Crane Valley Hydroelectric Project, FERC No. 1354

Crane Valley Water Temperature Monitoring Results – 2006

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

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1. INTRODUCTION

1.1 Objective

The Crane Valley Water Temperature Monitoring Program was initiated in 2005 to determine the water temperature conditions in the Crane Valley Project Area under operating conditions and ambient hydrological and meteorological conditions. Data collected during 2006 represents the second year of water temperature monitoring for the Crane Valley Project.

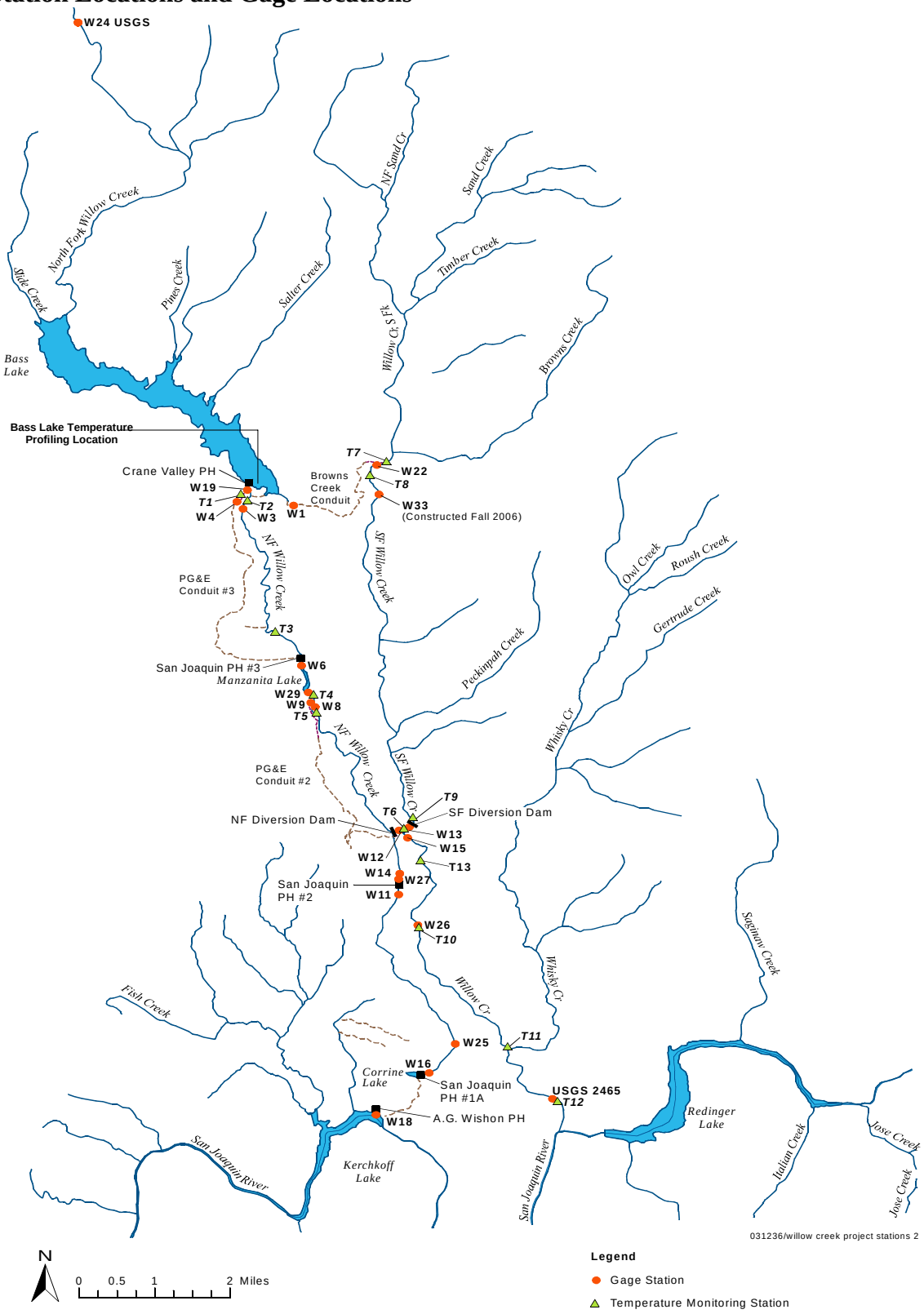
1.2 FERC License Article 405 and U.S. Forest Service 4(e) Condition No. 5

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 Resource 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 in Madera County, includes the North Fork Willow Creek (NFWC), the 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). 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 ft at Wishon Powerhouse on the San Joaquin River to 7,497 ft at Chilkoot Lake.

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



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 3,377ft. Bass Lake is formed by the Crane Valley Dam and is approximately 4 miles long. Bass Lake receives inflow from the NFWC, the 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 Chilkoot Lake 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 the NFWC and then into Bass Lake.

Operational Flows including Releases to Tunnels, Canals and Bypass Flows

Water from Bass Lake enters a tunnel beneath the lake and passes through the dam to 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 the 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 the 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 Kerkoff 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 to be a minimum of 2 cfs (all water year [WY] types, year round). Water is diverted into Manzanita Lake from the San Joaquin Powerhouse. Water is released from Manzanita Lake into the NFWC. The License requires PG&E to release a minimum of 2 cfs (all WY types, year round) from Manzanita Lake (as measured at steam gage W29). Below Mananita Lake water from NFWC flows into the North Fork Diversion Dam and is released to ins confluence with SFWC. With respect to the SFWC, Flows are released into the SFWC via Browns Creek Diversion Dam with a 4.5 cfs to 10 cfs minimum flow requirement, which is dependent upon the month (June through January 4.5 cfs, February and May 8.0 cfs, and March and April 10 cfs). The required flows will be measured at the newly installed stream gage W33. Below the confluence of the NFWC and SFWC (Willow Creek) no water is diverted from the system. However, flows within Willow

Creek (as measured at stream gage W26) are to be no less than 0.5 cfs (all WY types, year round).

2.0 METHODS

2.1 Sample Locations

Water temperature was measured at 13 stream locations from May 3 to November 1, 2006 (photos of each station are included in Appendix E). These water temperature monitoring stations are listed below.

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 the 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 the South Fork Diversion Dam at river mile 0.1

T10 Willow Creek at Gage W-26, river mile 4.3

T11 Willow Creek at Whisky 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

Table 2.1-1 (Page 16) presents a list of the sampling locations and the rationale for their selection. The locations of the sampling sites are presented in Figure 1.1-1.

In addition to the thirteen stream water temperature monitoring stations, water temperature profiles were collected on a monthly basis (May 3 – November 7, 2006) from Bass Lake from one location 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 3 through October 31, 2006 with VEMCO MiniLog 12 TR digital thermographs at the 13 water temperature monitoring stations to determine daily

maximum, minimum, average and hourly water temperatures. Redundant water temperature recorders were installed at all stations to reduce the risk of loss of water temperature data due to recorder malfunction, periods of low flow when recorders can be out of water, or vandalism. 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°C between 5 and 40°C. Data were downloaded monthly to a laboratory computer and stored to disk. Monthly downloads from the water temperature recorders to a laboratory computer occurred on June 7, July 6, August 8, September 6, October 9, and November 7, 2006. Water temperature monitoring equipment quality assurance/quality control (QA/QC) calibration documentation is included in Appendix D.

Both the primary and redundant water temperature recorders were deployed at each station in protective metal housings and affixed to the stream bank using a metal chain to minimize the potential for theft and vandalism. Each water temperature recorder was deployed in an accessible portion of the stream that is thermally homogenous and representative.

In addition to the 13 stream water temperature stations, water temperature profiles were collected on a monthly basis using an Idronaut Ocean Seven 304 and YSI 600XL multiparameter water quality measurement system coupled with a YSI 610 DM Display/Logger. The Idronaut and YSI 600XL instruments have an accuracy of approximately ±0.1°C between -2 and 38°C and -5 and 45°C respectively. Water temperature was recorded in 0.1 meter intervals for the profiling of Bass Lake.

2.3 Stream Flow (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]). Reservoir elevations 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 are below. Locations of the stream flow monitoring stations are presented in Figure 1.1-1.

<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

W22 Browns Creek Diversion Dam Spill in SFWC

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)

Operational Flow Monitoring Stations

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 average flow data in cubic feet per second (cfs) and storage data are presented in thousand acre feet (TAF). 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 meteorological stations were monitored within the Project area. The meteorological stations were located near the Crane Valley Powerhouse (at an elevation of 3,400 ft) and at the A.G. Wishon Powerhouse (at an Elevation of 990 ft). Date, time, and hourly average 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, and will be useful if a modeling effort is conducted in the future. Daily average and daily maximum air temperatures are presented in Appendix C for both meteorological stations during the 2006 monitoring program period (May – October). Also, the daily average air temperatures are presented along with the daily average water temperatures and stream flow (if available) in Figures 3.1-15 through 3.1-27.

3.0 RESULTS

3.1 Water Temperature

The raw data for the Bass Lake profile and each water temperature monitoring station is included in Appendix A (on CD) along with the hourly average water temperature, daily maximum, mean and minimum water temperatures. The hourly average water temperatures, daily maximum, mean and minimum water temperatures are presented in tabular format for each station and are separated by month. 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 3.1-13. 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, W3, W8, W22, 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. All data associated with preliminary and provisional stream flow and reservoir storage within the Project are located in Appendix B (on CD) along with plots of daily average flows.

Figures 3.1-15 through 3.1-29 provide a comparison between daily average water temperature, daily average air temperature and daily flow (if available) at each water temperature monitoring site.

In addition to the raw data and tabulated data included in Appendix A, a monthly summary of all water temperature is included in Table 3.1-1 (Page 15). The data in Table 3.1-1 provides the monthly minimum, maximum and average water temperatures and are derived from the daily average data, which were calculated from the hourly average water temperatures recorded during each day.

Water temperature recorders were deployed at 12 (T1 through T12) of the 13 sites on May 3, 2006. Recorders were placed at T13 on June 7, 2006. Because of the high flows observed on May 3 (from 214 cfs below Bass Lake and 389 cfs on SFWC below Browns Creek Diversion Dam to 614 cfs below the confluence of NFWC and SFWC and 477 cfs at station T12, Appendix B), many of the water temperature recorders were initially placed along the edge of the stream channel, as access to deeper portions of the stream channel was not possible or safe. On subsequent visits to each site, flows were receding, which required relocation of many of the recorders from their original location to a deeper channel within the stream.

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 temperature within the system increased with the onset of summer and peaked near the end of July/early August (during scheduled maintenance outage), and decreased throughout the remainder of the study period.

Results for the 2006 Crane Valley Water Temperature Monitoring Project are discussed below. Instances where flow and air temperature significantly impacted the water temperature are noted below. A summary of flow data throughout the project area is included in Section 3.2. It must be noted that decreasing flows recorded at instream flow monitoring stations in mid to late June correspond to the end of the spring runoff (descending limb of the hydrograph). Also, water temperature data are presented in order from upper elevation stations to lower elevation downstream stations.

An outage for annual maintenance for the Project occurred from July 10 through August 17, which resulted in zero flow through the Project's canal system.

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 average daily water temperatures recorded at both sites are nearly identical (Figures 3.1-1 and 3.1-2). The average daily water temperature did not exceed 20°C at either location during the monitoring program. However, on June 7, both water temperature recorders at T8 were found out of the water and were moved downstream approximately 150 feet and placed in the main stream channel. A review of the water temperature data recorded prior to June 7 indicates that both of the water temperature loggers were out of the water from June 6 and part of June 7, thus resulting in the recording of ambient air temperature. The compromised data (both loggers) was removed from the data set for T8 and represents a gap in the dataset.

Bass Lake Temperature Profile

Seven water temperature profiles of Bass Lake were collected between May 1 and November 7. All seven profiles are graphically shown in Figure 3.1-3. Water temperature profiles taken in early May and early June show a warming trend in Bass Lake with a slight thermocline forming within the first three meters of depth. Bass Lake became more stratified after the June profile and shows a thermocline at about five meters on July 6, 2006. The thermocline remains through September but drops to a depth of approximately nine meters. The October water temperature profile shows the reservoir water temperature as orthograde indicating that fall turnover had recently occurred.

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

The water temperature recorders at T1 recorded the outflow from Bass Lake via the spill channel from the No. 3 Conduit below the Crane Valley Powerhouse. The average daily water temperature at T1 remained below 12°C from May 3rd through June 25th (Figure 3.1-4). Water temperature began to rise on June 26th indicating that no water was being diverted through the No. 3 Conduit spill channel, and in fact during the July 6 visit to T1, it was noted that the spill channel was dry and all water was being diverted through the No. 3 Conduit. The lack of flow through the No. 3 Conduit spill channel is likely due to preparation for the annual maintenance outage, which occurred from July 10 through August 17 and stream flow measurements at stream gage W3 indicated that minimum stream flow requirements below Bass lake were being met without additional releases through the No. 3 Conduit spill channel. The water temperature recorders were removed from the spill channel and placed into the No. 3 Conduit. During the August 8 visit, the water temperature recorders were found to be out of water and subsequently moved back to the No. 3 Conduit spill channel. The No. 3 Conduit spill channel was now being fed by a 6-inch diameter pipe from the powerhouse, which was estimated by field staff to be releasing 2 cfs to 3 cfs of water. Data from the W19 stream gage, below the Crane Valley Powerhouse (measuring flow in the No. 3 Conduit) indicate that flow through the Conduit had been stopped on July 9, the day prior to the scheduled maintenance outage. The lack of water in the spill channel and No. 3 Conduit from June 25 through August 8 resulted in the recording of ambient air temperatures and the water temperature data was discarded.

Between August 8 and 15, the average daily water temperature in the spill channel remained constant at 7.7°C. From August 16 through October 3, water temperatures increased to a high of 18°C and subsequently decreased until the recorders were removed. Because T1 is located directly below Bass Lake, water temperature at this station is directly influenced by water released from Bass Lake. The increase in water temperatures observed at T1 from August 16 through October 3 corresponds to the warming of Bass Lake and subsequent onset of the fall turnover of Bass Lake.

From May 3 to June 25, and August 8 to October 31, water temperatures at T1 did not exceed 20°C.

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 the NFWC near gage W3. From May through July, water temperatures increased from an average daily water temperature of 15.9°C for the month of May to a high 22.4°C for July (Figure 3.1-5). During the May to July time frame, two large jumps in average daily water temperature were recorded. The first occurred during May (May 3 through May 18) with an increase of 5°C, which corresponds to an increase in air temperature from

10.5°C to 23.8°C with no significant decrease in flow as measured at gage W3. Water temperature subsequently fell to approximately 15°C with the onset of cooler weather. The second water temperature increase occurred from June 18 through 27 with an increase of 11.8°C. The increase in water temperature in late June corresponds to a reduction in flow from 94.2 cfs to 7.6 cfs (descending limb of the hydrograph) and an increase in the average daily air temperature from 13.8°C to 26.3°C. At the start of the outage, flows through station T2 were increased from 5.7 to 18.7 (July 11 through July 15), which correspond to a downward spike in average daily water temperature followed by an increase in water temperature with the onset of warmer average daily air temperatures. Water temperature, air temperature and flow at T2 fell until the water temperature recorders were removed in October. Average daily water temperatures exceeded 20°C on 77 days from late June through mid-September.

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

Like T2, T3 shows two noticeable increases in average daily water temperature (Figure 3.1-6. The first corresponds to the increase in average daily air temperature in mid May, while the second corresponds to the decrease in flow as measured at gage W3 (descending limb of the hydrograph) and increase in air temperature in late June. It appears that the scheduled outage impacted the average daily water temperature in the same manner it did at T2, with an initial downward water temperature spike followed by a slight increase in water temperature. While the average daily water temperature at T3 did exceed 20°C, it did so for a shorter period of time than at T2 (57 days at T3 vs. 77 days at T2).

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 site T5 is located downstream of the dam just below a weir and gage. During the months of July and August, a stilling well was installed at the face of Manzanita Dam. As part of the construction, Manzanita Lake was drawn down to a surface elevation of 2,810 feet (full is 2,817 feet) and the stream channel between the downstream face of Manzanita Dam and the weir was drained under proper notification of the representative agency personnel (approximately 130 feet of the stream channel was dewatered). During construction of the stilling well and drawdown of Manzanita Lake, additional lengths of chain were added to the T4 water temperature loggers so they would be sitting in deeper water.

Water was diverted around the dewatered area via a pipe into NFWC and water temperature was monitored daily by the construction crew. Also, the water temperature recorders at T5 were relocated downstream of the diversion pipe by the construction crew and were later relocated to their original position in the river after construction at the dam was completed. On July 11, the water temperature (as recorded by the construction crew)

exceeded 22°C. On July 12, an additional 5 cfs of water was released from Manzanita Lake. On July 14, water temperature in NFWC again exceeded 22°C, resulting in an additional 10 cfs released from the spill gate. However, the water released through the spill gate did not originate from the cooler water near the bottom of Manzanita Lake (it could not be accessed during the outage), but rather warmer surface water from the spill gate (Pers. Comm., Elizabeth Frantz, Pacific Gas and Electric Company, November 13, 2006).

During the June 7 visit it was discovered that both the primary and redundant water temperature recorders had failed at T4 (Figure 3.1-7). Both recorders were removed from service and replaced on June 12. The drawdown on July 10 of Manzanita Lake resulted in an average daily water temperature spike from 14.1°C to 26°C. While the water temperature loggers were placed in deeper water during the drawdown of Manzanita Lake the high average daily air temperatures (above 25°C) had an impact on water temperatures in the lake. From July 11 through the end of the outage on August 16, the water temperatures gradually fell to 19.4°C, and by August 18 the average daily water temperature was 13.5°C. From May 3 through October 31, the average daily water temperatures at Manzanita Lake exceeded 20°C for 31 days (July and early August).

With respect to station T5, the average daily water temperature increased prior to the start of construction on Manzanita Dam (12.4°C on June 19 to 18.9°C on June 25). Between June 25 and July 7, the average daily water temperature fell to 14.2°C (Figure 3.1-8). From July 8 through July 10, the average daily temperature increased to 22.7°C. As mentioned above, additional flows released from Manzanita Lake were through the spill gate (surface water) resulting in increased average daily water temperatures at T5. During the construction, the average daily water temperature exceeded 20°C for 33 consecutive days (July 9 through August 11).

