

FINAL TECHNICAL REPORT

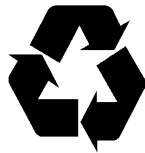
Klamath Hydroelectric Project  
(FERC Project No. 2082)

Spring Creek Water Quality Investigations

PacifiCorp  
Portland, Oregon

November 2004

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Appendix A - Jenny Creek Monthly Discharge for years 2000 through 2003

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FERC Project No. 2082

## SPRING CREEK WATER QUALITY INVESTIGATIONS

### 1.0 DESCRIPTION AND PURPOSE

PacifiCorp submitted a Final License Application (FLA) to the Federal Energy Regulatory Commission (FERC) for the Klamath Hydroelectric Project (Project) in February 2004. In the FLA, PacifiCorp committed to conducting environmental studies (e.g., water quality, terrestrial surveys) for the Spring Creek diversion which supplies water to the Fall Creek development. This report describes the water quality monitoring conducted for the Spring Creek diversion area.

### 2.0 STUDY AREA

Spring Creek is a tributary to Jenny Creek which flows into Iron Gate Reservoir (Figure 1). As its name implies, Spring Creek is spring fed; starting at Shoat Springs, it travels 1.2 miles before entering Jenny Creek at R.M. 5.5. Jenny Creek is included in the water quality monitoring since water diverted from Spring Creek may affect water quality in Jenny Creek.

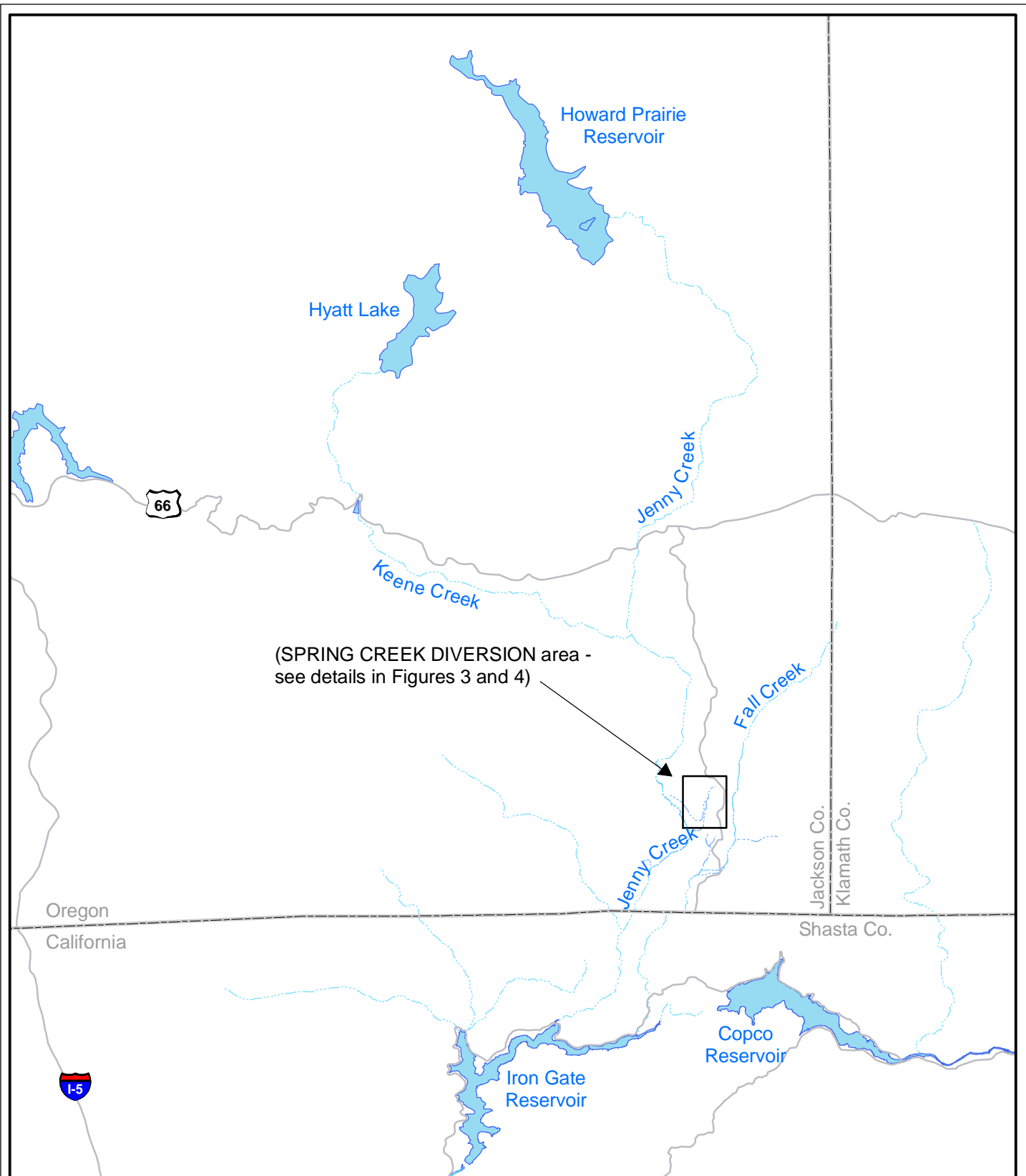
PacifiCorp maintains an earthen dam on Spring Creek, and has a water right for 16.5 cfs. The Spring Creek diversion canal is approximately 1.7 miles long and enters Fall Creek about 1.7 miles upstream of the Fall Creek power canal diversion. There are several unnamed springs that are captured in the Spring Creek canal. There are 2 other non-PacifiCorp diversions on Spring Creek, one approximately 0.1 mile above the PacifiCorp diversion; the other about 0.3 miles below PacifiCorp's diversion. These diversions are commonly referred to as the upper and lower Taylor diversions.

Jenny Creek flows approximately 25 miles before entering Iron Gate Reservoir. Two large reservoirs, Howard Prairie Reservoir and Hyatt Lake, and two smaller reservoirs near the headwaters of Jenny Creek store water during the high runoff season.

#### 2.1 Hydrology

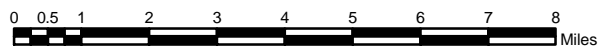
In May 2004 while PacifiCorp was not diverting water from Spring Creek, PacifiCorp measured 9.0 cfs at Shoat Springs (headwaters for Spring Creek), 3.1 cfs immediately below the PacifiCorp diversion, and 6.1 cfs at the bottom of the Spring Creek bypass reach (defined here as the area between the PacifiCorp diversion and the Lower Taylor diversion). When PacifiCorp is diverting water from Spring Creek, there is approximately 0.22 cfs immediately below the diversion and 0.41 cfs at the bottom of the Spring Creek bypass reach (Note: Flows at the bottom of the bypass reach increase due to spring accretion).

Since 1998 the Bureau of Land Management (BLM), Medford District Office, has maintained a stream gage at Jenny Creek approximately 0.5 mile downstream of the Spring Creek confluence. For years 2000 to 2003, the average summer base flow was about 14 cfs and typical winter flows are approximately 110 cfs (Figure 2). However, peak flows of 500 to 800 cfs are not uncommon. Plots of annual average daily discharges for years 2000 through 2003 are included in Appendix A.



