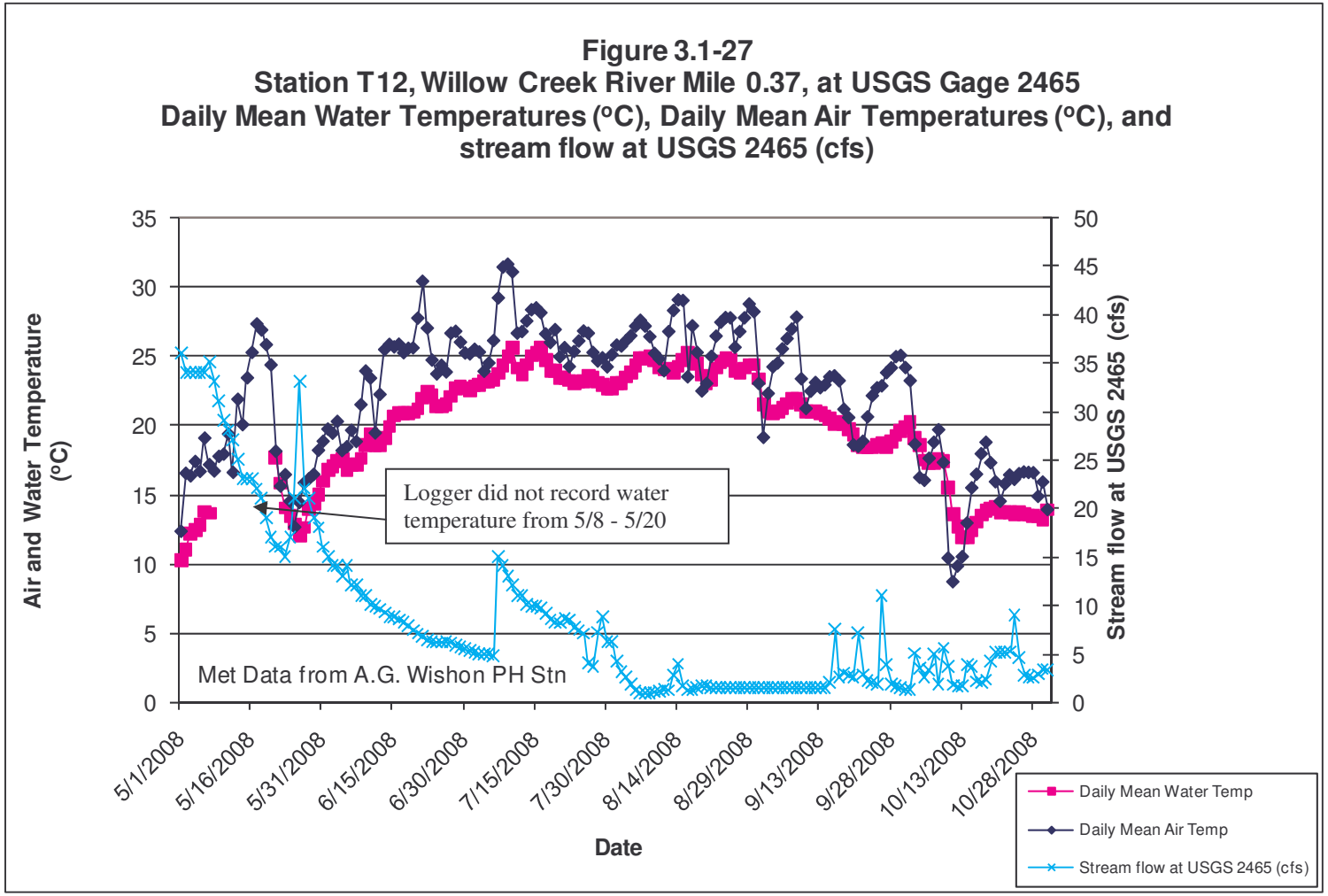


Figure 3.1-27
Station T12, Willow Creek River Mile 0.37, at USGS Gage 2465
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at USGS 2465 (cfs)
Air and Water Temperature (°C)
Stream flow at USGS 2465 (cfs)
Date
Logger did not record water temperature from 5/8 - 5/20
Met Data from A.G. Wishon PH Stn
Daily Mean Water Temp
Daily Mean Air Temp
Stream flow at USGS 2465 (cfs)
5/1/2008
5/16/2008
5/31/2008
6/15/2008
6/30/2008
7/15/2008
7/30/2008
8/14/2008
8/29/2008
9/13/2008
9/28/2008
10/13/2008
10/28/2008