<u>Water Temperature Monitoring Site T6: NFWC upstream of the North Fork Diversion Dam at river mile 0.25</u>

T6 is located at the upstream face of the North Fork Diversion Dam. Between May 3 and June 15, the average daily water temperature remained at or below 15°C (Figure 3.1-9). From June 16 to June 25, the average daily water temperature increased to 21.2°C. This increase in water temperature corresponds to a reduction in flow (descending limb of the hydrograph) at the T6 water temperature station (as recorded at gage W15) and a 13.2°C increase in average daily air temperature for the same period. Shortly after June 25, the water temperature at T6 fell to less than 20°C, but again spiked above 20°C where it remained until August 18. From August 18 through the end of the monitoring period, the average daily water temperature decreased to 9.0°C on October 31.

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

Water temperature monitoring site T9 is located upstream of the South Fork Diversion Dam. Water temperature recorders were initially placed along the north bank of the impoundment approximately 100 feet from the dam. During the June 7 site visit, the water temperature recorders were moved because the water surface elevation had dropped. On August 8, the recorders were again relocated because they were found to be out of the water. As a result of both recorders being out of the water, data from the 5th at 10:00 am through the 8th at 11:00 am were discarded (Figure 3.1-10). The average daily water temperature exceeded 20°C on 24 days between June 24 and July 31.

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 the NFWC and SFWC. Because of safety concerns due to a lack of access and high flows on May 3, water temperature recorders were deployed at T13 on June 7, 2006. The average daily water temperature at T13 exceeded 20°C on 40 days, of which, 23 occurred in July (Figure 3.1-11).

On September 6, both loggers at T13 were found buried in sand. On August 8, it was noted that PG&E was using an excavator and small bulldozer to remove sand from the sand trap. It appears that during removal of the sand from the trap, some sand made its way into the spill channel and was deposited in Willow Creek at T13. While no data was lost as a result of the sand deposition at T13 it is difficult to determine the effect on stream water temperatures recorded at T13 because of the deposited sand. When compared to water temperature data collected at sites immediately above and below T13, the graphs all demonstrate a normal water temperature regime with differences between daytime and nighttime water temperatures. The graph also shows a stabilization of water temperature during the month of August (i.e., a more linear average daily water temperature), which may be due to the sand dampening the effect of ambient air temperature and solar heating on the recorders.

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 average daily water temperature at T10 exceeded 20°C on nine days in June with a daily average high of 23.9°C, 31 days in July with a daily average high of 27.4°C, 19 days in August with a daily average high of 23.6, and six days in September with a daily average high of 20.7°C (Figure 3.1-12). All of the elevated water temperatures noted at T10 correspond to elevated air temperatures (Figure 3.1-25), and the fact that the water temperature loggers are situated immediately below a weir. The weir causes the water to form a pool upstream of the water temperature loggers that is approximately 50 feet wide by 100 feet long, with a depth no greater than 1.5 feet (likely averaging six inches to one

foot deep). The pooled water allows the warm summer air and solar radiation to heat the water to a greater degree than in other portions of the Project. The heated water then flows over the weir and into the stream channel where the water temperature loggers are located only a 1 or 2 feet downstream of the weir at a depth of approximately 2.5 feet. Decreased flow at T10 (632.7 cfs on May 3 to 0.2 cfs on July 15) further increases the thermal heating of the pooled water. The placement of the water temperature loggers during the 2006 water temperature monitoring period immediately below the weir may not have been the most representative location for water temperatures in the stream reach. Future placement of the water temperature recorders will be investigated to determine where the recorders should be placed (where the water is fully mixed in the deepest part of the stream channel) so that future water temperature data will better represent the reach rather than one specific location.

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

Site T11 is located on the main stem of Willow Creek just below its confluence with Whisky Creek. The water temperature at T11 is influenced by the inflow from Whisky Creek and is lower (maximum, minimum and mean daily water temperature) than the water temperature recorded upstream at T10. The average daily water temperature at T11 exceeded 20°C on six days in June with a daily average high of 21.5°C, 18 days in July with a daily average high of 23.5°C, 26 days in August with a daily average high of 21.7°C, and eight days in September with a daily average high of 20.9°C. Also, the increases and decreases in average daily water temperature at T11 follows the increases and decreases in average daily air temperature (Figure 3.1-13).

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 average daily water temperature at site T12 exceeded 20°C more often than any of the other 12 sampling sites (85 consecutive days between June 22 and September 14, 2006). However, the highest average daily water temperature was not recorded at T12 (25.3°C), but rather at T10 (27.4°C). The increases and decreases in average daily water temperature at T12 follows the increases and decreases in average daily air temperature. Figure 3.1-14 depicts the reduction in flow from a high of 477 cfs (May 3) to a low of 8.8 cfs (July 24) corresponds to the overall increase in average daily water temperature of 10.6 (May 4) to 25.3°C (July 24). Water flowing through T12 spent a greater amount of time being heated prior to it flowing through the station when compared to the other stations within the Project Again, water temperature monitoring station T12 is the lowest in elevation and is therefore is the most likely to experience the highest ambient air temperatures thus resulting in higher average 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 average flows in Table 3.2-1 (Page 17). These data encompass May 1 through October 31, 2006.

Stream Flow (Preliminary and Provisional)

The highest average, maximum and minimum stream flow recorded at each gaging station was during the month of May. The high flows were associated with the spring snowmelt and resulting runoff. The highest flows within the NFWC, SFWC or Willow Creek were recorded at gage W26 (located at T10 water temperature monitoring station) with a maximum flow of 643.1 cfs on May 1. It is unknown as to why flows recorded at W26 were higher than those reported at USGS/SCE gage 2465 since the USGS/SCE gage is located downstream of W26, and it captures accretion from Whiskey Creek, whereas W26 does not. W26 also recorded the highest monthly average flow for the month of May at 489 cfs. Of the 8 gages located within NFWC, SFWC and Willow Creek (this does not include flows through Project canals), three recorded the spill over Project diversion dams and not actual stream flow. The three gages are W22, W15 and W13. Gage W22 recorded zero spill from June 7 through August 21 and again from October 9 through October 31; gage W15 recorded zero spill from June 16 through October 31; gage W13 recorded zero spill from May 28 through October 31. It must be noted that while the three spill gages recorded zero spill the actual flow within the 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 the NFWC, SFWC and Willow Creek. Within NFWC a minimum flow of 2 cfs are to be measured at gages W3 and W29 year round. According to the preliminary and provisional stream flow data for the NFWC during the 2006 Crane Valley Water Temperature Monitoring Project (as measured at W3 and W29), the minimum flow requirements were generally met. However on June 21 and June 22 and from June 27 through July 8 flows measured at W29 fell below the minimum stream flow requirement (preliminary data). At stream gage W3 the minimum stream flow requirements (2.0 cfs) were met for the duration of the 2006 Crane Valley Water Temperature Monitoring Project.

Within the SFWC the minimum stream flow requirements during the course of the Crane Valley Water Temperature Monitoring Project are set at 8 cfs for May and 4.5 cfs through October. The required flows will be measured at the newly installed stream gage W33, downstream of the Browns Creek Diversion Dam and water temperature monitoring sites T7 and T8. For the purpose of this report, the spill data recorded at gage W22 has been graphed along with water temperature data collected at T7 and T8. This spill data does not reflect the actual flow within the SFWC, but it does provide information as to the timing of spring runoff at this location.

For the mainstem of Willow Creek flows (as reported at W26) met or exceed the 0.5 cfs minimum requirement from May 1 through July 12, July 20 through July 25, and July 31 through August 20. From August 20 through October 31 data is not yet available. Between July 13 and July 19 and from July 26 through July 30 minimum stream flow requirements were not met. These periods occur during the scheduled outage for maintenance on the Project.

With respect to the conduits, the greatest flows were also recorded during the month of May, but in many cases these high flows continued into June. According to the gage data, minimum flows recorded at 12 gaging stations within the Project related conduits was 0 cfs during limited periods of time. Of those 12 stations, five recorded zero flow from July 9, 2006 through the end of the outage on August 17.

While it is understood that these data are preliminary and yet to be finalized, it should be noted that some data from four of the gaging stations are not yet available and will likely not be available until early in 2007 after review of the field data has been completed (W26, and USGS 2465).

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 August 18, storage fluctuated in Bass Lake between 42,000 and 45,000 af of water. After August 18, PG&E began to drawdown Bass Lake, and by October 31, storage had fallen to 26,940 af.

Water storage in Corrine Lake remained at about 47.7 af from May 1 through July 8. However, during the scheduled outage, storage in Corrine Lake fluctuated and ultimately reached a low of 23.1 af on August 17. By August 18, the volume of water in Corrine Lake had been brought back up to slightly above 50 af, where it was maintained until October 31.

3.3 Discussion of Results

During the 2006 Crane Valley water temperature monitoring study, some data were lost at T1, T4, T5, T8, and T9 due to reduced or no flows or recorder malfunction. Data loss was limited to a couple of days at T4 and T5, and was due to recorder malfunction. The recorder malfunction at T4 was related to field crews not being able to download the water temperature data recorded for the month of May (data download for May occurred on June 7) and subsequently not being able to reinitialize the water temperature logger in the field. Both water temperature loggers were removed from service and taken to the PG&E Technology Center in San Ramon California. PG&E was able to retrieve the

water temperature data recorded in May and returned the water temperature loggers to service at T4 on June 12 at 12:00pm. No data was lost prior to the removal of T4 from service; however a data gap exists from June 7 through June 12. The recorder malfunction at T5 caused a loss of data from July 18 through July 20. The manufacture of the VEMCO loggers was contacted regarding the malfunction; however the cause was never determined. Data loss at T8 and T9 was limited to June 5 through June 7 and August 5 through August 8 respectively. Data loss at T8 and T9 resulted from a reduction in flow at these stations. Data loss at T1 spanned from June 26 through August 8 and was due to zero flow through the spill channel where T1 was located.

The datasets for both the primary and redundant water temperature loggers at each site were compared against each other and the instantaneous water temperature measured during each monthly visit to ensure the loggers were calibrated. At each site the water temperature recorded between the primary and redundant logger never varied by more than 1°C and in most cases was less than 0.5°C. The difference between the two loggers can be attributed to logger placement at each site which was generally no more than 5 meters apart (the spacing between loggers was to minimize data loss due to vandalism). If the loggers were placed in different locations at each site, field staff tried to ensure that placement of both loggers was in similar steam settings (deeper channel, with the most flow available resulting in a representative water temperature of the stream reach).

In all but a few cases data used for this report originated from the primary water temperature logger at each site. Those instances in which data from the redundant water temperature logger were used in place of the primary logger are: 1) T5 May and June data, primary logger data was replaced with data from the redundant logger because primary logger malfunctioned; 2) T6 June data, primary logger was replaced with data from the redundant logger because primary logger was found out of water; 3) T7 June data, primary logger data was replaced with data from the redundant logger because primary logger was found out of the water; 4) T12 July data, primary logger data was replaced with data from the redundant because primary logger was removed from the stream channel by an unknown person; 5) T13 July data, primary logger data was replaced with data from the redundant because primary logger was removed from the stream channel by an unknown person.

According to the ambient air temperature data collected at the A.G. Wishon and Crane Valley Powerhouse weather stations, July was, on average the warmest month with air temperatures ranging from a minimum of 12.8°C to a maximum of 37.2°C at the A.G. Wishon Powerhouse and a minimum of 8.9°C to a maximum of 33.3°C at the Crane Valley Powerhouse. The high air temperatures and extended periods of daylight combined with the low flow conditions (scheduled outage) increased the water temperatures in NFWC, SFWC and Willow Creek.

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 coincided with the fall turnover.

However, it is difficult to know how much of an effect the warm July air temperatures had on the water temperature at T1 because the data was discarded due to the lack of flow at this station.

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.

Pers. Comm., Elizabeth Frantz, Pacific Gas and Electric Company with Justin Tortosa of DTA regarding release from Manzanita Lake during construction, November 13, 2006.

Studley et al., 1995. Response of Fish Populations to Altered Flows Project, volume 1: Predicting Trout Populations from Streamflow and Habitat Variables.

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 the 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 the 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 Whisky 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 average, minimum and maximum water temperatures observed during the monitoring program (May 3 to October 31, 2006) by station.

Station ID	Month during 2006	Data Days	Water Temperature (°C)		
			Min	Mean	Max
T1	May	29	7.4	8.0	8.6
	June	25	8.8	10.2	13.8
	July	0	0	0	0
	August	23	7.7	10.6	13.5
	September	30	13.6	15.6	17.8
	October	31	14.6	16.4	18.0
T2	May	29	13.0	15.9	18.0
	June	30	11.7	17.3	23.5
	July	31	18.1	22.4	23.8
	August	31	19.6	21.0	22.1
	September	30	16.5	18.7	21.6
	October	31	13.1	15.1	17.0
T3	May	31	13.5	16.0	18.2
	June	30	13.1	17.3	22.2
	July	31	19.9	22.2	23.4
	August	31	19.1	20.1	21.1
	September	30	14.9	17.2	20.2
	October	31	9.6	12.7	15.7
T4	May	31	11.5	13.6	14.9
	June	26	12.2	13.2	14.1
	July	31	13.5	21.9	27.1
	August	31	13.4	17.3	21.4
	September	30	14.5	16.1	18.1
	October	31	14.3	16.3	18.1
T5	May	31	11.5	13.6	15.0
	June	30	12.4	14.7	18.9
	July	30	14.2	21.3	24.9
	August	31	13.4	17.8	23.1
	September	30	14.5	16.2	18.1
	October	31	14.3	16.3	18.1
T6	May	31	11.1	13.4	15.0
	June	30	13.7	16.7	21.2
	July	31	19.1	21.5	23.9
	August	31	16.9	19.7	21.2
	September	30	13.9	16.2	19.1
	October	31	9.1	12.2	16.5
T7	May	31	6.7	9.1	11.2
	June	30	10.4	13.6	16.6
	July	31	14.6	16.3	18.5
	August	31	14.1	14.7	15.8
	September	30	10.7	12.9	15.5
	October	31	6.8	9.5	12.4
T8	May	31	6.6	9.1	11.3
	June	29	10.5	13.8	16.8
	July	31	14.8	16.5	18.7
	August	31	14.2	14.9	16.0
	September	30	10.9	13.1	15.7
	October	31	6.9	9.6	12.5

Table 3.1-1 (*continued*)

Station ID	Month during 2006	Data Days	Water Temperature (°C)		
			Min	Mean	Max
T9	May	31	8.2	11.1	13.4
	June	30	13.2	17.3	21.0
	July	31	18.8	20.7	23.2
	August	29	17.6	18.6	19.9
	September	30	13.6	15.8	18.7
	October	31	8.5	11.6	14.8
T10	May	31	9.8	12.8	14.7
	June	30	14.1	18.2	23.9
	July	31	22.5	25.0	27.7
	August	31	18.9	20.6	23.6
	September	30	15.7	18.1	20.7
	October	31	8.9	12.8	17.3
T11	May	31	10.3	13.5	15.8
	June	30	14.0	17.5	21.5
	July	31	18.7	20.8	23.7
	August	31	19.5	20.6	21.7
	September	30	15.5	17.9	21.5
	October	31	9.8	13.4	17.2
T12	May	31	10.6	13.8	16.3
	June	30	15.2	18.8	22.8
	July	31	20.4	22.6	25.3
	August	31	20.5	21.4	22.5
	September	30	16.7	19.1	21.9
	October	31	10.3	14.0	17.6
T13	May	0	*	*	*
	June	24	14.2	17.6	21.3
	July	31	19.2	21.4	24.1
	August	31	17.9	19.4	20.9
	September	30	12.7	15.8	19.3
	October	31	9.0	12.2	16.2

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

Table 3.2-1 Summary of 2006 stream flow (cfs) monitoring and reservoir storage (AF) at PG&E and USGS-SCE maintained stations. All flow data is preliminary and provisional.