**Legend**

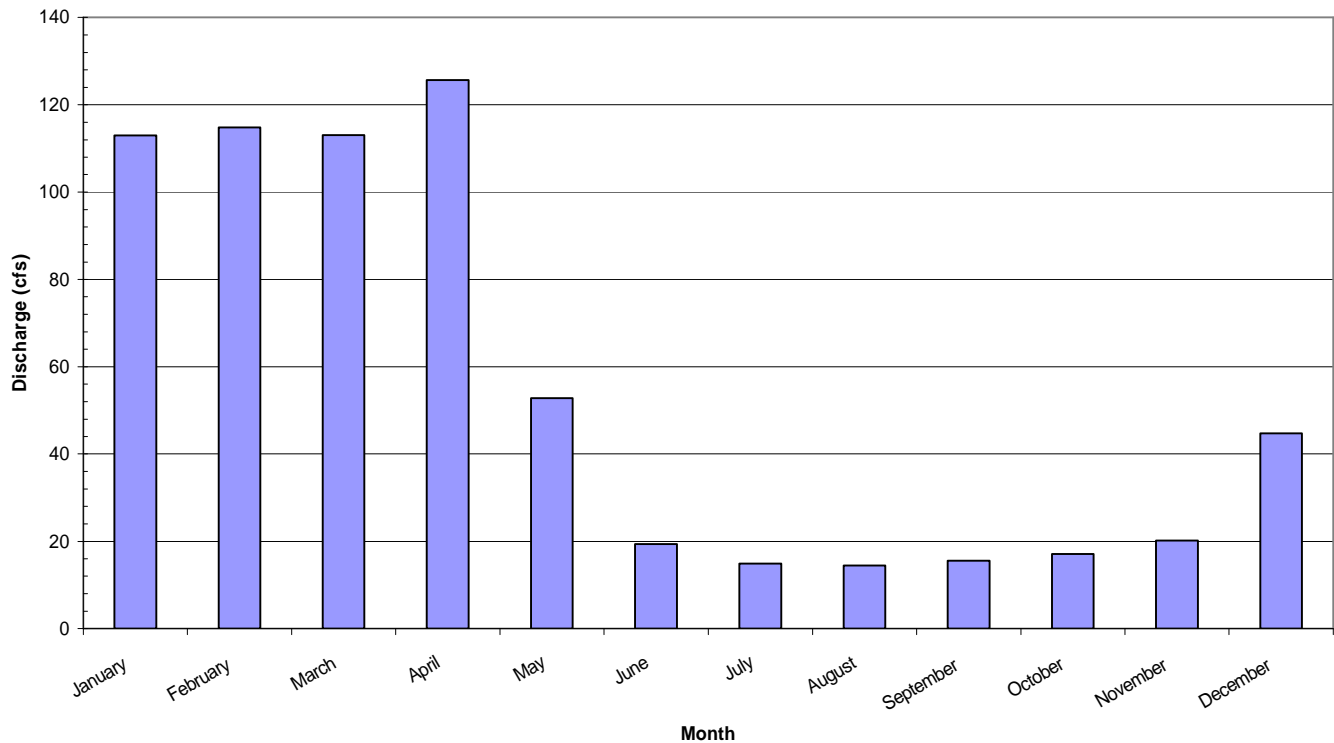
- County
- Roads
- Streams
- Lakes



1 inch equals 14,963 feet

**Klamath Hydroelectric Project**

**Figure 1.**  
Map of Jenny Creek watershed



\*No January or February data for year 2000.

Figure 2.0 Jenny Creek OR/CA Average Monthly Discharge for years 2000\* through 2003 (gage located in Oregon downstream of Spring Creek confluence)

Most of the stored Jenny Creek basin water is diverted into the Rogue River basin to the north. These out-of-basin diversions total approximately 30 percent of the mean annual water yield of the Jenny Creek basin. Water released from the headwater reservoirs into Jenny Creek occurs only when the reservoirs are full. In some years no water is released. In addition, four large ranches in the Jenny Creek basin use small dams to divert water for irrigation.

### 3.0 OBJECTIVES

The Spring Creek diversion supplies water for generation at the Fall Creek Development, diverting water that would have contributed to flows in Jenny Creek. Data collected in this study are used to summarize the general water quality conditions in Spring Creek and Jenny Creek, a tributary of Spring Creek that flows into Iron Gate Reservoir. Temperature, dissolved oxygen, pH, and conductivity measurements conducted under operational and non-operational conditions are described in this report. It should be noted that PacifiCorp is not the sole diverter from Spring Creek and water withdrawal activities beyond PacifiCorp's control affect the water quality in both Spring and Jenny Creeks.

The objectives addressed in this report are as follows:

- Summarize baseline water quality conditions without PacifiCorp diversions from Spring Creek.
- Summarize water quality conditions when PacifiCorp is diverting water from Spring Creek.
- Assess the 7-day average of daily maximum temperatures (7DADM) in studied reaches.
- Provide long-term daily maximum temperature data for Jenny Creek.