Station ID	Month during 2006	Data Days	Daily Average Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W24	May	29	89.0	139.6	287.0
	June	30	39.0	73.5	113.0
	July	31	11.0	24.5	40.0
	August	31	11.0	17.2	21.0
	September	30	No Data*	No Data*	No Data*
	October	31	No Data*	No Data*	No Data*
W22	May	29	57.0	191.8	389.0
	June	6	0.0	6.2	58.0
	July	0	0.0	0.0	0.0
	August	10	0.0	1.9	13.0
	September	30	11.0	12.1	22.0
	October	8	0.0	3.8	20.0
W1	May	29	49.6	58.8	75.8
	June	6	0.0	11.9	72.6
	July	0	0.0	0.0	0.0
	August	0	0.0	0.0	0.0
	September	0	0.0	0.0	0.0
	October	21	0.0	1.6	4.0
W2 Bass Lake Storage	May	29	42,811	43,563	44,492
	June	30	43,440	43,867	44,230
	July	31	43,091	43,620	43,993
	August	31	40,581	43,157	44,097
	September	30	34,153	37,154	40,364
	October	31	26,940	30,569	33,825
W19	May	29	134.6	146.6	158.7
	June	30	95.3	132.6	174.6
	July	8	0.0	22.6	96.6
	August	15	0.0	56.7	147.4
	September	27	0.0	104.1	128.3
	October	31	98.8	124.9	137.7
W3	May	29	153.2	244.8	326.4
	June	30	5.7	67.2	121.5
	July	31	5.7	11.4	18.7
	August	29	0.0	5.3	7.0
	September	30	2.0	2.7	4.0
	October	31	2.0	2.5	3.0
W4	May	29	105.5	113.3	120.2
	June	30	73.1	101.6	160.0
	July	31	0.3	17.2	72.6
	August	20	0.5	61.9	142.5
	September	*	86.7	99.4	111.5
	October	*	118.5	138.0	150.8
W6	May	29	89.8	103.9	115.3
	June	30	78.6	87.9	98.0
	July	8	0.0	18.8	80.5
	August	16	0.0	48.8	118.5
	September	30	84.2	91.7	103.0
	October	30	0.0	108.6	328.0

Table 3.2-1 (*continued*)

Station ID	Month during 2006	Data Days	Daily Average Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W8	May	29	70.0	186.4	256.0
	June	30	1.0	35.4	107.0
	July	30	0.0	11.0	20.0
	August	30	0.0	4.2	9.0
	September	30	2.0	2.4	3.0
	October	31	2.0	2.3	3.0
W29	May	29	59.0	98.5	132.5
	June	30	1.4	22.7	41.8
	July	31	0.4	9.3	18.1
	August	31	2.4	4.9	8.7
	September	30	2.5	2.7	3.5
	October	31	2.4	3.7	31.0
W9	May	29	150.0	159.6	160.0
	June	30	112.0	143.3	160.0
	July	19	0.0	27.0	140.0
	August	14	0.0	59.2	150.0
	September	30	107.0	122.0	136.0
	October	31	113.0	136.6	147.0
WC3	May	29	259.1	352.9	438.0
	June	30	79.5	169.2	227.8
	July	31	6.6	29.3	78.9
	August	20	7.5	67.9	148.0
	September	*	89.4	102.3	115.4
	October	*	120.9	140.5	153.4
W11	May	29	133.7	141.8	148.6
	June	30	93.7	127.0	150.0
	July	8	0.0	23.0	114.0
	August	15	0.0	55.1	135.6
	September	30	100.0	105.4	115.7
	October	30	0.0	112.9	132.5
W12	May	29	73.0	96.7	104.0
	June	30	10.0	24.1	73.0
	July	25	0.0	6.5	11.0
	August	4	0.0	0.7	6.0
	September	23	0.0	4.8	8.0
	October	31	3.0	5.4	12.0
W15	May	29	67.0	116.1	231.0
	June	15	0.0	13.1	64.0
	July	0	0.0	0.0	0.0
	August	0	0.0	0.0	0.0
	September	0	0.0	0.0	0.0
	October	0	0.0	0.0	0.0
W13	May	27	0.0	114.9	282.0
	June	0	0.0	0.0	0.0
	July	0	0.0	0.0	0.0
	August	0	0.0	0.0	0.0
	September	0	0.0	0.0	0.0
	October	0	0.0	0.0	0.0

Table 3.2-1 (*continued*)

Station ID	Month during 2006	Data Days	Daily Average Flow (cfs) or Storage (AF)		
			Min	Mean	Max
W14	May	31	84.0	92.4	98.0
	June	29	15.0	57.1	93.0
	July	31	8.0	20.0	31.0
	August	18	0.0	2.9	14.0
	September	30	3.0	7.7	10.0
	October	31	6.0	7.7	14.0
W27	May	29	84.0	92.4	98.0
	June	30	15.0	57.1	93.0
	July	31	8.0	20.0	31.0
	August	7	0.0	1.6	14.0
	September	0	0.0	0.0	0.0
	October	0	0.0	0.0	0.0
W26	May	29	238.1	489.0	643.1
	June	30	1.6	39.8	146.1
	July	31	0.1	0.7	1.5
	August	20	0.5	8.3	23.7
	September	*	0.3	1.9	6.4
	October	*	1.1	1.1	1.1
USGS Gage 2465	May	29	60.0	240.1	477
	June	30	20.0	28.6	51.0
	July	31	6.9	12.3	20.0
	August	20	6.7	13.2	26.0
	September	14	1.8	6.2	11.0
	October	*	No Data*	No Data*	No Data*
W25	May	29	196.3	201.5	202.0
	June	30	116.8	173.7	202.4
	July	31	10.9	46.9	121.1
	August	22	0.0	63.6	152.0
	September	30	113.0	121.1	134.0
	October	31	116.0	134.2	144.0
W16	May	0	0.0	0.0	0.0
	June	0	0.0	0.0	0.0
	July	0	0.0	0.0	0.0
	August	0	0.0	0.0	0.0
	September	2	0.0	5.4	140.0
	October	31	72.8	138.9	150.8
W17 Corrine Lake Storage	May	29	41.0	47.8	49.0
	June	30	40.9	47.6	48.9
	July	31	33.0	44.6	52.0
	August	31	23.1	40.2	52.0
	September	30	47.9	51.0	52.1
	October	31	50.7	51.7	55.7
W18	May	29	192.0	200.8	206.5
	June	30	117.3	174.2	204.5
	July	31	5.0	46.1	121.8
	August	20	0.0	64.6	145.9
	September	30	115.0	123.9	149.6
	October	31	96.1	134.1	148.7

* No flow values are available at this time. They will be incorporated into the report if they become available.

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)

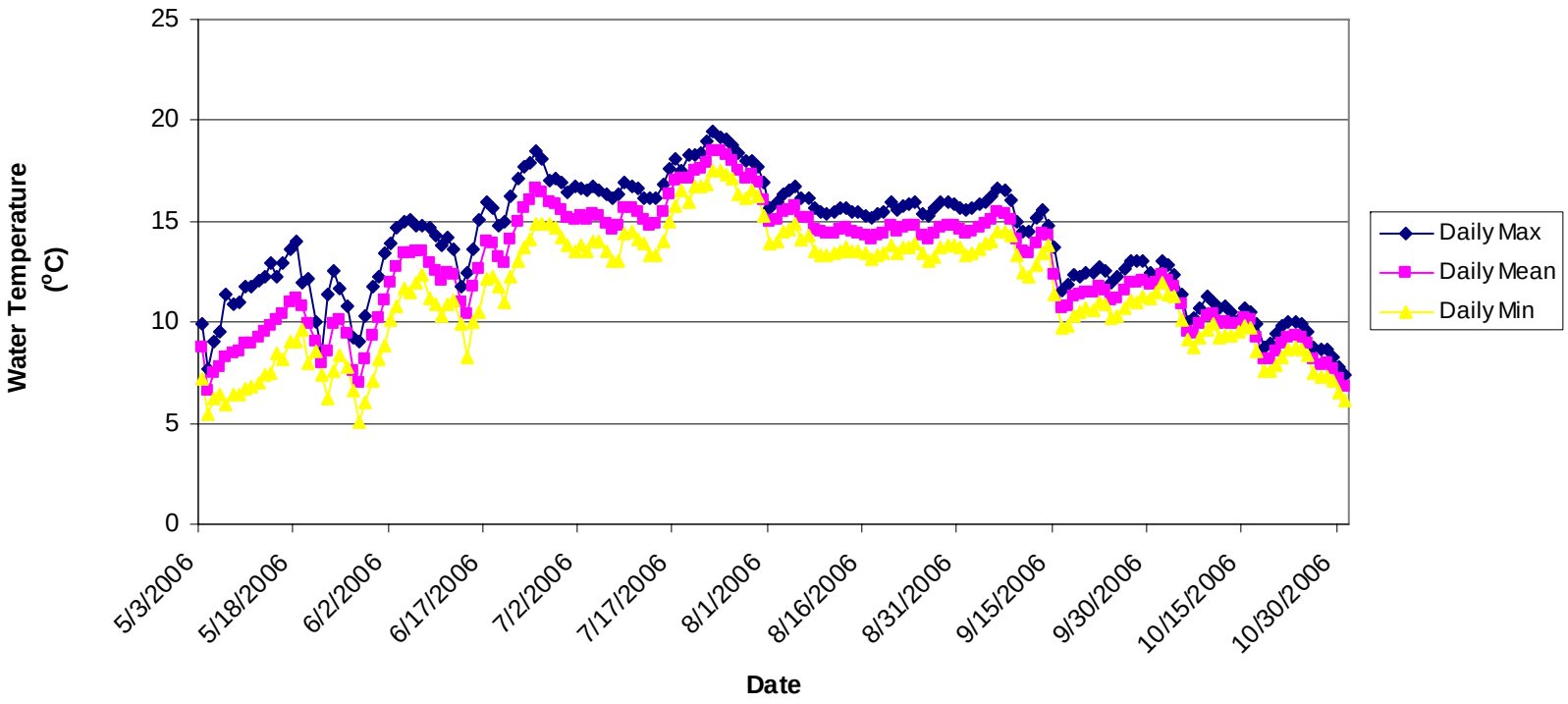


Figure 3.1-2
Station T8, SFWC River Mile 6.5, downstream of the Browns Creek Diversion Dam
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and spill at gage W22 (cfs)

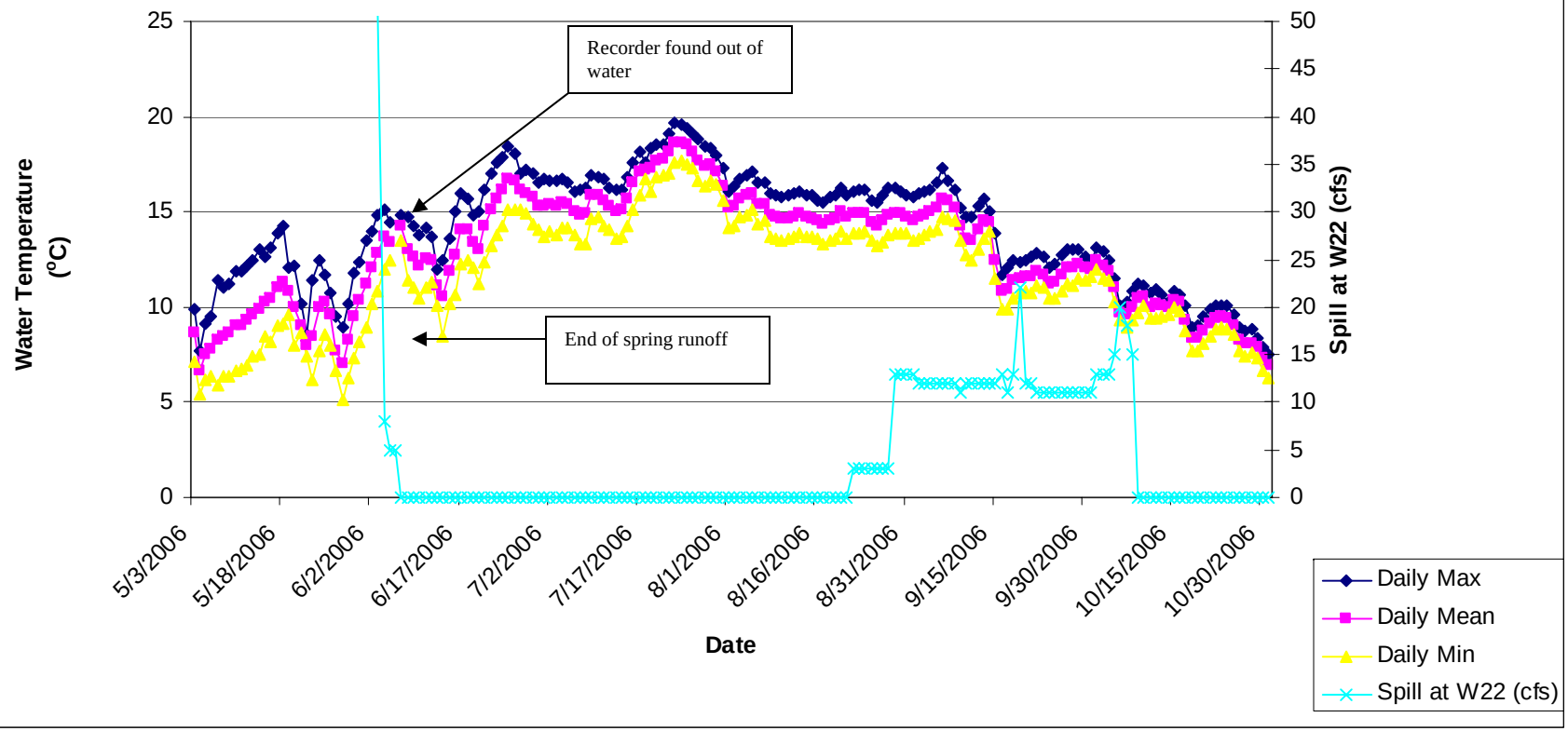


Figure 3.1-3
Bass Lake Water Temperature Profiles, May 3 through November 7, 2006

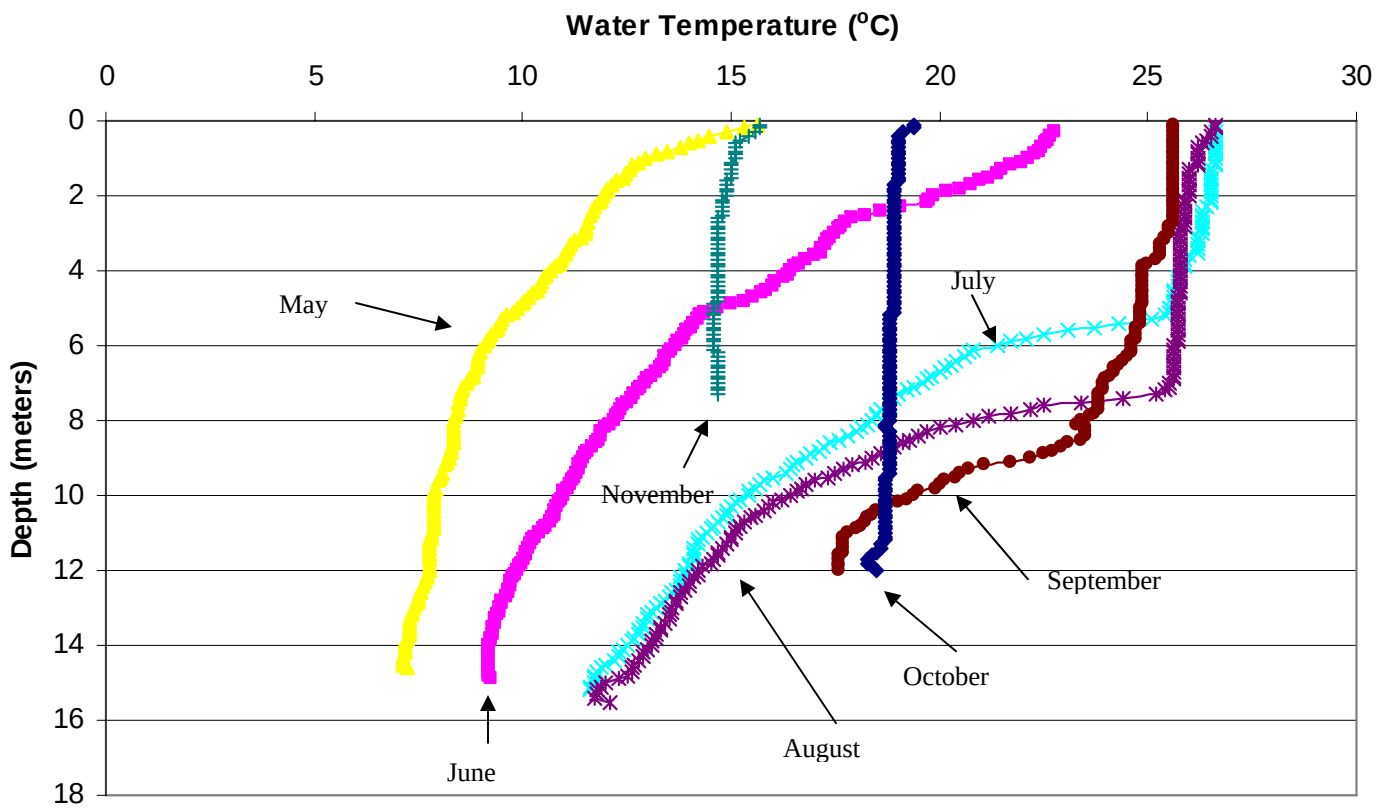
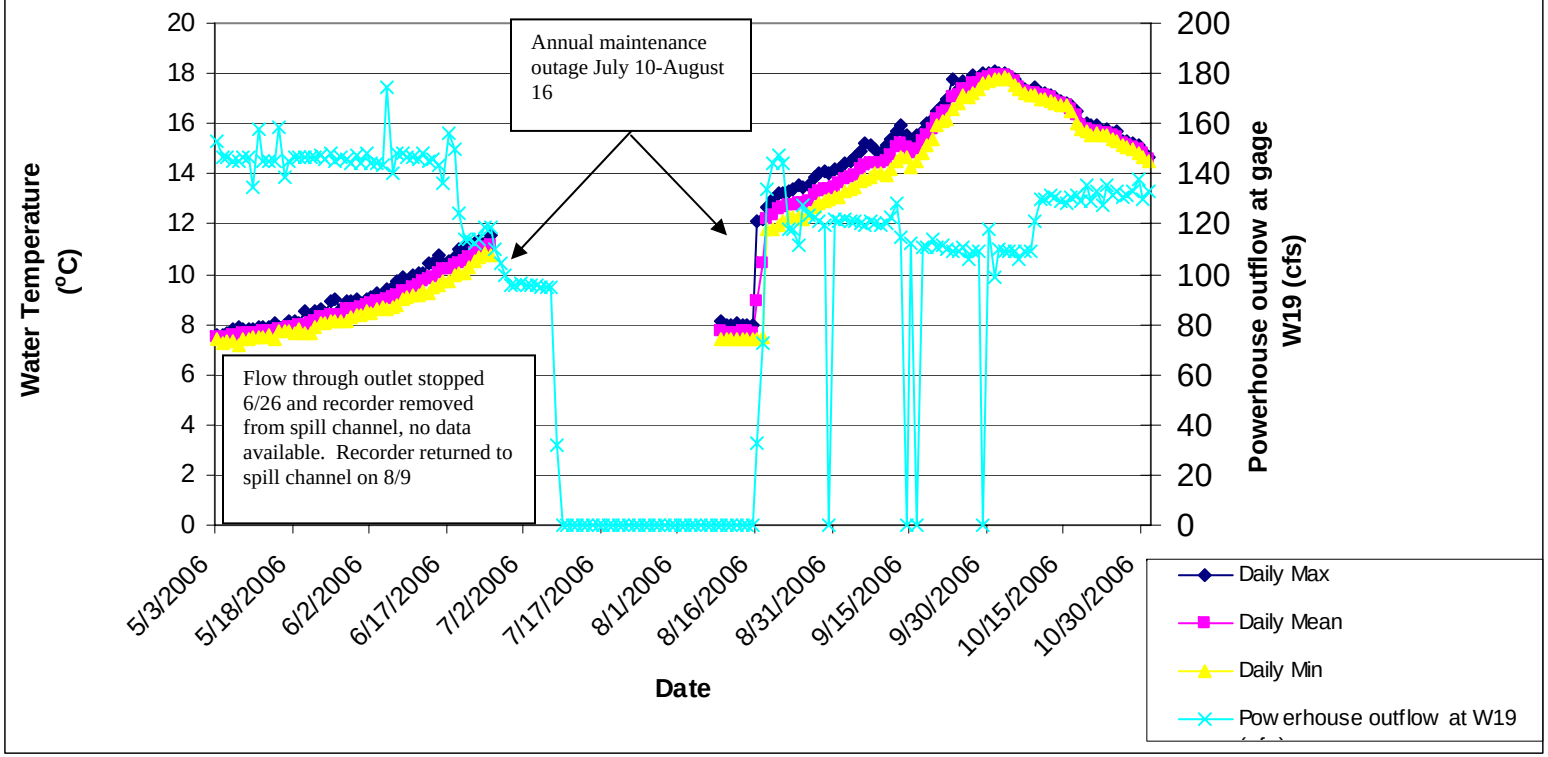