## 4.0 METHODS

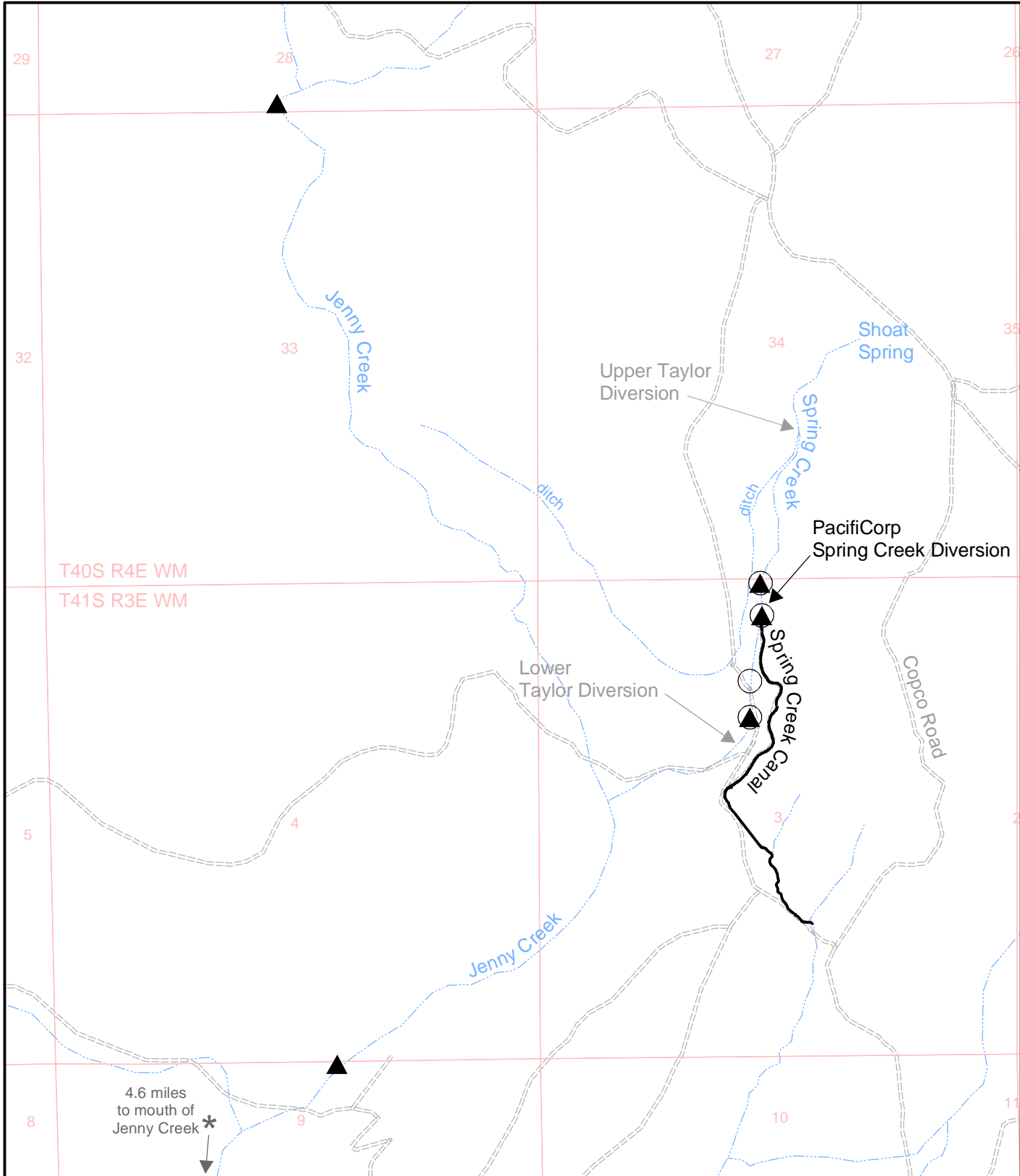
### 4.1 Water Quality Monitoring

PacifiCorp used multiparameter probes to describe water quality conditions during August in Spring and Jenny Creeks with and without PacifiCorp's diversions from Spring Creek. The instruments were programmed to record hourly temperature, dissolved oxygen (DO), pH and conductivity. All probe sensors were calibrated for their specific measured constituents prior to deployment. In-situ calibration of dissolved oxygen to correct for local barometric pressure was completed as a quality assurance measure for the dissolved oxygen data to be collected. Additional dissolved oxygen measurements using the Winkler method and NIST temperature readings provided further data reliability.

During the water quality monitoring, only one flow measurement was made in the Spring Creek bypass reach when the Project was not diverting water from the creek. On August 11, 2004, the flow at the bottom of the bypass reach was 5 cfs.

On August 8, 2004, six multiparameter probes were deployed; above and below the Spring Creek confluence in Jenny Creek, the mouth of Jenny Creek, Spring Creek above the PacifiCorp diversion, and the top and bottom of the Spring Creek bypass reach (Figure 3). To provide background water quality data, the probes were deployed at least 24 hours prior to ceasing to divert water from Spring Creek. However, once the diversion ceased, the probes in Spring Creek were exposed to air and the data collected at the Spring Creek sites were useless. To correct this information gap, a second monitoring event occurred on August 23, 2004, and focused directly on the Spring Creek bypass reach. Four probes were deployed in Spring Creek; 1) above the PacifiCorp diversion, 2) at the top of the bypass reach, 3) the lower bypass reach near the road crossing; and 4) the bottom of the bypass reach.





**Legend**

- |            |   |
|------------|---|
| Section    | <b>Water Quality Monitoring Sites</b>             |
| Facilities | August 23, 2004 Monitoring Sites                  |
| Roads      | August 8, 2004 Monitoring Sites                   |
| Streams    | Monitoring site at mouth of Jenny Creek not shown |
- 0 0.1 0.2 0.4 0.6 0.8 1 Miles  
1 inch equals 1,542 feet



**Klamath Hydroelectric Project**

**Figure 3. Revised**

Locations of water quality monitoring sites on Spring Creek and Jenny Creek

## 4.2 Temperature Monitoring

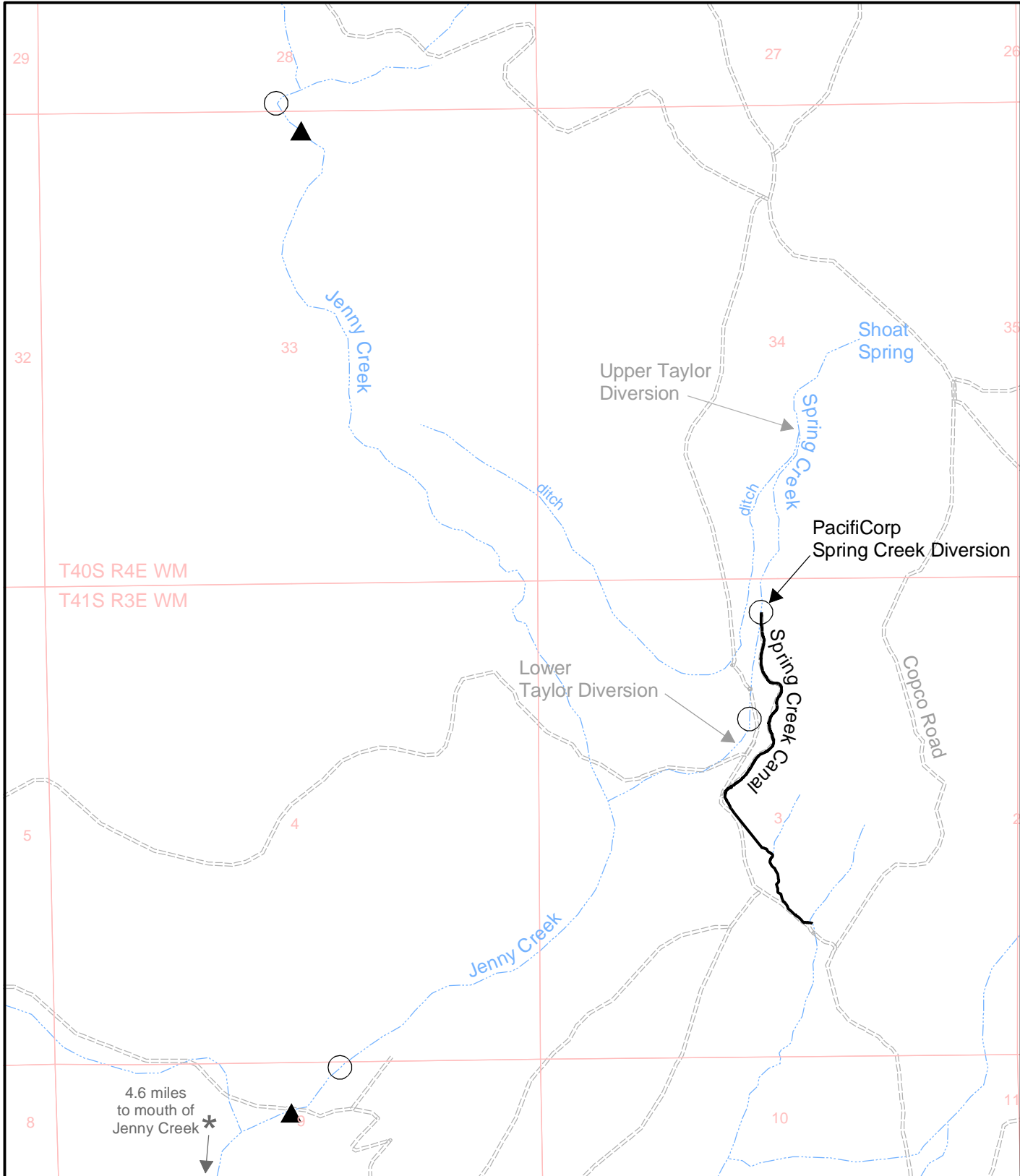
In 2004 PacifiCorp began monitoring water temperatures in the Spring Creek bypass reach and in Jenny Creek to characterize the thermal conditions associated with these aquatic environments. Water temperatures were recorded hourly using OnSet Optic® thermographs. Thermographs were tested for accuracy following procedures outlined in the Water Quality Monitoring Guidebook, part of the Oregon Plan for Salmon and Watersheds (ODEQ 2001). A National Institute of Standards and Technology (NIST) registered digital thermometer was used to cross-check the Tidbit data upon deployment and at each subsequent site visit to download data.

The temperature monitoring sites included: 1) the top of the Spring Creek bypass reach, 2) the bottom of the Spring Creek bypass reach, 3) Jenny Creek above the Spring Creek confluence, 4) Jenny Creek below the Spring Creek confluence; and 5) the mouth of Jenny Creek (Figure 4). The sampling sites and dates monitored are presented in Table 1. In addition, the BLM provided PacifiCorp the temperature data that they have been collecting since 1993 in Jenny Creek above and below the Spring Creek confluence.

Table 1. Locations and monitoring dates of thermographs deployed in Spring and Jenny Creeks. Data acquired from the BLM does not include every month for years listed.

Location	Tidbit #	Monitoring Dates
Top of Spring Creek Bypass Reach.	631776	3/25/04-present
Bottom of Spring Creek Bypass Reach	631773	5/26/04-present
Jenny Cr. above confluence with Spring Cr.	493740	8/12/04-present
Jenny Cr. below confluence with Spring Cr.	735677	4/8/04-present
Jenny Cr. at Mouth	631779	11/24/03-present
Jenny Cr. above Spring Cr. confluence at Box O Ranch S. Boundary – BLM Data	NA	1999-2003
Jenny Cr. below Spring Cr. confluence at Road Crossing – BLM Data	NA	1993, 1995-2002

Analysis of the temperature data was conducted using Oregon Department of Environmental Quality (ODEQ) Hydrostat Macro. This program, developed by ODEQ, is designed to calculate and plot 7-day moving averages, i.e., the average of the maximum daily temperature occurring over a 7-day period. The program also calculates minimum, maximum and delta values (difference between daily maximum and minimum), and allows the user to qualify a data point that appears erroneous, due for example to exposure of the thermograph to air.



**Legend**

- |            |                                     |   |
|------------|-------------------------------------|---|
| Section    | <b>Temperature Monitoring Sites</b> |   |
| Facilities | PacifiCorp Monitoring Sites         | Temperature monitoring site at mouth of Jenny Creek not shown |
| Roads      | BLM Monitoring Sites                |   |
| Streams    |                                     |   |
- 0 0.1 0.2 0.4 0.6 0.8 1 Miles  
1 inch equals 1,542 feet



**Klamath Hydroelectric Project**

**Figure 4. Revised**

Locations of temperature monitoring sites on Spring Creek and Jenny Creek

## 5.0 RESULTS

PacifiCorp deployed multiparameter probes twice in August 2004 to assess what effect, if any, the Spring Creek diversion has on water quality in Spring and Jenny Creeks. The probes were deployed at least 24 hours prior to ceasing diversions from Spring Creek to capture background water quality conditions. Thermographs were used in Spring and Jenny Creeks to describe the thermal regime. The results of these efforts are presented below.

### 5.1 August 8, 2004 Monitoring

Six YSI multiparameter probes were deployed in three locations in Jenny Creek and three in Spring Creek on August 8, 2004, starting at 1:00 PM under diverted flow conditions. The Jenny Creek monitoring stations were located above and below its confluence with Spring Creek and at the mouth upstream of the influence of Iron Gate reservoir. Probes remained in place until August 12 at 1:00 PM following a 48 hour period of un-diverted flows in the Spring Creek bypass reach. Upon retrieval of the probes and analysis of the data it was determined that the two probes in the Spring Creek bypass reach had become exposed to air prior to flow reduction, and the data were not used. The following sections are the results of data collection at three sites in Jenny Creek during the first monitoring event.

#### 5.1.1 Dissolved Oxygen

While PacifiCorp was diverting water from Spring Creek, DO levels in Jenny Creek ranged from 7.2 to 9.9 mg/L, with average readings varying from 8.0 to 8.9 mg/L at all three sites. Although the most downstream station near the mouth of Jenny Creek had the highest average dissolved oxygen level, the highest single hourly reading was captured at the most upstream site above the confluence with Spring Creek (Figure 5). The lowest recorded level (7.2 mg/L) occurred below the confluence with Spring Creek. A summary of the results are provided below (Table 2).

Table 2. Dissolved oxygen levels recorded at three locations in Jenny Creek on 8/8/04 through 8/12/04 with and without diversions from Spring Creek.

Location	Minimum Dissolved Oxygen (mg/L)	Maximum Dissolved Oxygen (mg/L)	Average Dissolved Oxygen (mg/L)
8/8/04 through 8/10/04 – Project Actively Diverting			
Jenny Cr. above confluence with Spring Cr	7.6	9.9	8.6
Jenny Cr. below confluence with Spring Cr.	7.2	9.2	8.0
Jenny Cr. at Mouth	8.2	9.7	8.9
8/10/04 through 8/12/04 – Project Not Diverting			
Jenny Cr. above confluence with Spring Cr.	7.3	9.8	8.4
Jenny Cr. below confluence with Spring Cr.	7.7	9.9	8.6
Jenny Cr. at Mouth	8.1	9.8	8.8

When PacifiCorp was not diverting water from Spring Creek, DO levels in Jenny Creek ranged from 7.3 to 9.9 mg/l (Table 2). During this period, DO levels were lower above the Spring Creek confluence, a site unaffected by Project operations, and consistently higher below the confluence. Dissolved oxygen remained virtually the same at the mouth of Jenny Creek (Figure 5.0).

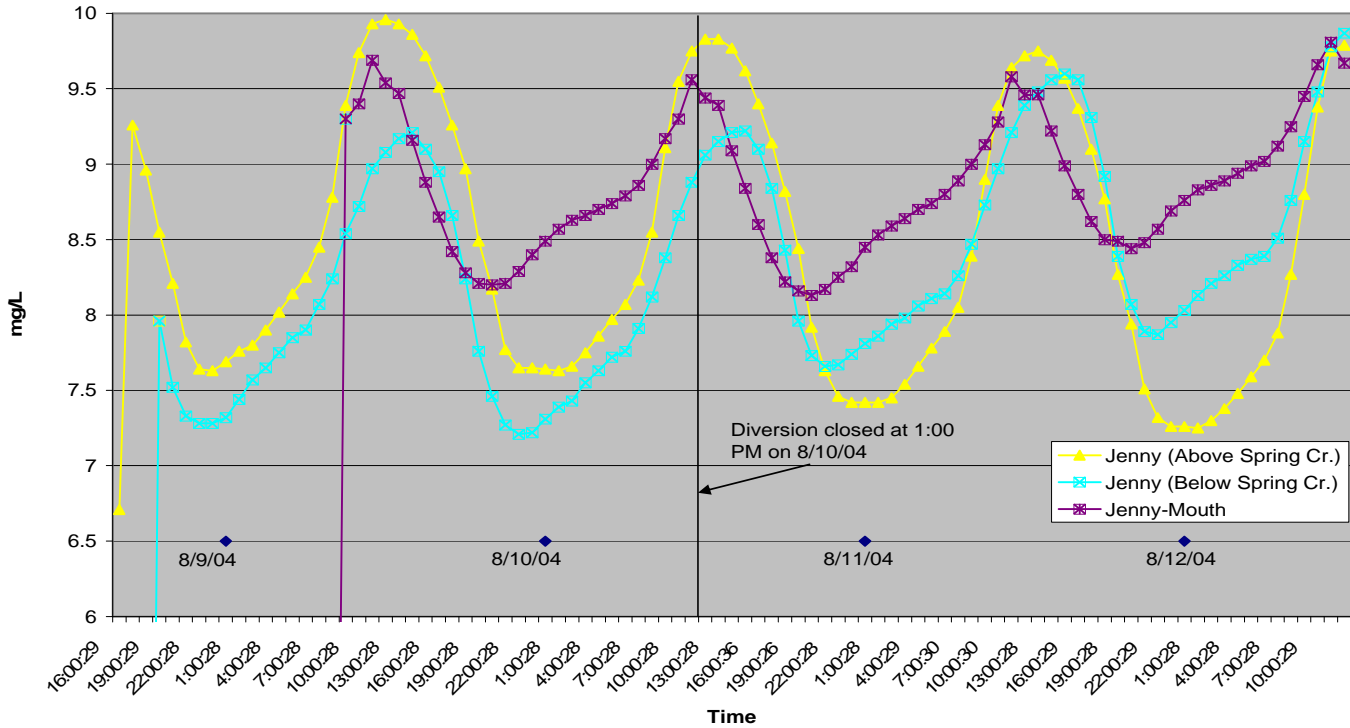


Figure 5.0 Dissolved oxygen levels recorded at three locations in Jenny Creek on 8/8/04 through 8/12/04 with and without diversions from Spring Creek.