Figure 3.1-4
Station T1, NFWC downstream of Bass Lake at the Crane Valley PH Tailrace
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and Powerhouse outflow at gage W19 (cfs)



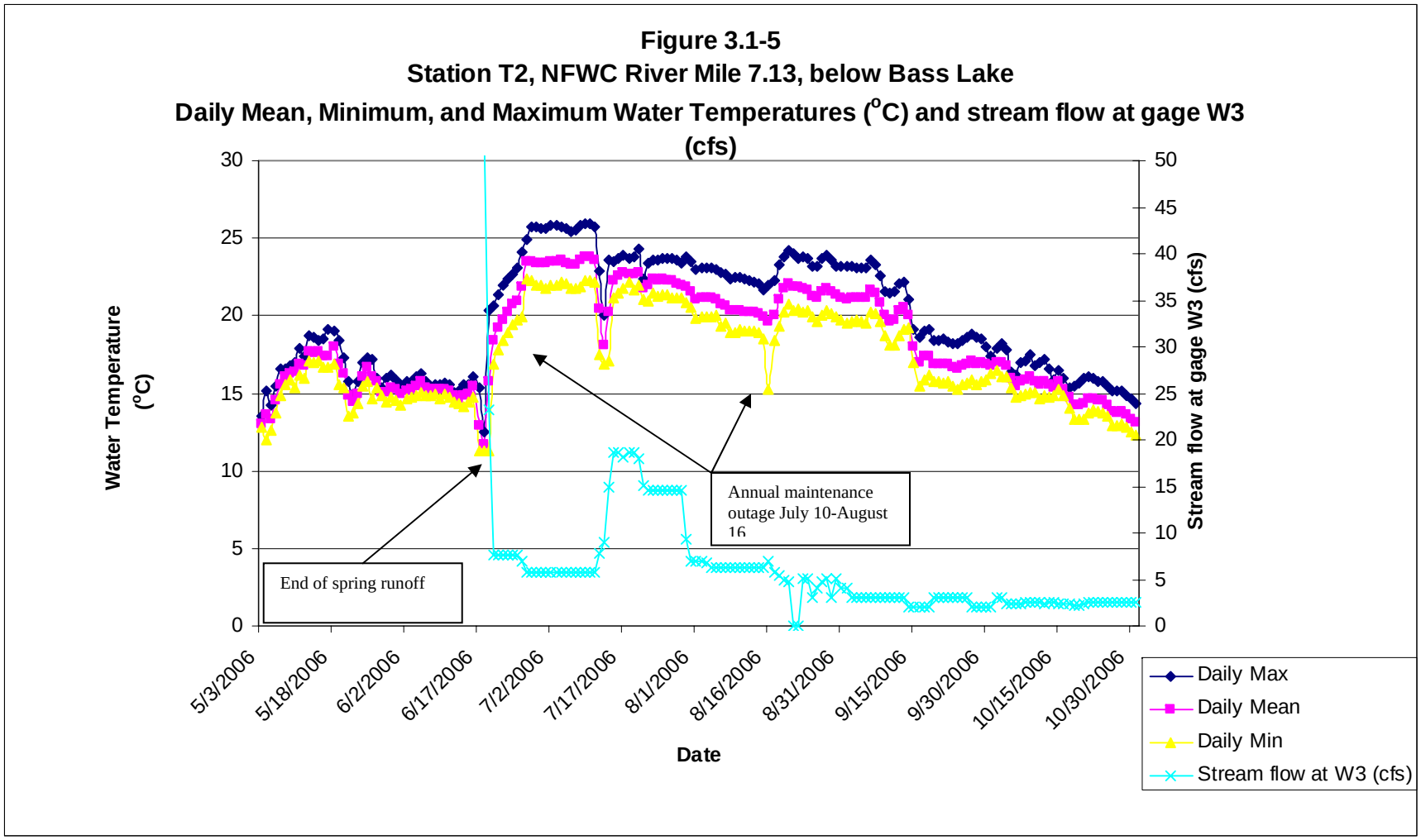


Figure 3.1-5
Station T2, NFWC River Mile 7.13, below Bass Lake
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and stream flow at gage W3 (cfs)
Water Temperature (°C)
Stream flow at gage W3 (cfs)
Date
Annual maintenance outage July 10-August 16
End of spring runoff
Daily Max
Daily Mean
Daily Min
Stream flow at W3 (cfs)

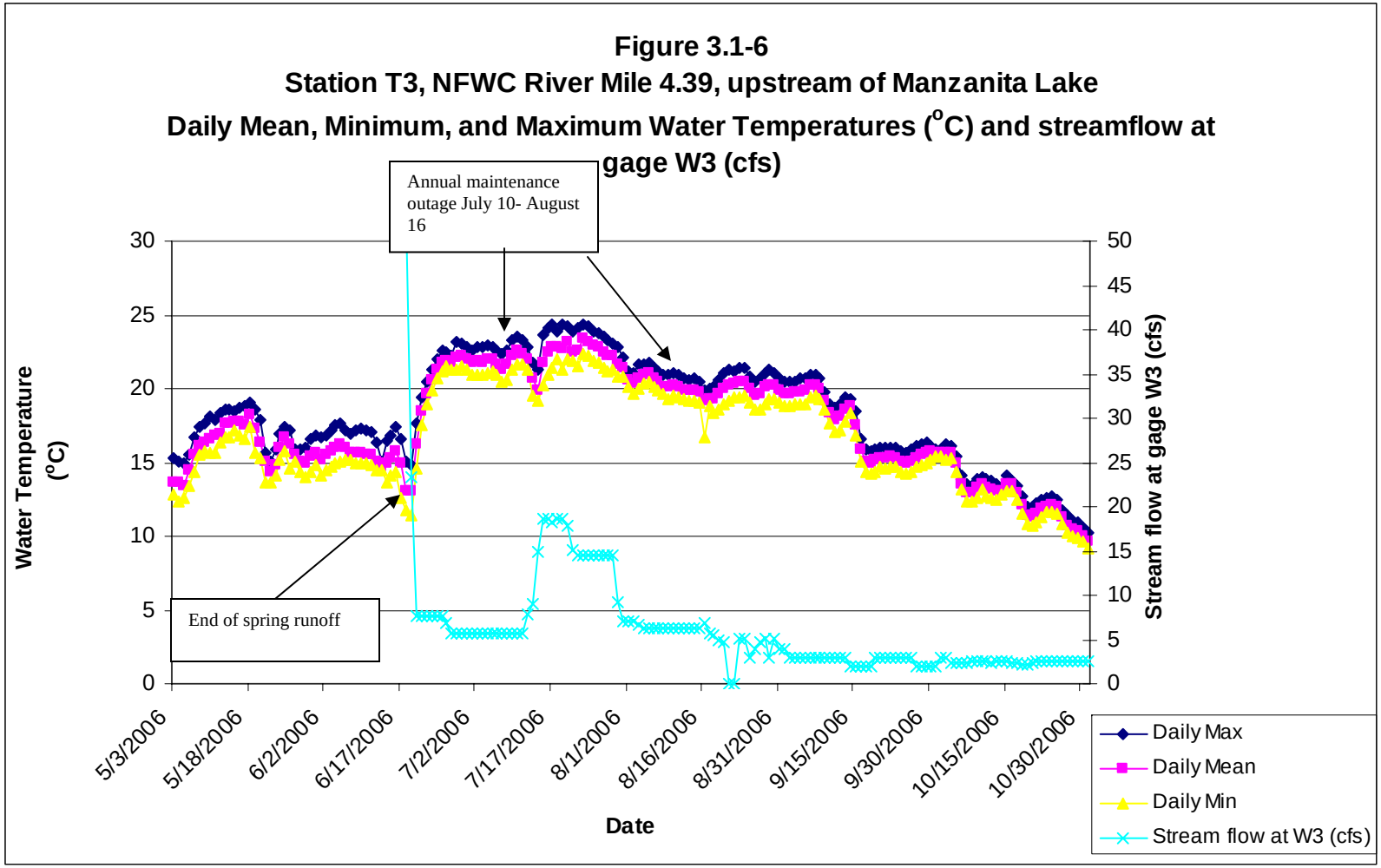


Figure 3.1-6
Station T3, NFWC River Mile 4.39, upstream of Manzanita Lake
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and streamflow at gage W3 (cfs)
Annual maintenance outage July 10- August 16
End of spring runoff
Water Temperature (°C)
Stream flow at gage W3 (cfs)
Date
30
25
20
15
10
5
0
50
45
40
35
30
25
20
15
10
5
0
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006
Daily Max
Daily Mean
Daily Min
Stream flow at W3 (cfs)

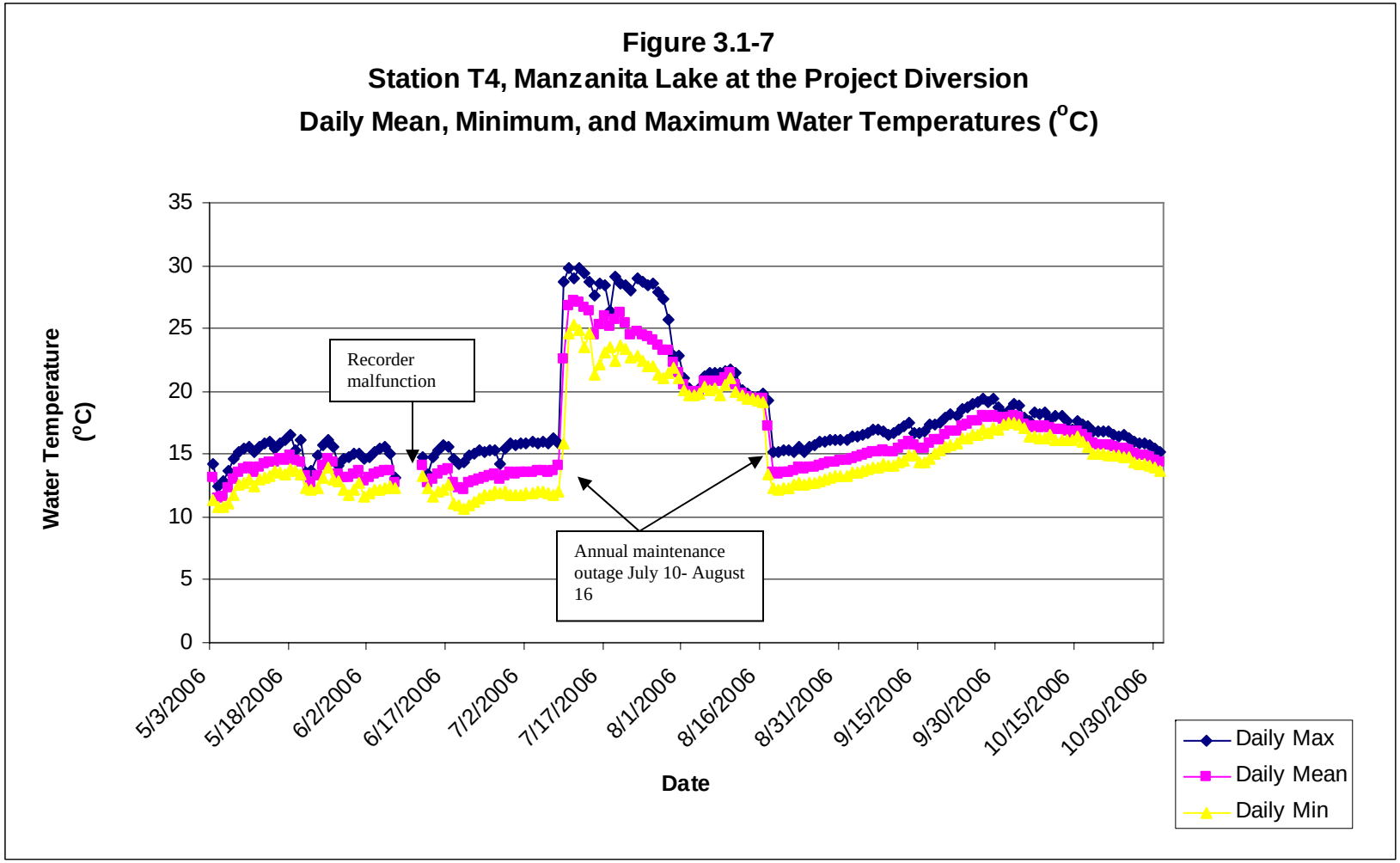


Figure 3.1-7
Station T4, Manzanita Lake at the Project Diversion
Daily Mean, Minimum, and Maximum Water Temperatures (°C)
Water Temperature (°C)
35
30
25
20
15
10
5
0
Recorder malfunction
Annual maintenance outage July 10- August 16
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006
Date
Daily Max
Daily Mean
Daily Min

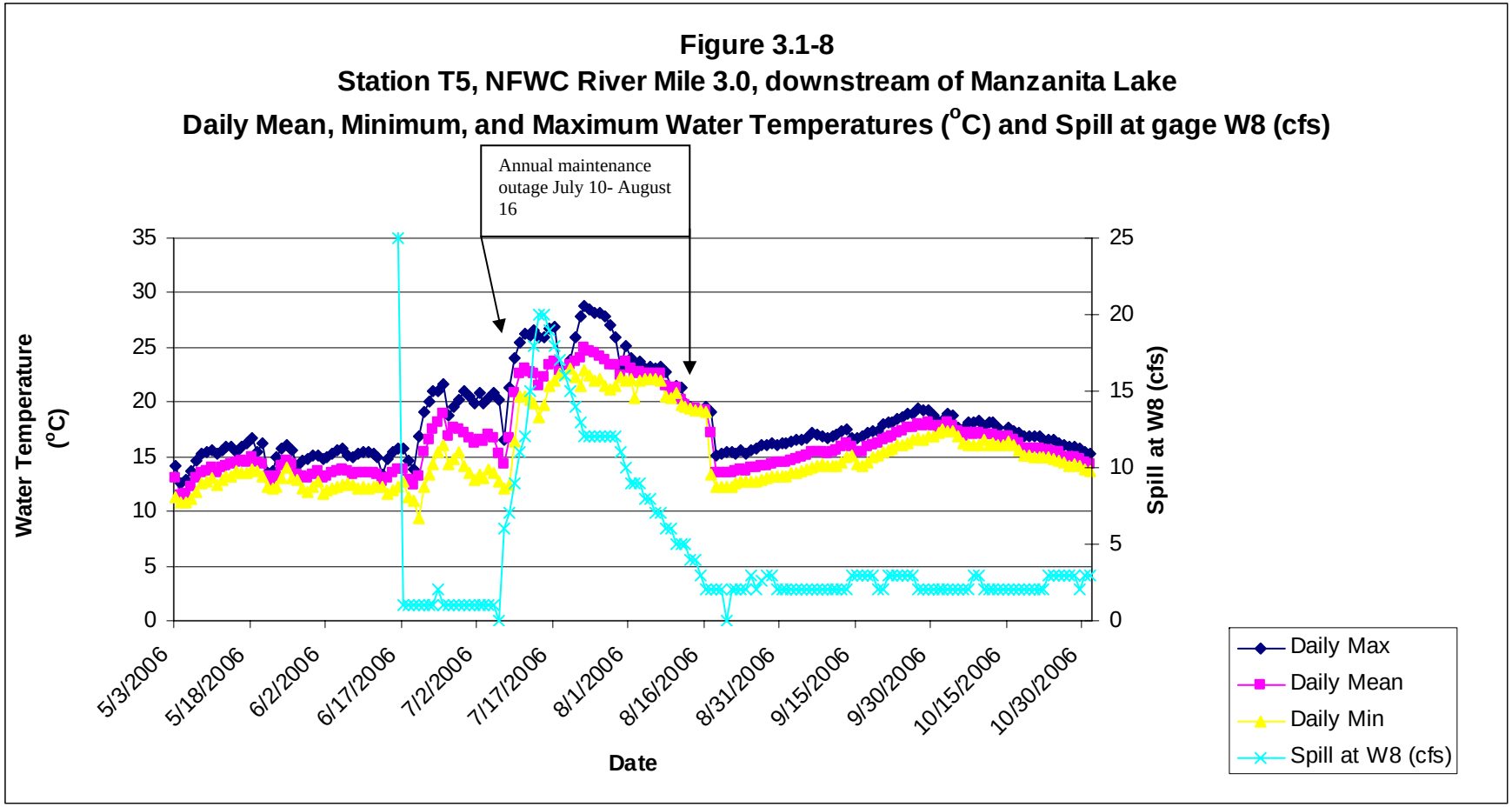


Figure 3.1-8
Station T5, NFWC River Mile 3.0, downstream of Manzanita Lake
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and Spill at gage W8 (cfs)
Annual maintenance outage July 10- August 16
Water Temperature (°C)
Spill at W8 (cfs)
Date
35
30
25
20
15
10
5
0
25
20
15
10
5
0
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006
Daily Max
Daily Mean
Daily Min
Spill at W8 (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 (°C) and Spill at gage W15 (cfs)