### 5.1.2 Temperature

With PacifiCorp was diverting water from Spring Creek, temperatures recorded in Jenny Creek ranged from 16.4 to 26.1° C (Table 3). Maximum daily temperatures at the mouth of Jenny Creek were consistently lower than either of the upstream sites. The lowest recorded hourly temperature (16.4° C) occurred at the site below the confluence with Spring Creek. Average temperatures were consistent among sites and varied by only 0.7° C. The site at the mouth of Jenny Creek showed the least variation in minimum and maximum temperatures as well as the lowest average temperature.

Table 3. Stream temperatures recorded at three locations in Jenny Creek on 8/8/04 through 8/12/04 with and without diversions from Spring Creek.

Location	Minimum Temperature (°C)	Maximum Temperature (°C)	Average Temperature (°C)
8/8/04 through 8/10/04 – Project Actively Diverting			
Jenny Cr. above confluence with Spring Cr.	16.9	25.0	20.9
Jenny Cr. below confluence with Spring Cr.	16.4	26.1	20.5
Jenny Cr. at Mouth	17.9	22.4	20.2
8/10/04 through 8/12/04 – Project Not Diverting			
Jenny Cr. above confluence with Spring Cr.	18.7	26.6	22.5
Jenny Cr. below confluence with Spring Cr.	16.1	26.3	20.1
Jenny Cr. at Mouth	19.5	23.3	21.2

When PacifiCorp did not divert water from Spring Creek, temperatures ranged from 16.1 to 26.6° C. The site above the confluence with Spring Creek is not affected by Project operations yet this temperature increased (Figure 6.0). Even though the average water temperature at the site below the Spring Creek confluence had the least variation among the sites when water was not diverted from Spring Creek, there was a downward shift in the diel cycle (Figure 6).

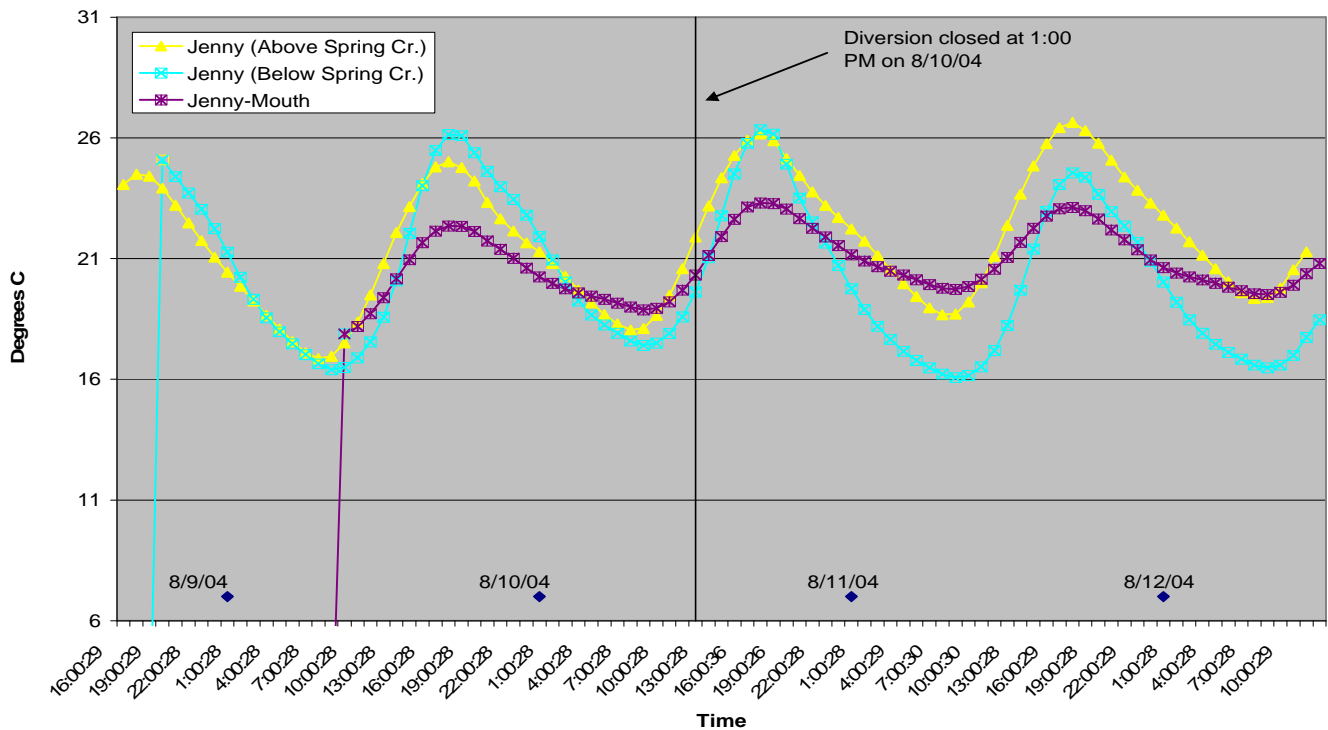


Figure 6.0 Stream temperatures recorded at three locations in Jenny Creek on 8/8/04 through 8/12/04 under diverted and un-diverted flow conditions in the Spring Creek bypass reach.

### 5.1.3 pH

pH values while diverting water from Spring Creek ranged from 7.9 to 8.7 (Table 4). Readings were consistently higher at the most upstream sampling site with diel peaks reaching 8.7 (Figure 7.0). The site below the confluence with Spring Creek had the lowest minimum, maximum and average pH values.

Table 4. pH values recorded at three locations in Jenny Creek on 8/8/04 through 8/12/04 with and without diversions from Spring Creek.

Location	Minimum pH	Maximum pH	Average pH
8/8/04 through 8/10/04 – Project Actively Diverting			
Jenny Cr. above confluence with Spring Cr.	8.0	8.7	8.3
Jenny Cr. below confluence with Spring Cr.	7.9	8.5	8.1
Jenny Cr. at Mouth	8.2	8.6	8.3
8/10/04 through 8/12/04 – Project Not Diverting			
Jenny Cr. above confluence with Spring Cr.	7.9	8.8	8.3
Jenny Cr. below confluence with Spring Cr.	7.9	8.6	8.2
Jenny Cr. at Mouth	8.1	8.6	8.3

During the period when PacifiCorp was not diverting from Spring Creek, pH levels remained similar at all sites, ranging from 7.9 to 8.8 (Table 4). A decrease in the minimum and maximum pH values did occur at the site located at the mouth of Jenny Creek. This is not exhibited until August 11<sup>th</sup> on the second diel cycle following the cessation of diversion (Figure 7.0). Virtually no change in pH occurred at either the site above or below the confluence with Spring Creek. pH levels remained stable at both of these sites, only showing the typical diel swings also exhibited in both the temperature and dissolved oxygen data collected.

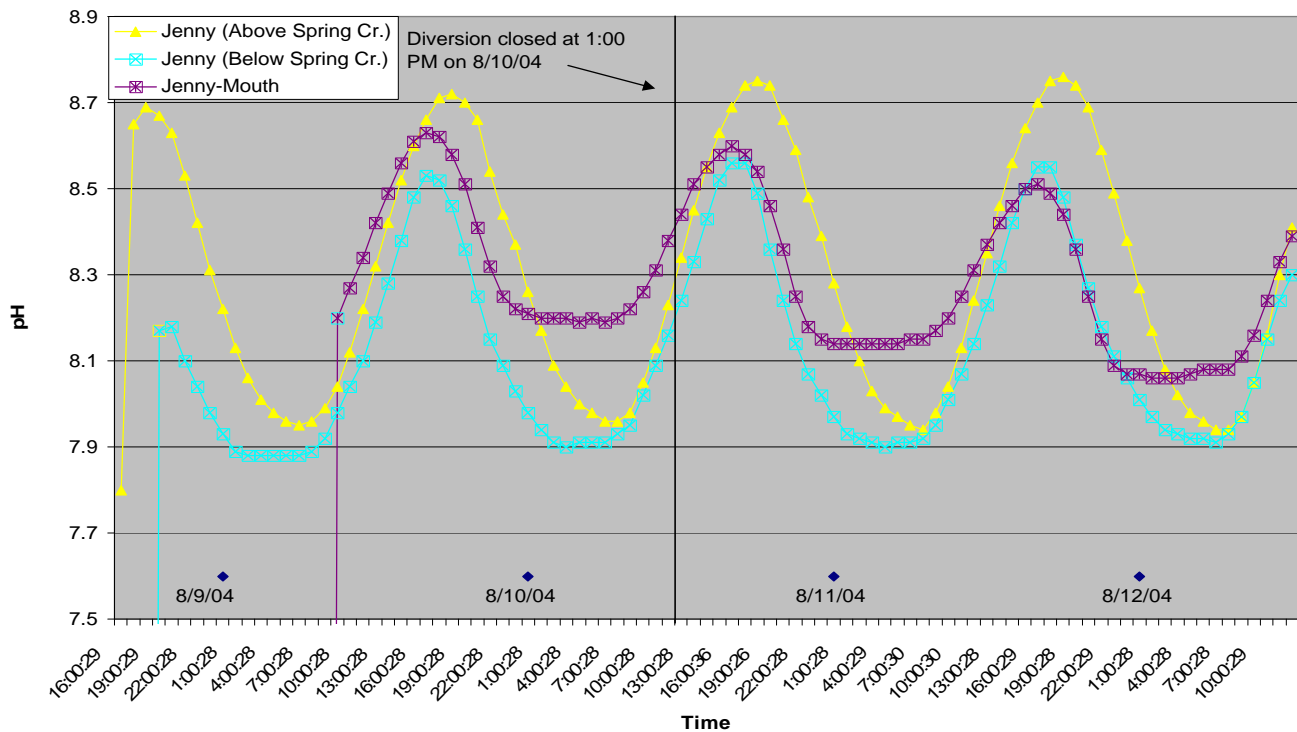


Figure 7.0 pH values recorded at three locations in Jenny Creek on 8/8/04 through 8/12/04 under diverted and un-diverted flow conditions in the Spring Creek bypass reach.

#### 5.1.4 Conductivity

Specific conductance ranged from 0.19 to 0.26 mS/cm at all sites during diversions from Spring Creek (Table 5). Measurements above the confluence with Spring Creek were consistently higher than either of the other two sites. The site below the confluence of Spring Creek had the lowest readings when compared to the other two sites.

Table 5. Specific conductance recorded at three locations in Jenny Creek on 8/8/04 through 8/12/04 with and without diversions from Spring Creek.

Location	Minimum Specific Conductance	Maximum Specific Conductance	Average Specific Conductance
8/8/04 through 8/10/04 – Project Actively Diverting			
Jenny Cr. above confluence with Spring Cr.	0.25	0.26	0.26
Jenny Cr. below confluence with Spring Cr.	0.19	0.20	0.19
Jenny Cr. at Mouth	0.21	0.22	0.21
8/10/04 through 8/12/04 – Project Not Diverting			
Jenny Cr. above confluence with Spring Cr.	0.25	0.26	0.25
Jenny Cr. below confluence with Spring Cr.	0.17	0.19	0.18
Jenny Cr. at Mouth	0.19	0.22	0.20



When water was not diverted from Spring Creek, there was a slight decrease in specific conductance below the Spring Creek confluence and at the mouth of Jenny Creek (Figure 8.0). The change in specific conductance was relatively minor and ranged from 0.02 to 0.03 Ms/cm.

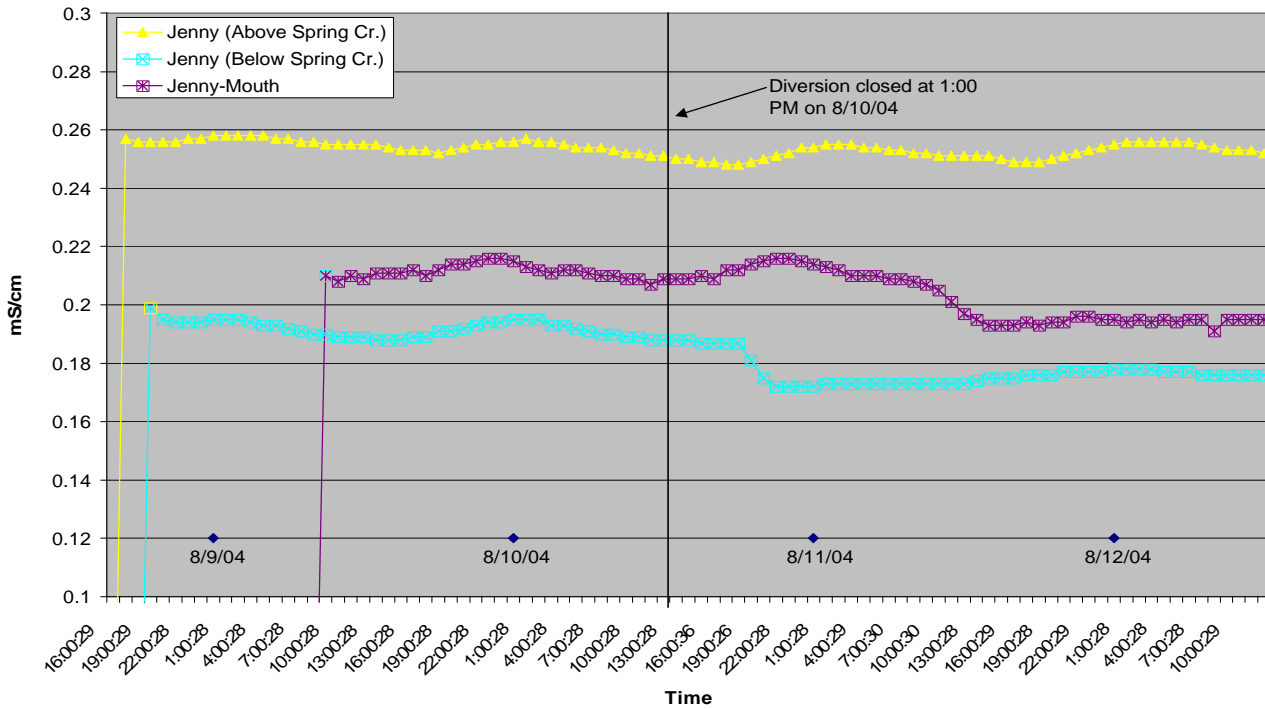


Figure 8.0 Specific conductance recorded at three locations in Jenny Creek on 8/8/04 through 8/12/04 under diverted and un-diverted flow conditions in the Spring Creek bypass reach.