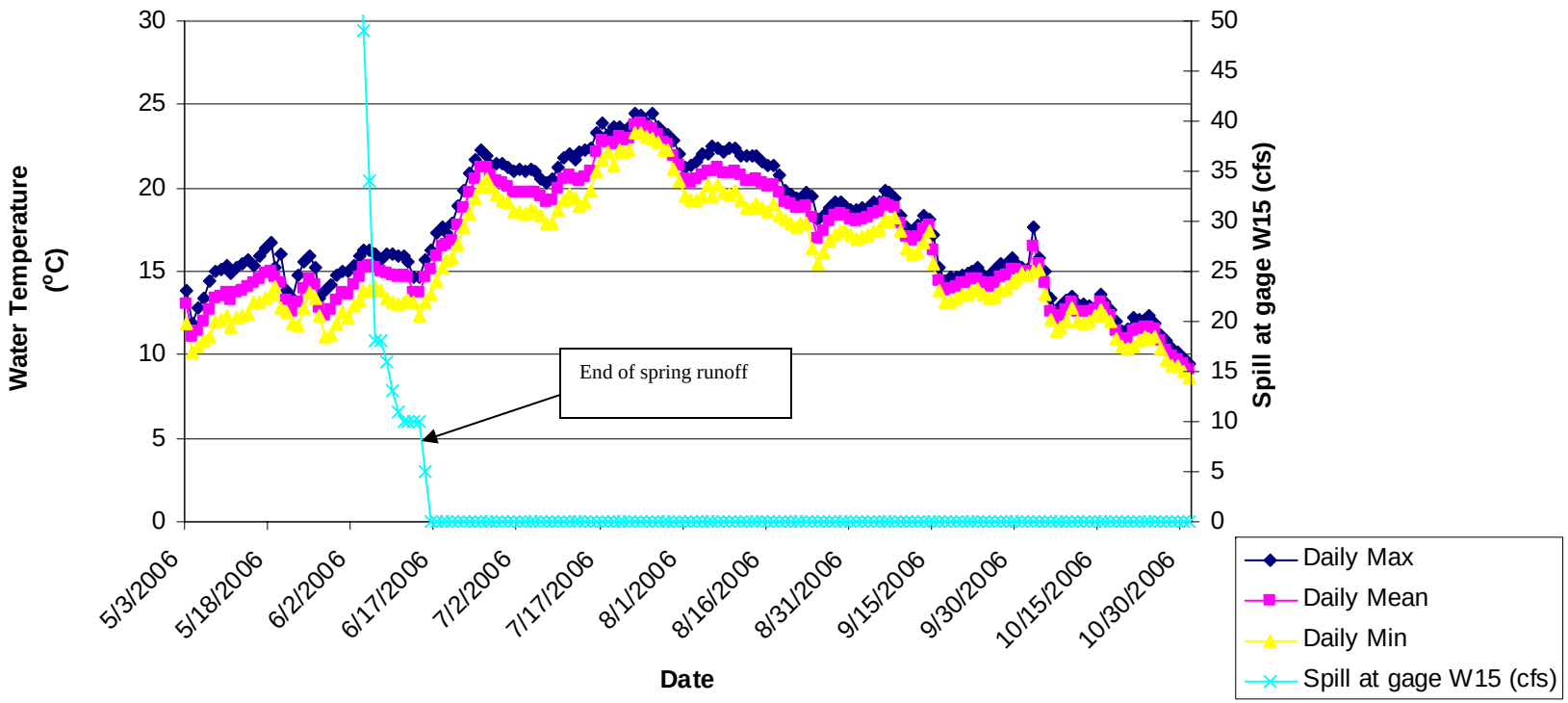


Figure 3.1-10
Station T9, SFWC River Mile 0.1, upstream of the SFWC Diversion Dam
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and spill at gage W13 (cfs)

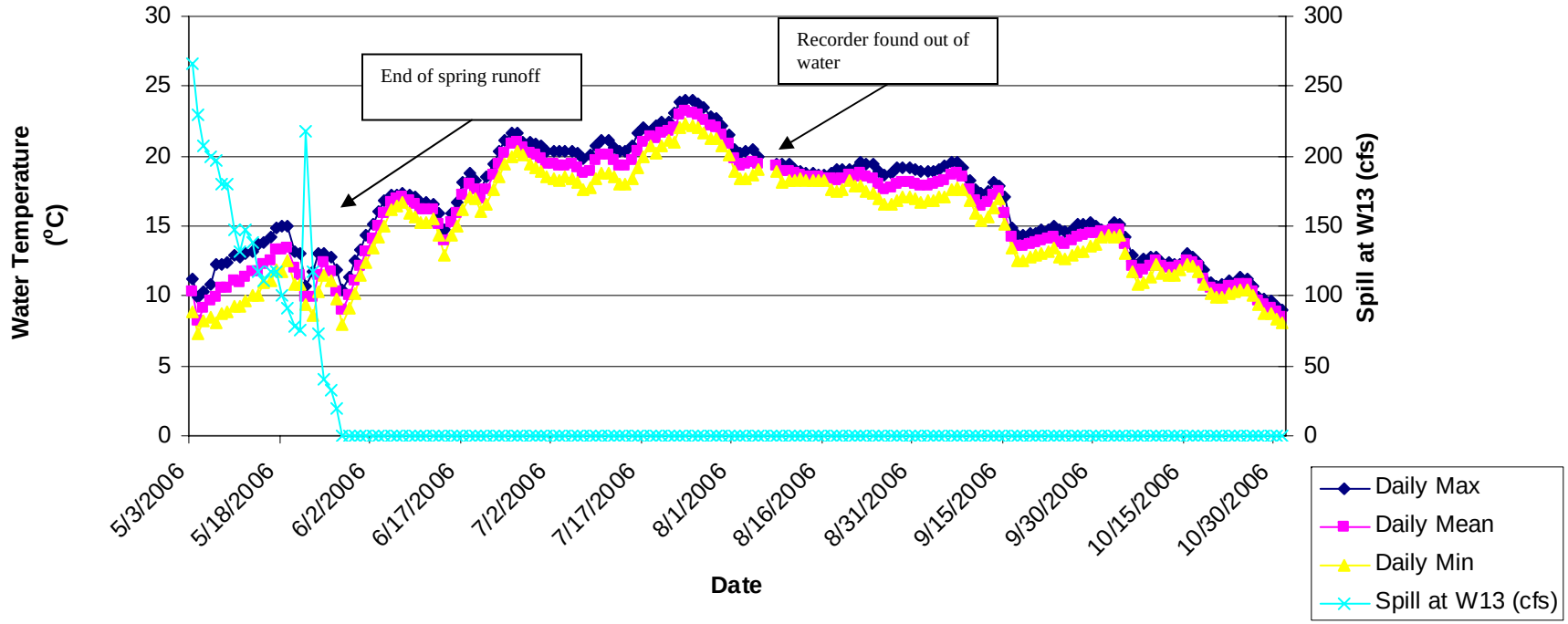


Figure 3.1-11
Station T13, Willow Creek downstream of the sand trap spill channel confluence
Daily Mean, Minimum, and Maximum Water Temperatures (°C)

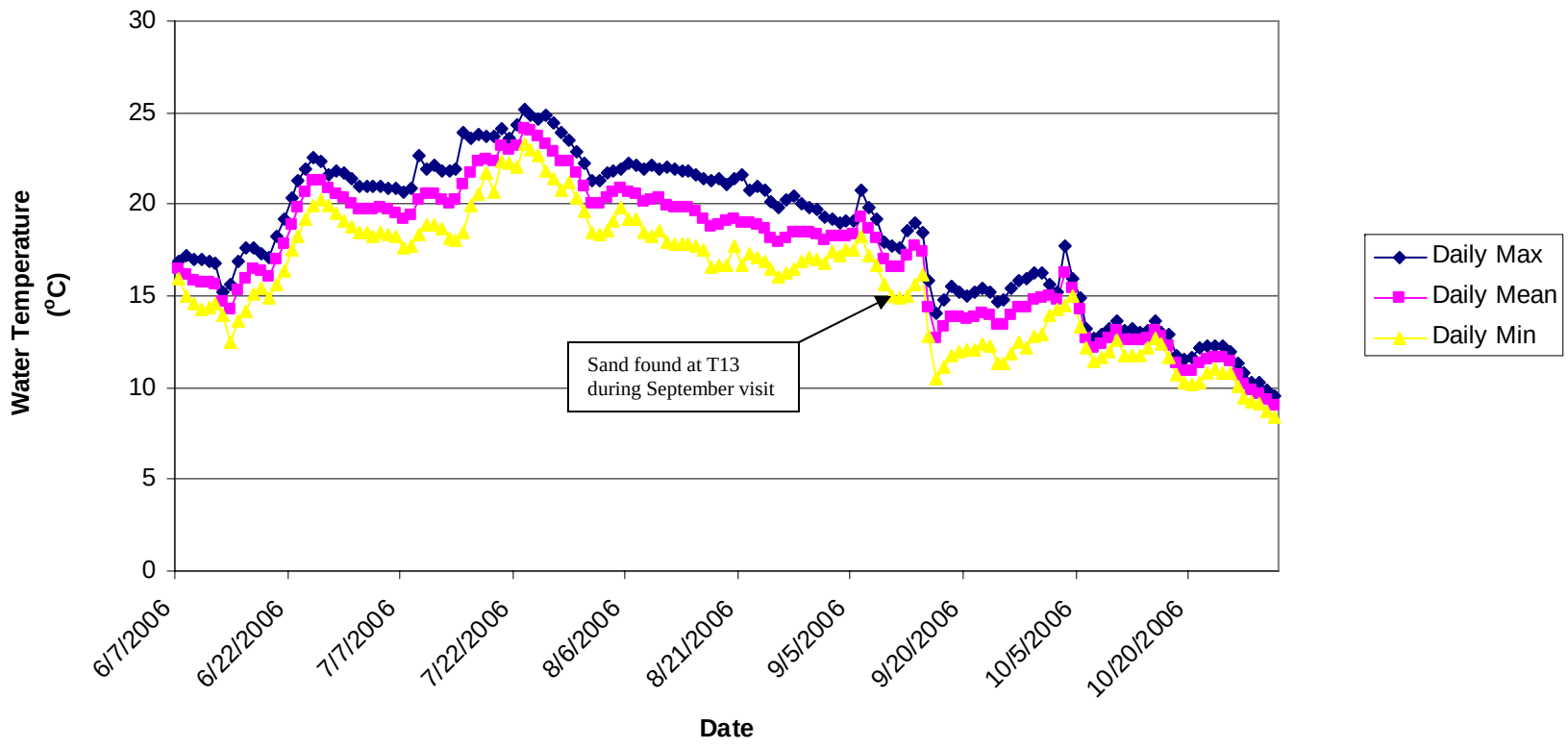
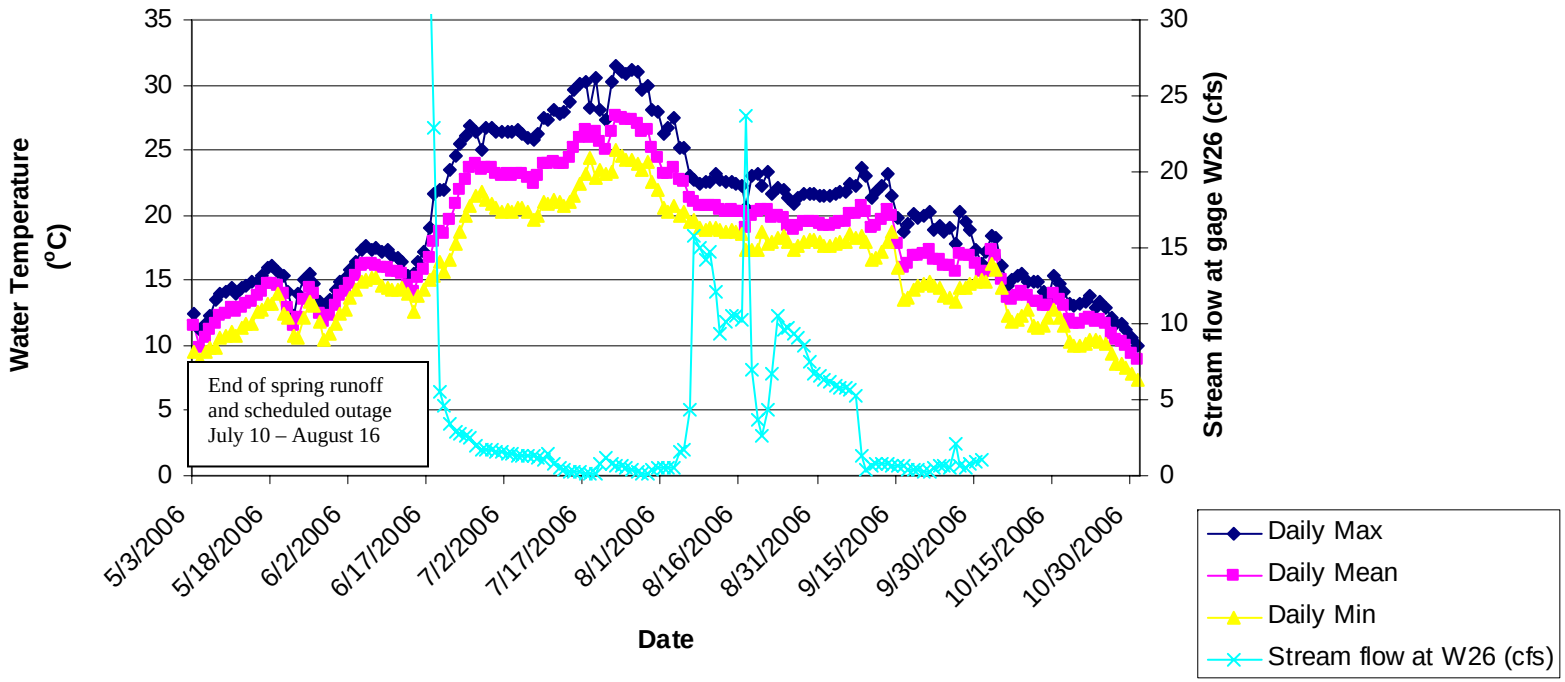


Figure 3.1-12
Station T10, Williow Creek River Mile 4.3, at Gage W-26
Daily Mean, Minimum, and Maximum Water Temperatures (^{o}C) and stream flow at gage W26 (cfs)



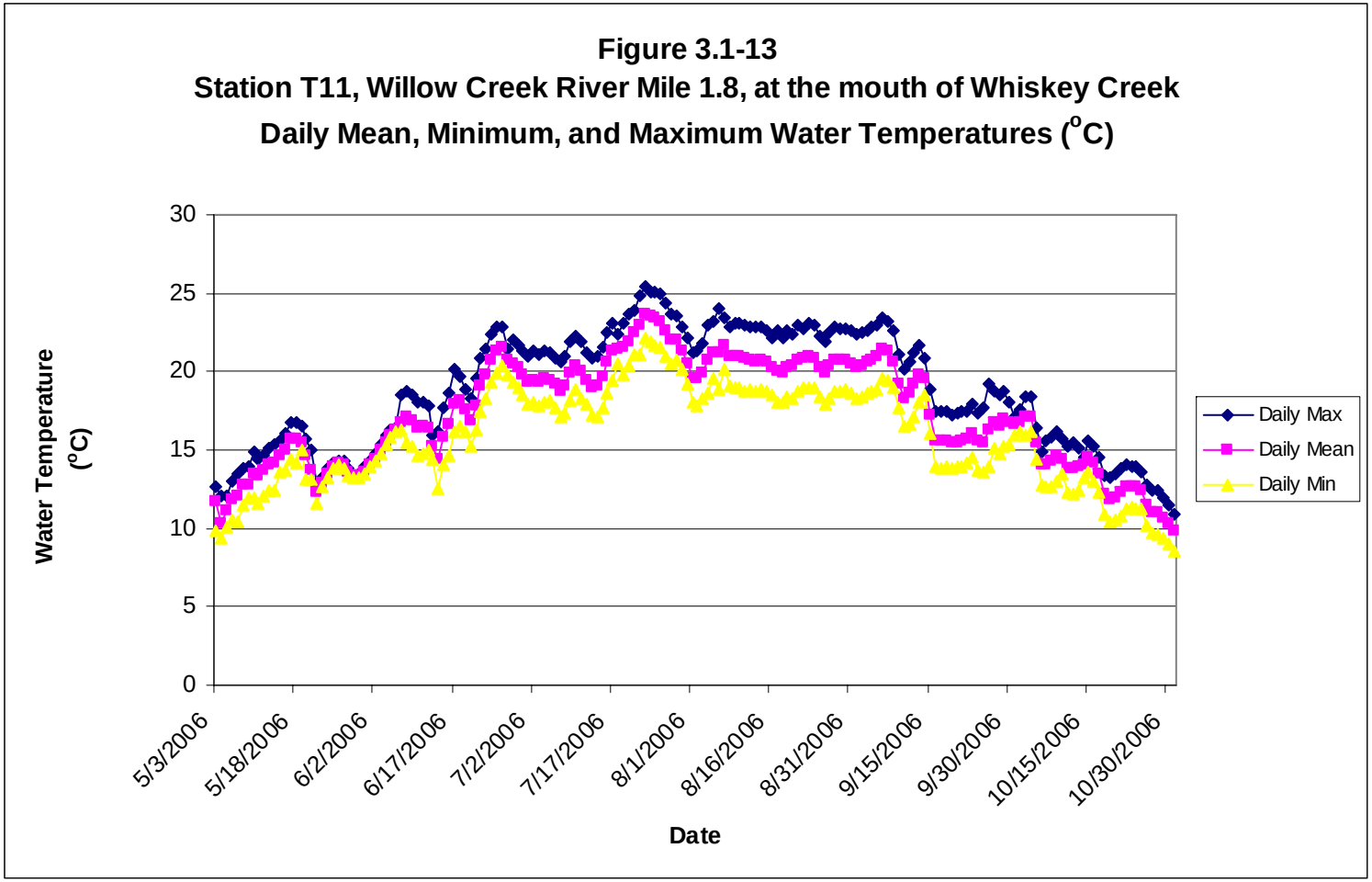


Figure 3.1-13
Station T11, Willow Creek River Mile 1.8, at the mouth of Whiskey Creek
Daily Mean, Minimum, and Maximum Water Temperatures (°C)
Water Temperature (°C)
30
25
20
15
10
5
0
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006
Date
Daily Max
Daily Mean
Daily Min