## 5.2 August 23, 2004 Monitoring

PacifiCorp monitored water quality for a second time in the Spring Creek bypass reach on August 23, 2004. During the first event previously discussed, the probes deployed in Spring Creek had become exposed to air prior to the closure of the diversion and the subsequent flow increase in the bypass reach. On August 23, 2004, PacifiCorp deployed three YSI multiparameter probes in the Spring Creek bypass reach and one above the diversion to describe any changes in water quality that may occur due to Project operations (Figure 3). The Project diverted water from Spring Creek from the time of deployment until August 25, 2004 when diversions ceased. Data was collected under diverted flow conditions for approximately 50 hours. The probes remained in place until 9:00 A.M on August 27<sup>th</sup>, following a period of 45 hours of undiverted flows. Results of this monitoring event are described below by water quality parameter.

### 5.2.1 Dissolved Oxygen

Dissolved oxygen levels recorded in Spring Creek while PacifiCorp diverted water from the creek ranged from 9.4 mg/L to 11.7 mg/L at the four sites monitored (Table 6). The site monitored near the road crossing exhibited the highest dissolved oxygen levels during the reduced flow period, while the site at the upper end of the bypass reach generally had the lowest readings.

Table 6. Dissolved Oxygen recorded at four locations in Spring Creek on 8/23/04 through 8/27/04 with and without diversions from Spring Creek.

Location	Minimum Dissolved Oxygen (mg/L)	Maximum Dissolved Oxygen (mg/L)	Average Dissolved Oxygen (mg/L)
8/23/04 through 8/25/04 – Project Actively Diverting			
Spring Creek above diversion	10.1	11.3	10.6
Top of bypass reach	9.4	10.3	9.9
Bypass reach at road crossing	10.4	11.7	11.2
Bottom of bypass reach	9.6	10.8	10.3
8/25/04 through 8/27/04 – Project Not Diverting			
Spring Creek above diversion	9.8	11.7	10.6
Top of bypass reach	9.1	10.4	9.7
Bypass reach at road crossing	11.1	12.6	11.6
Bottom of bypass reach	10.5	11.5	11.0

Dissolved oxygen levels remained fairly consistent following closure of the intake canal headgates. Average readings for the two sites increased by 0.4 and 0.7 mg/L for the road crossing site and the site at the bottom of the bypass reach respectively. A slight decrease (0.2 mg/L) in average DO occurred at the top of the bypass reach (Figure 9.0).

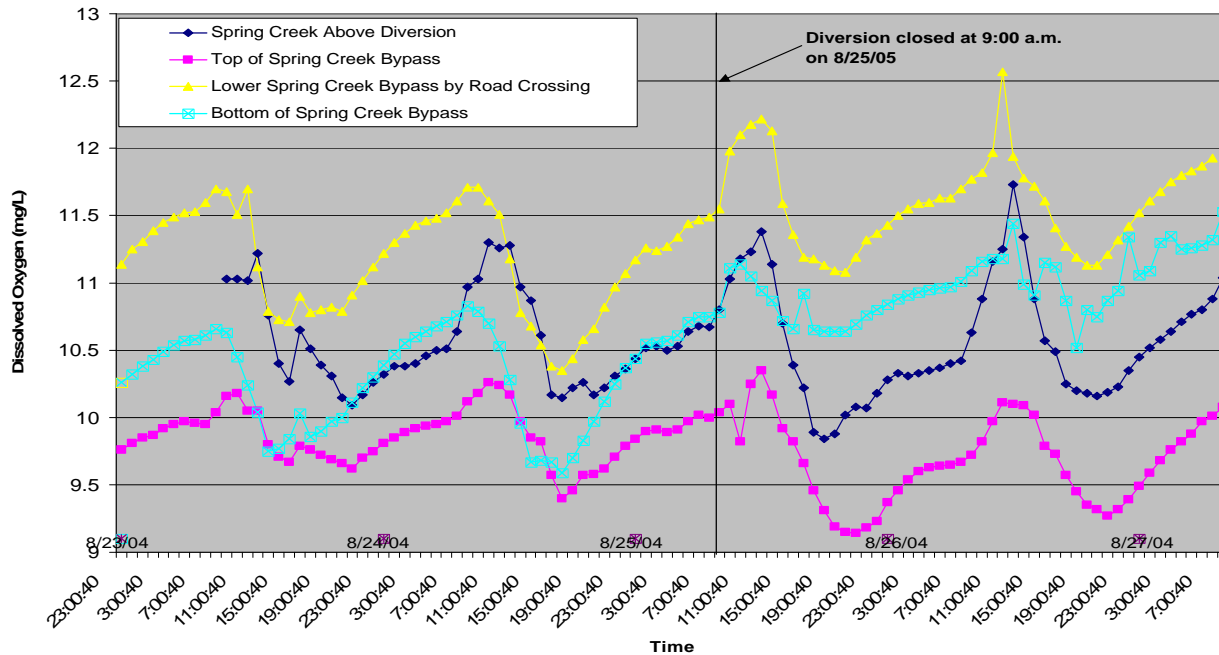


Figure 9.0 Dissolved oxygen recorded at four locations in Spring Creek on 8/23/04 through 8/27/04 under diverted and un-diverted flow conditions in the Spring Creek bypass reach.

### 5.2.2 Temperature

Average temperatures ranged from 10.8 to 11.9°C at all sites while PacifiCorp diverted water from Spring Creek (Table 7). The lowest recorded temperatures occurred at the top of the bypass reach (9.4°C) while the highest was recorded at the site near the road crossing (16.3°C). All sites exhibit fairly consistent diel swings with peak temperatures occurring in late afternoon and lows in the mid morning hours.

Table 7. Stream temperatures recorded at four locations in Spring Creek on 8/23/04 through 8/27/04 with and without diversions from Spring Creek.

Location	Minimum Temperature (°C)	Maximum Temperature (°C)	Average Temperature (°C)
8/23/04 through 8/25/04 – Project Actively Diverting			
Spring Creek above diversion	9.5	14.3	11.1
Top of bypass reach	9.4	14.3	10.8
Bypass reach at road crossing	9.8	16.3	11.9
Bottom of bypass reach	10.1	15.7	11.9
8/25/04 through 8/27/04 – Project Not Diverting			
Spring Creek above diversion	8.9	15.0	11.3
Top of bypass reach	9.0	14.9	11.7
Bypass reach at road crossing	9.1	12.9	10.9
Bottom of bypass reach	9.3	11.9	10.6

When diversions from Spring Creek ceased, there was an immediate temperature response at the two lower bypass locations (Figure 10.0). The flow change occurred during the low temperature range of the diel cycle. Both minimum and maximum temperature values recorded by the two probes in the lower portion of the bypass reach were reduced by the increased flow. Minimum temperature readings were similar among all sites following the cessation of diversions. The most notable change is the reduction in daily maximum temperatures in the two lower bypass reach sites.