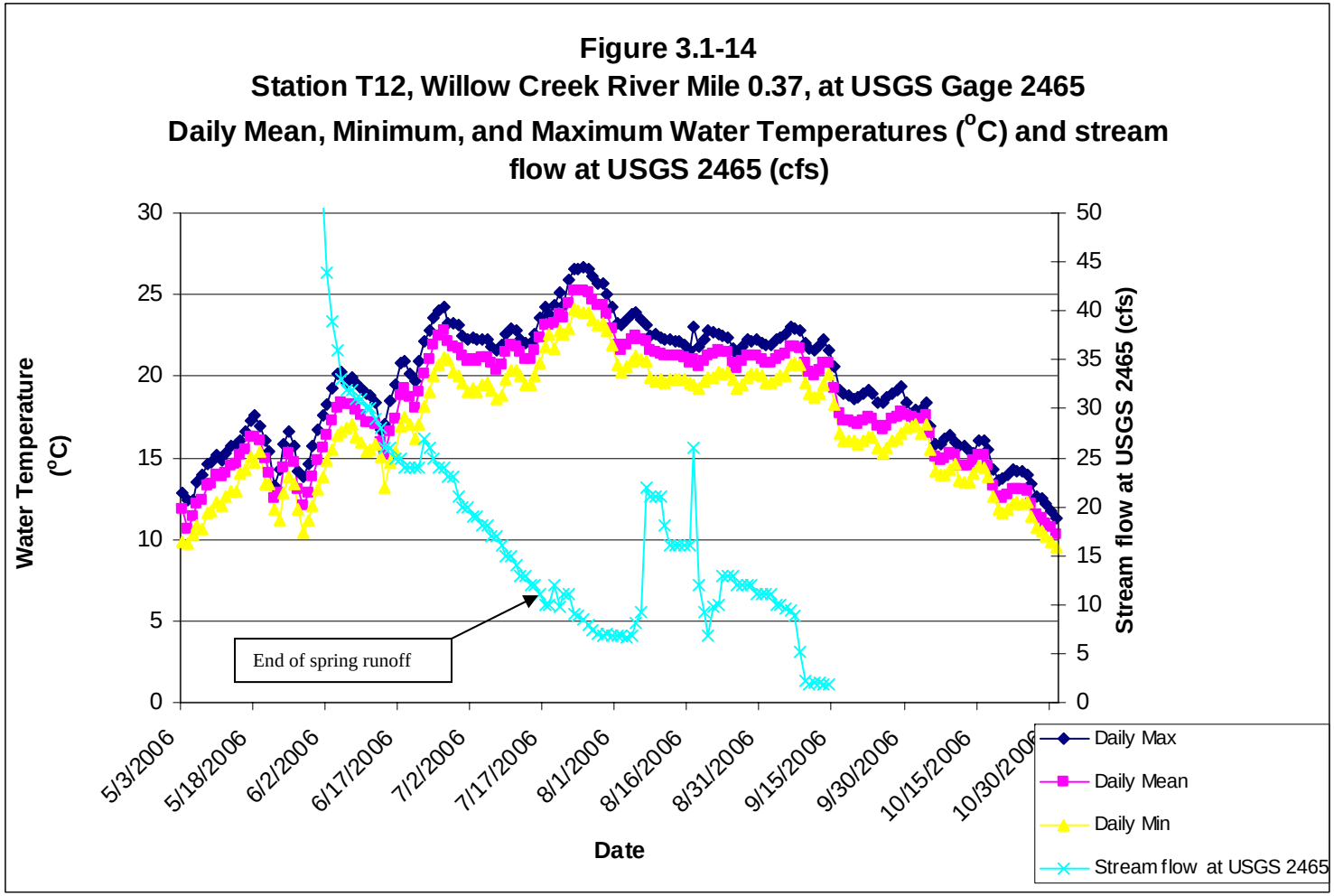


Figure 3.1-14
Station T12, Willow Creek River Mile 0.37, at USGS Gage 2465
Daily Mean, Minimum, and Maximum Water Temperatures (°C) and stream flow at USGS 2465 (cfs)
Water Temperature (°C)
Stream flow at USGS 2465 (cfs)
Date
End of spring runoff
Daily Max
Daily Mean
Daily Min
Stream flow at USGS 2465
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006

Figure 3.1-15
Station T7, SFWC River Mile 6.59, upstream of the Browns Creek Diversion Dam
Daily Mean Water Temperatures (^{o}C) and Daily Mean Air Temperatures (^{o}C)

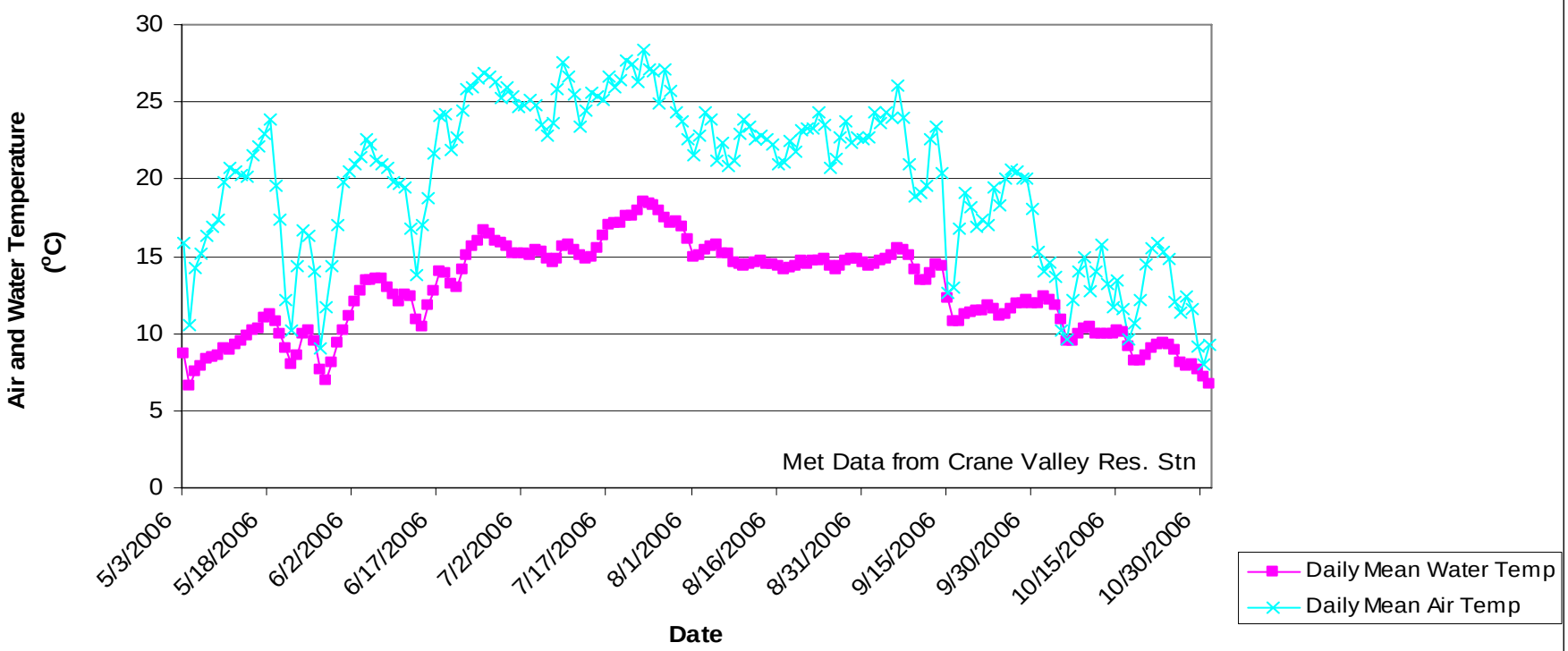
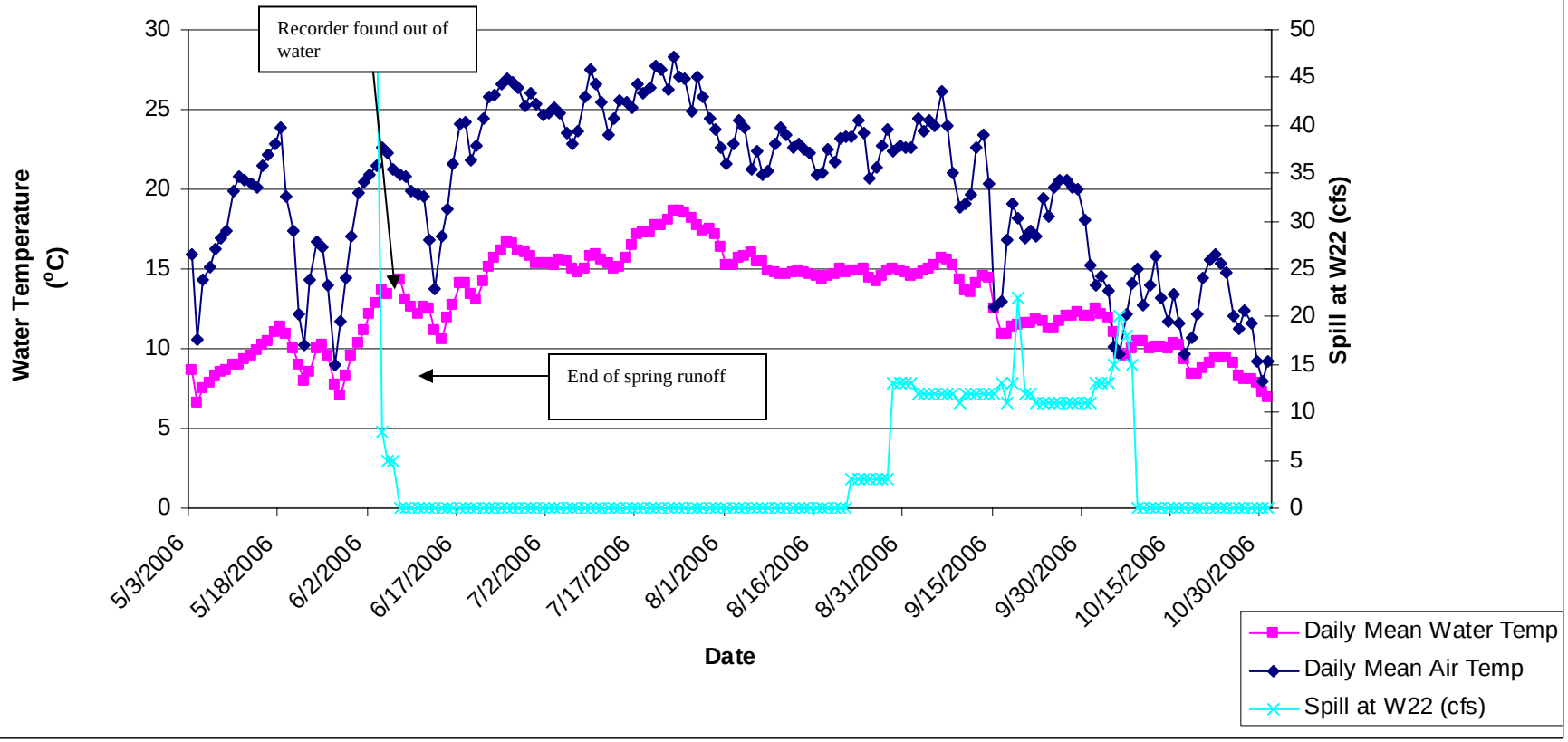


Figure 3.1-16
Station T8, SFWC River Mile 6.5, downstream of the Browns Creek Diversion Dam
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and spill at gage W22 (cfs)



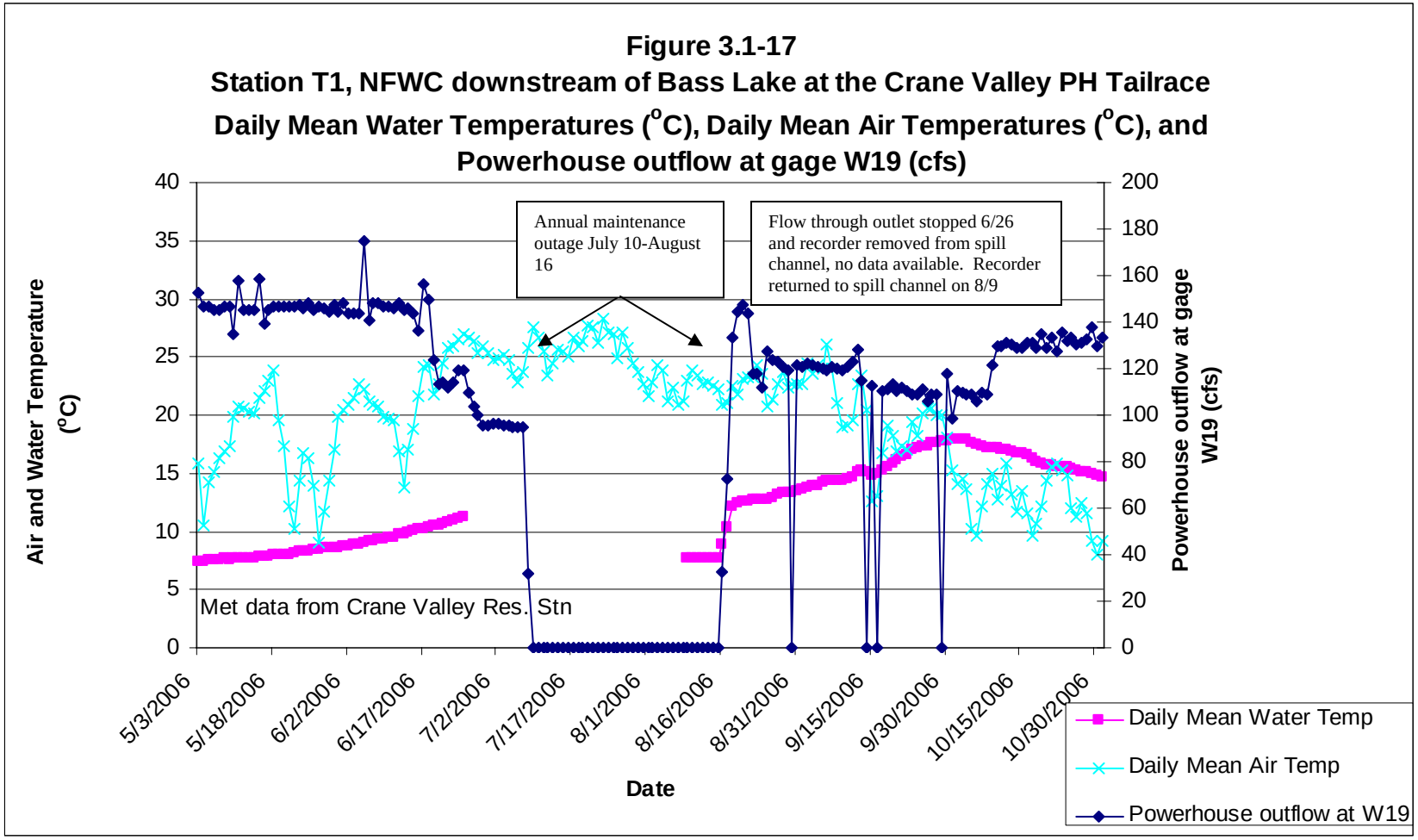


Figure 3.1-17
Station T1, NFWC downstream of Bass Lake at the Crane Valley PH Tailrace
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and
Powerhouse outflow at gage W19 (cfs)
Annual maintenance outage July 10-August 16
Flow through outlet stopped 6/26 and recorder removed from spill channel, no data available. Recorder returned to spill channel on 8/9
Met data from Crane Valley Res. Stn
Air and Water Temperature (°C)
Powerhouse outflow at gage W19 (cfs)
Date
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006
Daily Mean Water Temp
Daily Mean Air Temp
Powerhouse outflow at W19

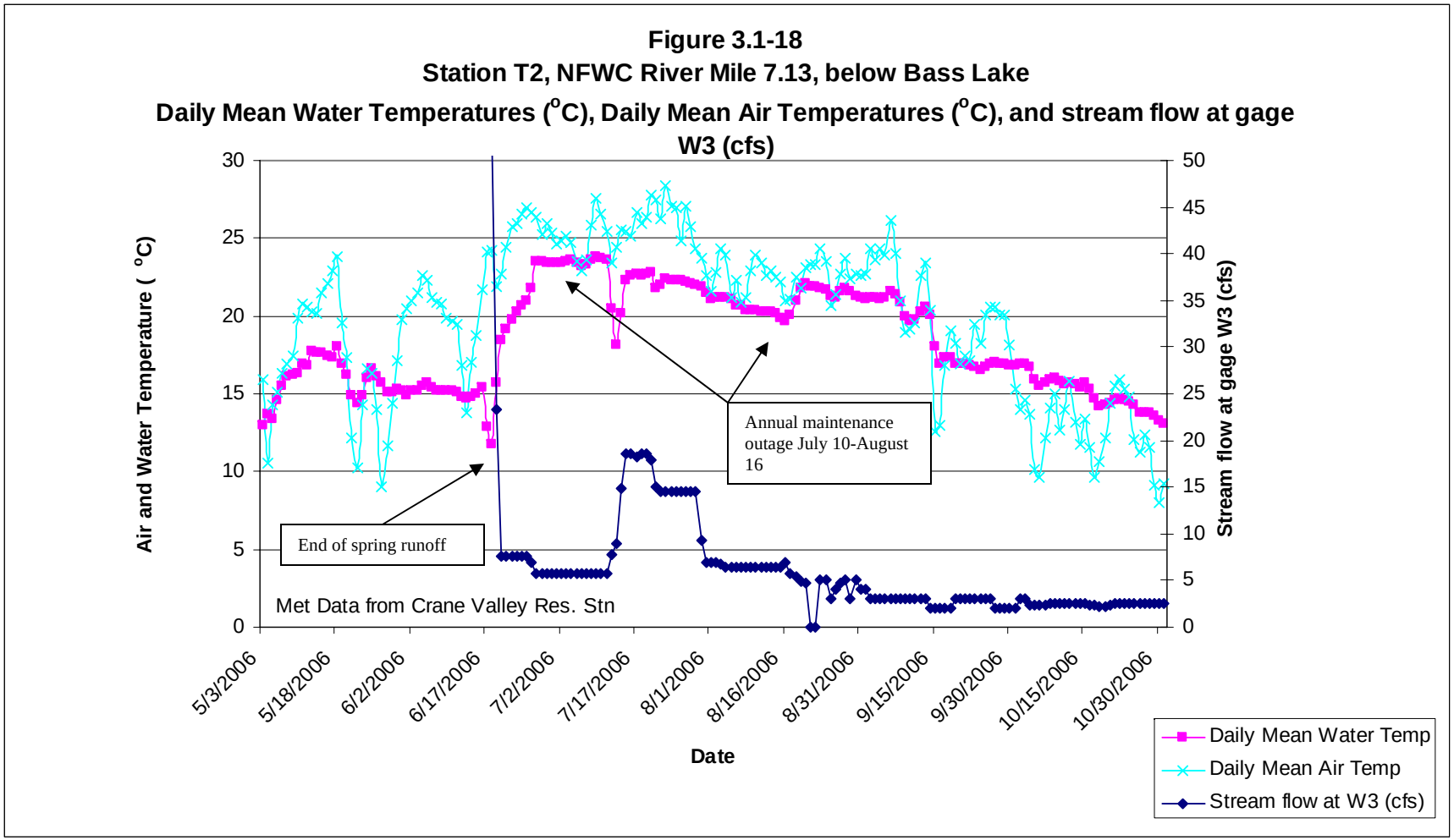
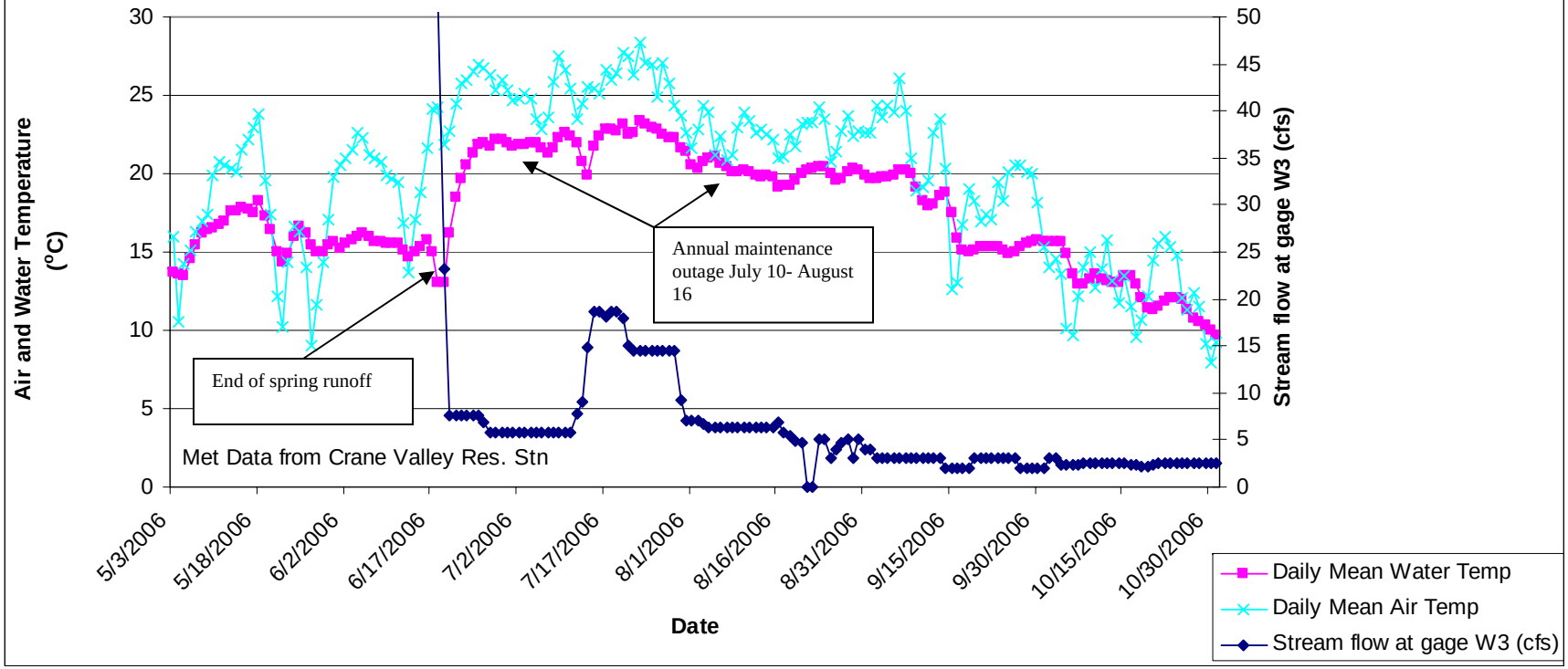


Figure 3.1-18
Station T2, NFWC River Mile 7.13, below Bass Lake
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at gage W3 (cfs)
Air and Water Temperature (°C)
Stream flow at gage W3 (cfs)
Date
Annual maintenance outage July 10-August 16
End of spring runoff
Met Data from Crane Valley Res. Stn
Daily Mean Water Temp
Daily Mean Air Temp
Stream flow at W3 (cfs)
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006

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)



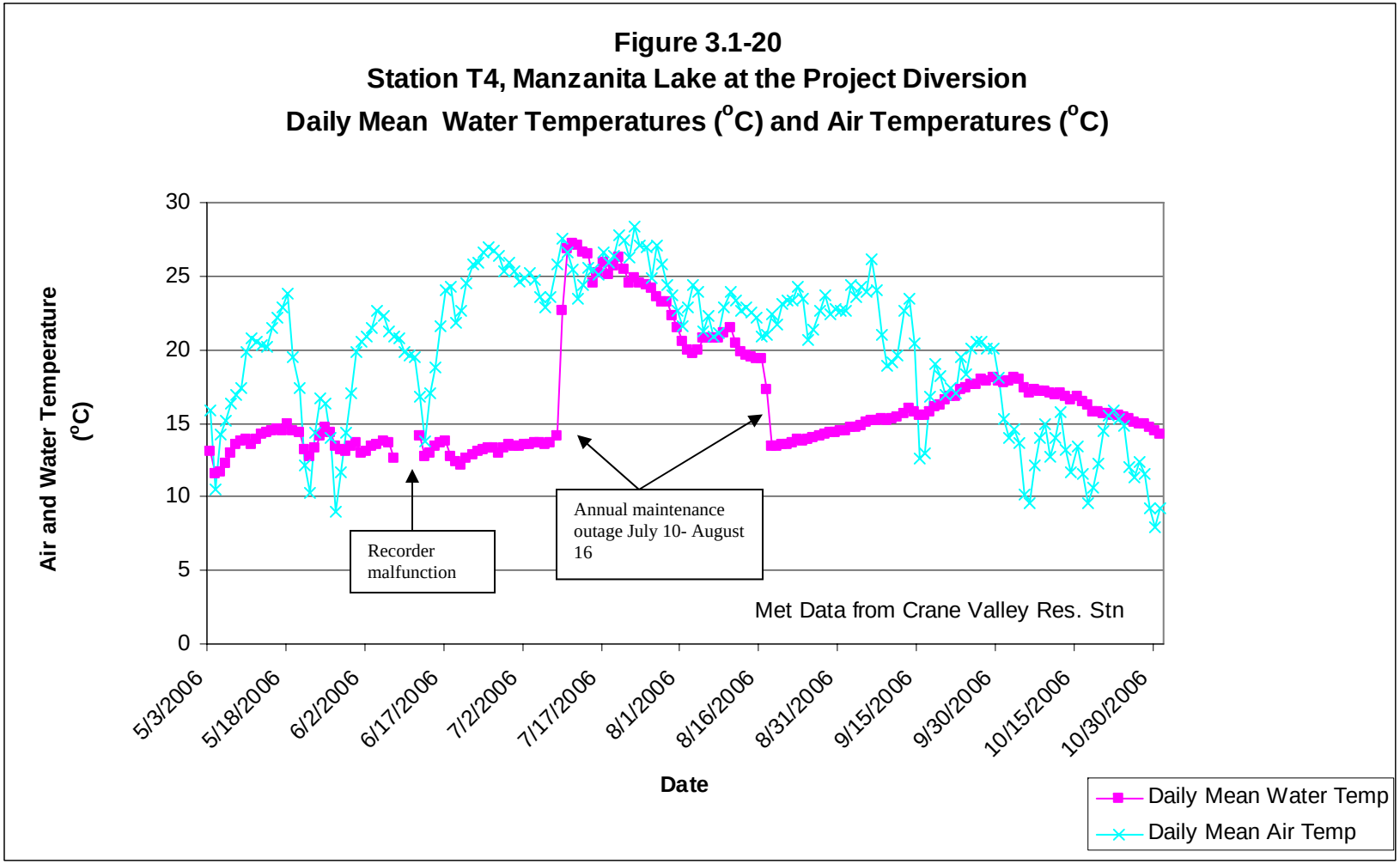


Figure 3.1-20
Station T4, Manzanita Lake at the Project Diversion
Daily Mean Water Temperatures (°C) and Air Temperatures (°C)
Air and Water Temperature (°C)
30
25
20
15
10
5
0
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006
Date
Recorder malfunction
Annual maintenance outage July 10- August 16
Met Data from Crane Valley Res. Stn
Daily Mean Water Temp
Daily Mean Air Temp

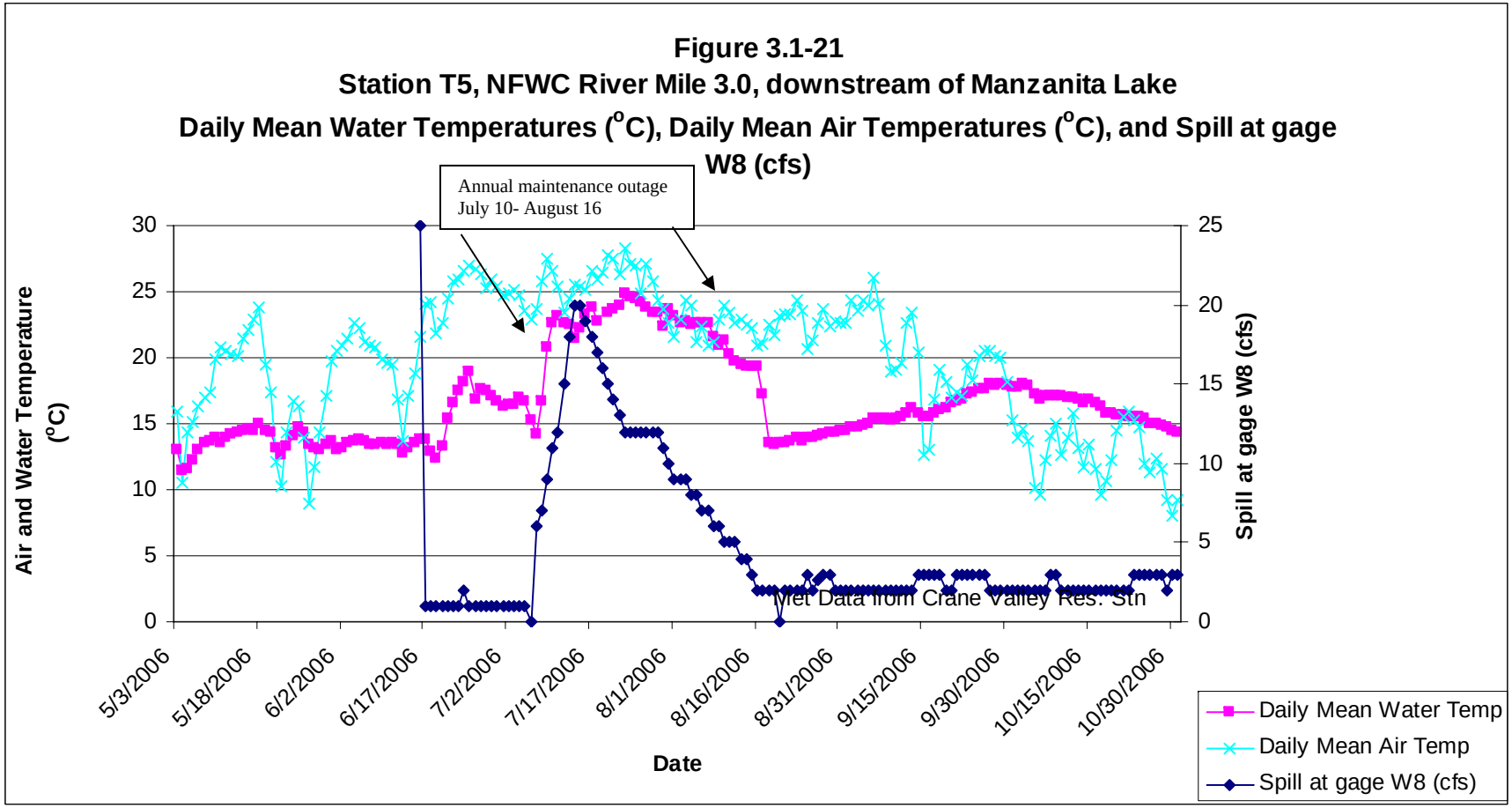
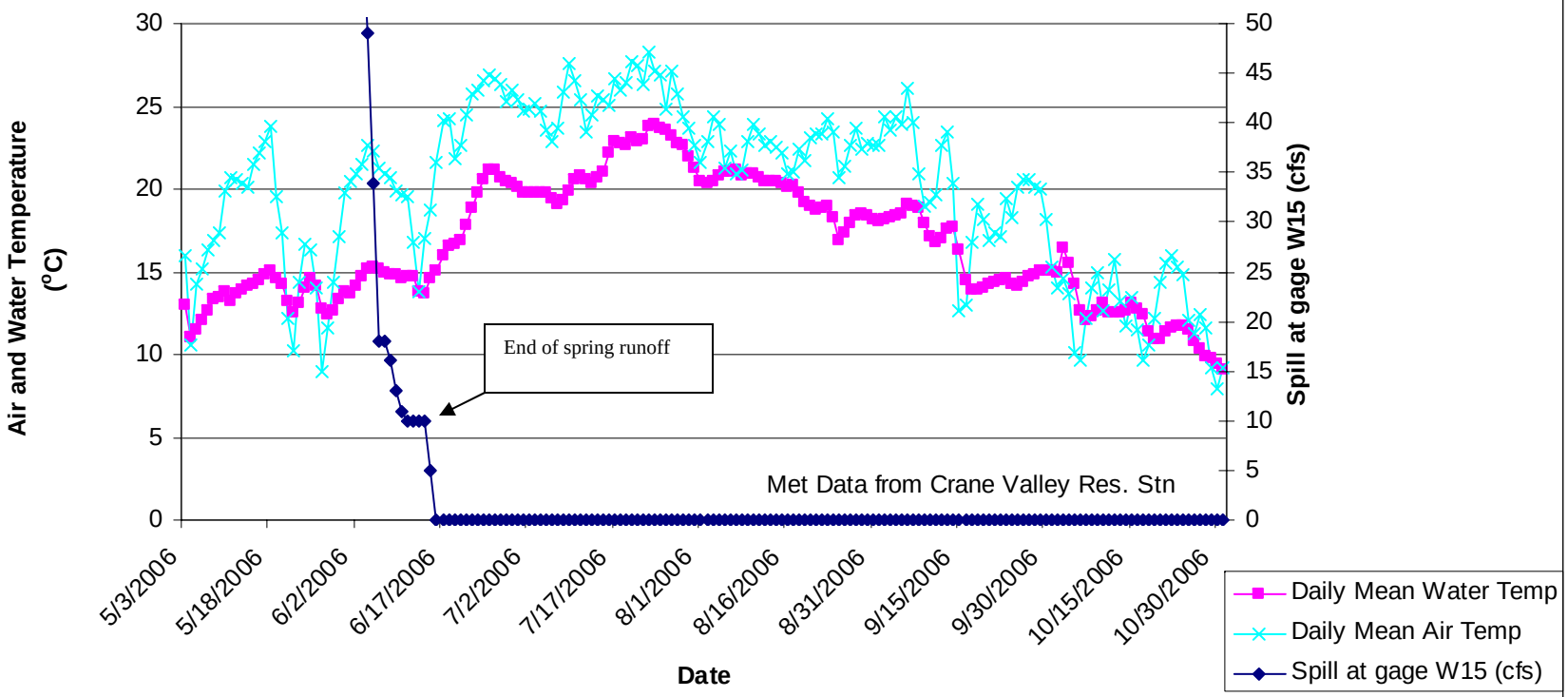


Figure 3.1-21
Station T5, NFWC River Mile 3.0, downstream of Manzanita Lake
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and Spill at gage W8 (cfs)
Annual maintenance outage
July 10- August 16
Air and Water Temperature (°C)
Spill at gage W8 (cfs)
Met Data from Crane Valley Res. Stn
Date
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006
Daily Mean Water Temp
Daily Mean Air Temp
Spill at gage W8 (cfs)

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



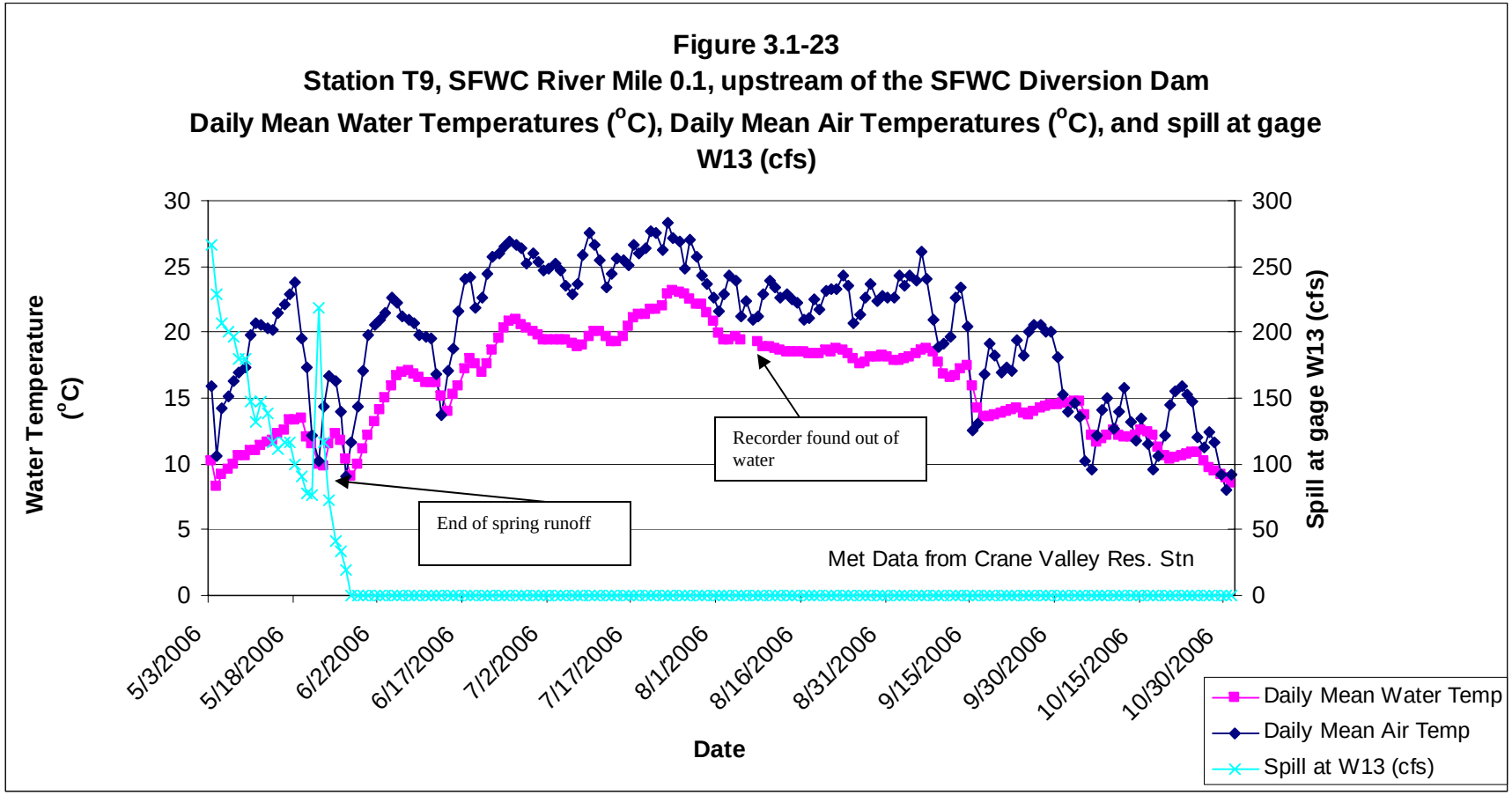


Figure 3.1-23
Station T9, SFWC River Mile 0.1, upstream of the SFWC Diversion Dam
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and spill at gage W13 (cfs)
Water Temperature (°C)
Spill at gage W13 (cfs)
30
25
20
15
10
5
0
300
250
200
150
100
50
0
Recorder found out of water
End of spring runoff
Met Data from Crane Valley Res. Stn
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006
Date
Daily Mean Water Temp
Daily Mean Air Temp
Spill at 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)

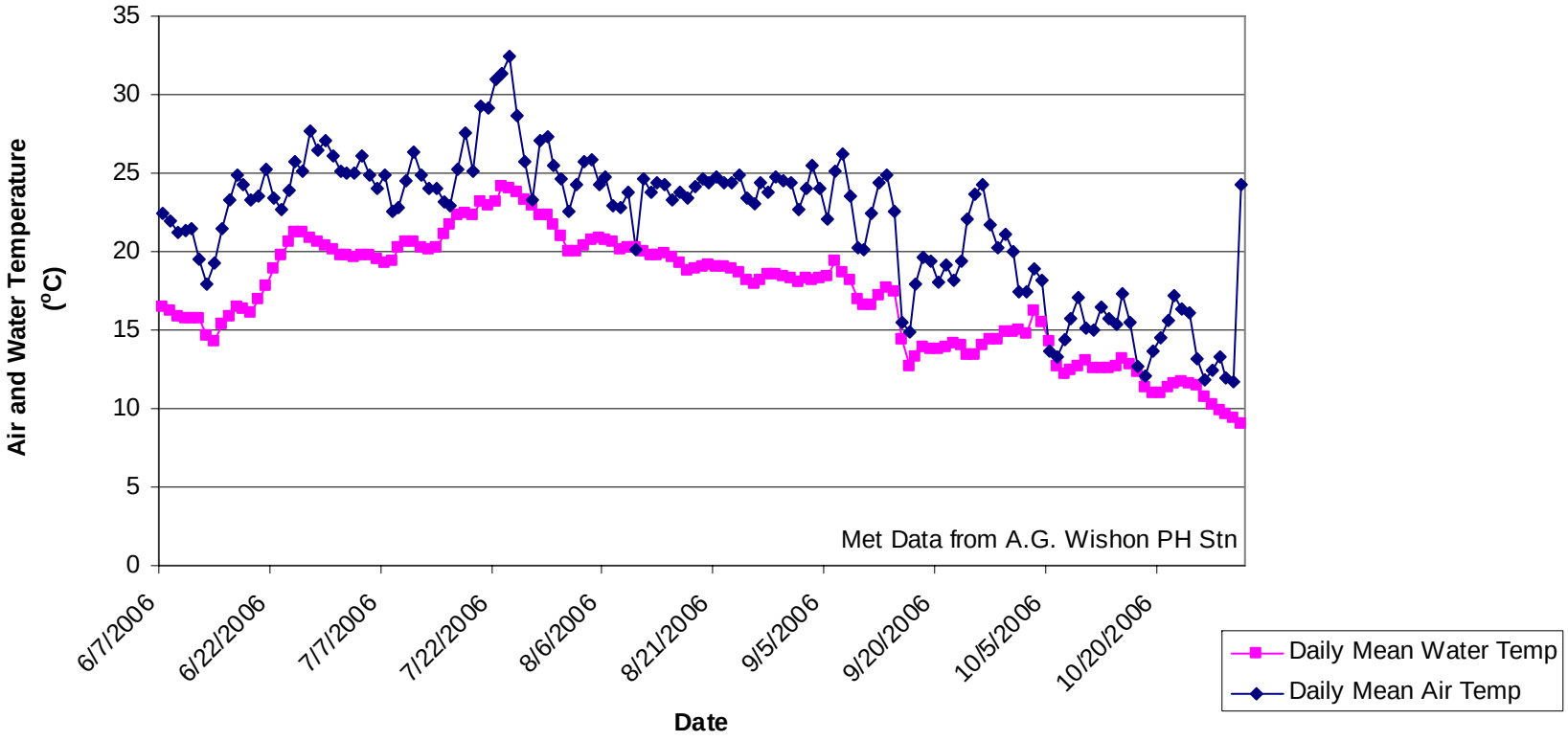
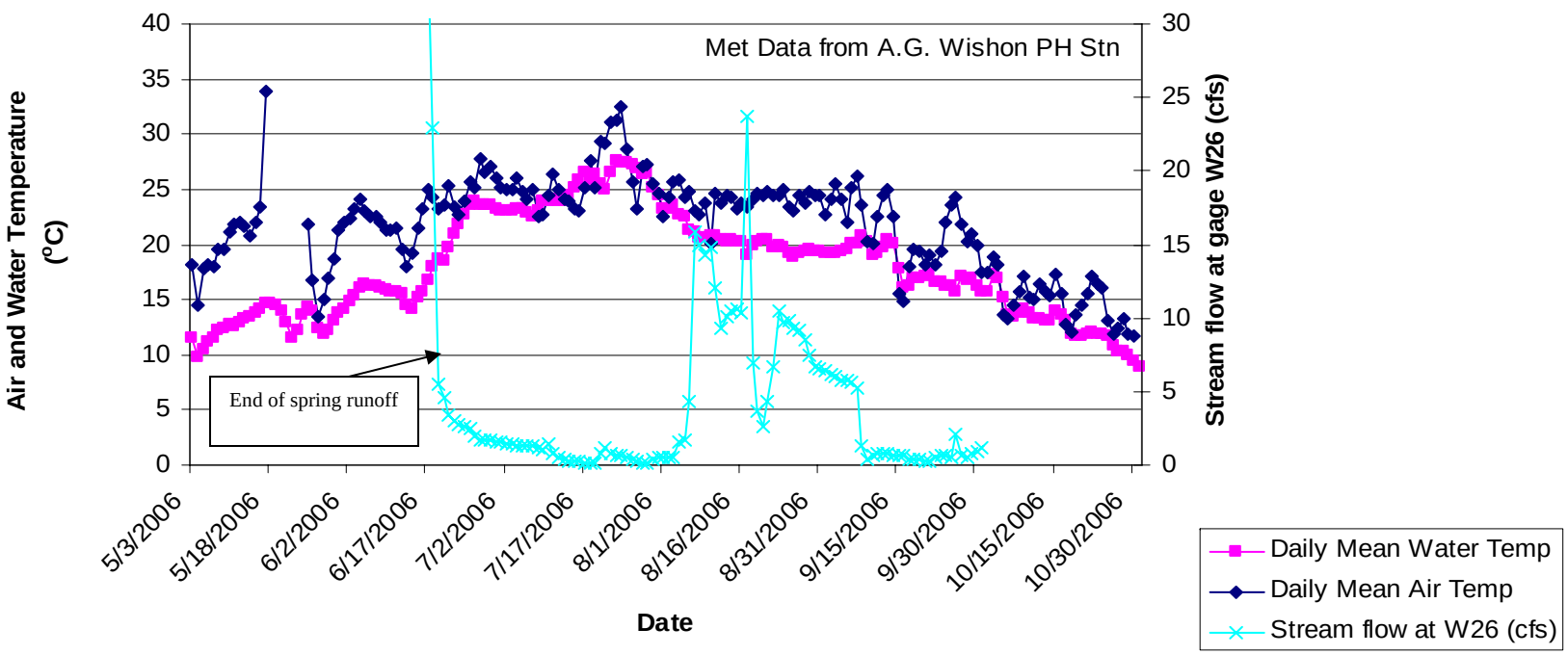


Figure 3.1-25
Station T10, Williow Creek River Mile 4.3, at Gage W-26
Daily Mean Water Temperatures (^{o}C), Daily Mean Air Temperatures (^{o}C), and stream flow at gage W26 (cfs)



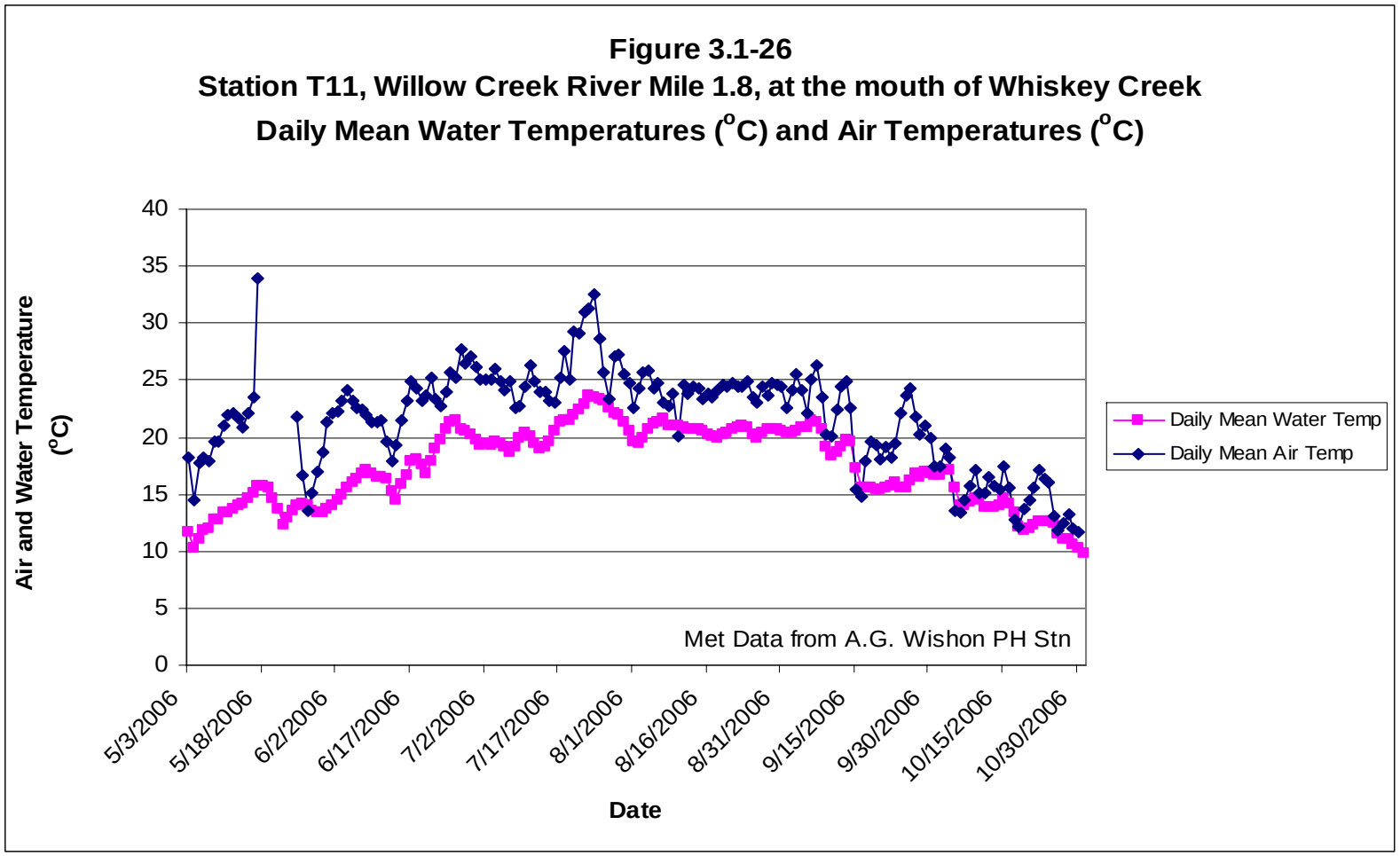


Figure 3.1-26
Station T11, Willow Creek River Mile 1.8, at the mouth of Whiskey Creek
Daily Mean Water Temperatures (°C) and Air Temperatures (°C)
Air and Water Temperature (°C)
40
35
30
25
20
15
10
5
0
Met Data from A.G. Wishon PH Stn
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006
Date
Daily Mean Water Temp
Daily Mean Air Temp

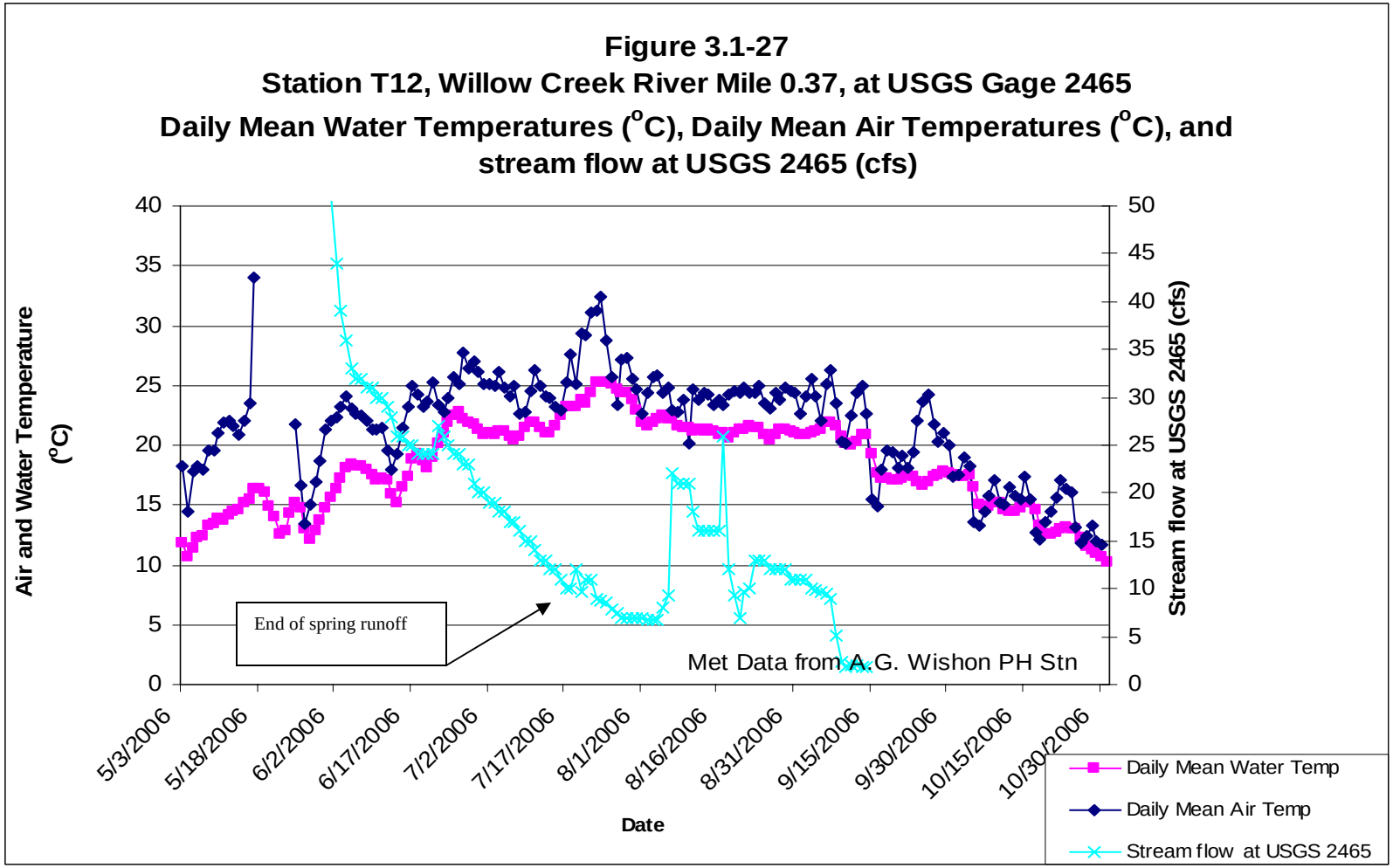


Figure 3.1-27
Station T12, Willow Creek River Mile 0.37, at USGS Gage 2465
Daily Mean Water Temperatures (°C), Daily Mean Air Temperatures (°C), and stream flow at USGS 2465 (cfs)
Air and Water Temperature (°C)
Stream flow at USGS 2465 (cfs)
Date
End of spring runoff
Met Data from A.G. Wishon PH Stn
Daily Mean Water Temp
Daily Mean Air Temp
Stream flow at USGS 2465
5/3/2006
5/18/2006
6/2/2006
6/17/2006
7/2/2006
7/17/2006
8/1/2006
8/16/2006
8/31/2006
9/15/2006
9/30/2006
10/15/2006
10/30/2006