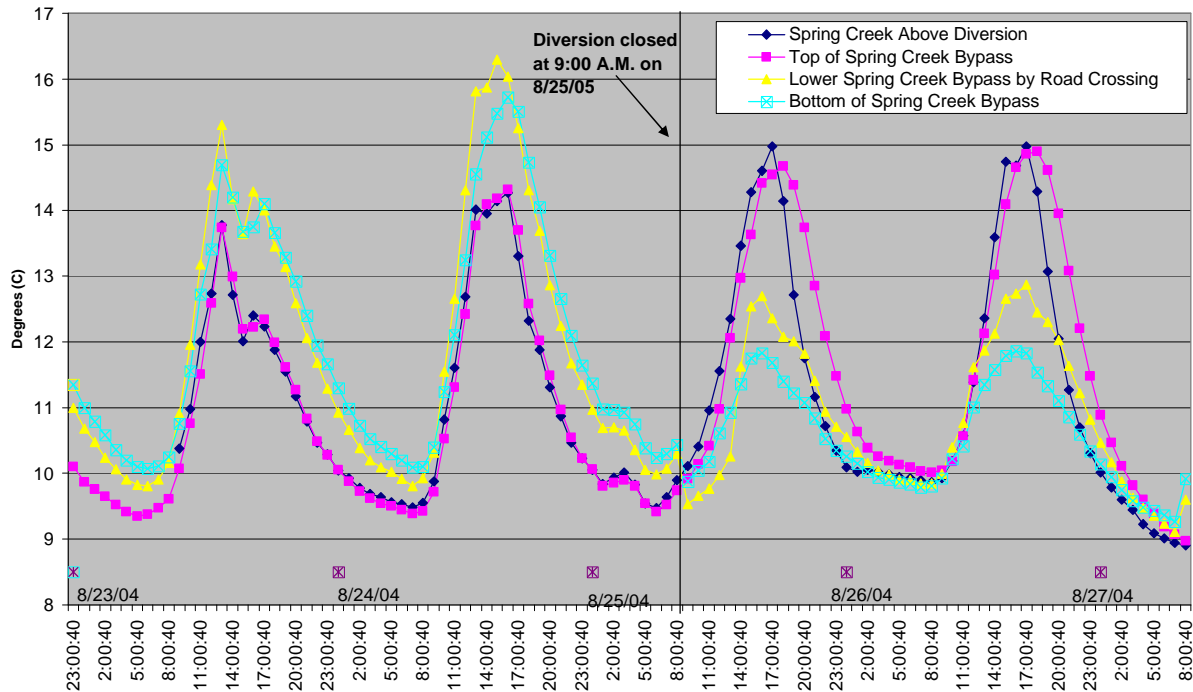


Figure 10.0 Stream temperatures (°C) recorded at four locations in Spring Creek on 8/23/04 through 8/27/04 with and without diversions from Spring Creek.

### 5.2.3 pH

pH values ranged from 7.7 to 8.1 at all monitoring locations while PacifiCorp diverted water from Spring Creek. There was very little difference among the minimum, maximum and average values (Table 8).

Table 8. pH recorded at four locations in Spring Creek on 8/23/04 through 8/27/04 with and without diversion from Spring Creek.

Location	Minimum pH	Maximum pH	Average pH
8/23/04 through 8/25/04 – Project Actively Diverting			
Spring Creek above diversion	7.7	8.0	7.8
Top of bypass reach	7.9	8.1	8.0
Bypass reach at road crossing	7.8	7.9	7.8
Bottom of bypass reach	8.0	8.1	8.0
8/25/04 through 8/27/04 – Project Not Diverting			
Spring Creek above diversion	7.9	8.1	8.0
Top of bypass reach	7.8	8.0	7.9
Bypass reach at road crossing	7.8	7.9	7.8
Bottom of bypass reach	7.9	8.0	7.9

Although a minor decrease in pH values at the two lowermost bypass reach sites was noted following the cessation of diversion, the overall pH ranges in the bypass reach sites virtually remained the same. There was a decrease in the diel cycle at these two locations (Figure 11). Even though the site above the diversion is not affected by Project operations, there was a trend of increasing pH values above the diversion during this monitoring event.

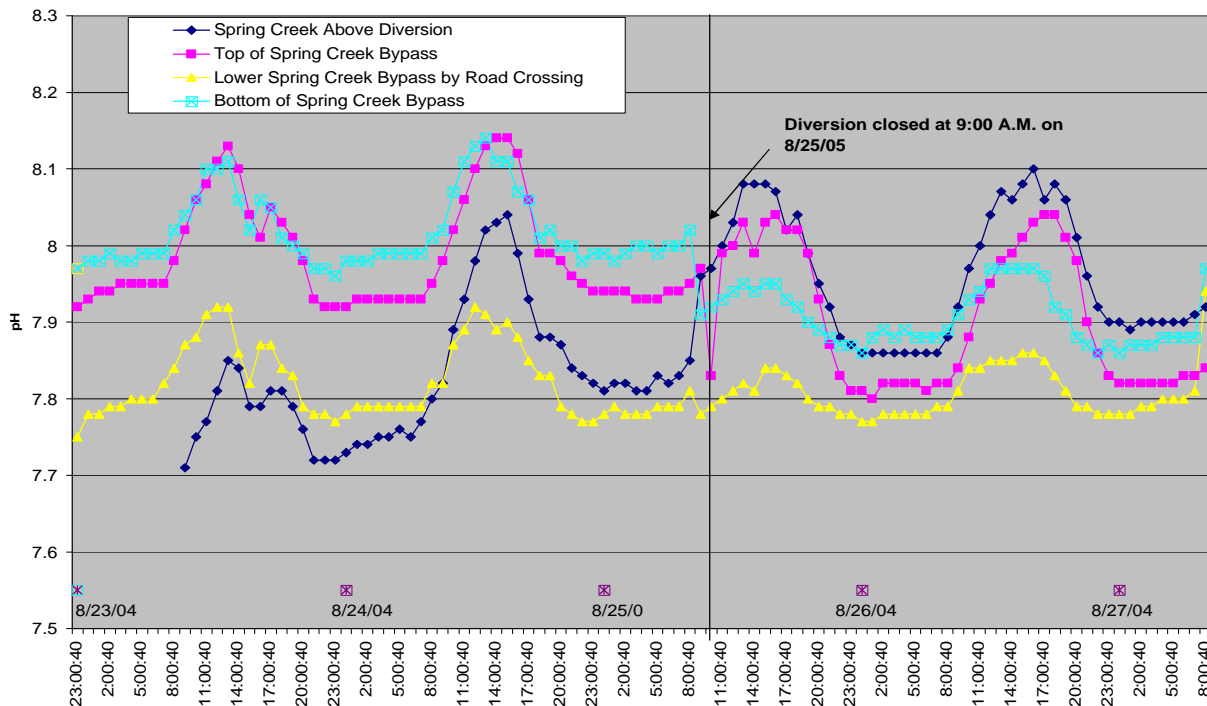


Figure 11.0 pH recorded at four locations in Spring Creek on 8/23/04 through 8/27/04 under diverted and un-diverted flow conditions in the Spring Creek bypass reach.

### 5.2.4 Conductivity

Specific conductance was similar with and without diversions from Spring Creek (Table 9, Figure 12). Generally, all measurements remained within 0.01 mS/cm at all sites, averaging either .14 to .16 mS/cm. This lack in variation may be related to the spring source of this water, the short distance between the source and the monitoring location, and absence of other surface water input within the reach. The slight fluctuations (within 0.03 mS/cm) in specific conductance at the lower sites may have been related to the spring accretion that occurs at the lower end of the bypass reach. This data corroborates with results of the prior monitoring event which indicated the lowest conductance in Jenny Creek at the site below the confluence of Spring Creek.

Table 9. Conductivity recorded at four locations in Spring Creek on 8/23/04 through 8/27/04 with and without diversion from Spring Creek .

Location	Minimum Conductivity	Maximum Conductivity	Average Conductivity
8/23/04 through 8/25/04 – Project Actively Diverting			
Spring Creek above diversion	.15	.15	.15
Top of bypass reach	.15	.16	.15
Bypass reach at road crossing	.16	.16	.16
Bottom of bypass reach	.15	.16	.16
8/25/04 through 8/27/04 – Project Not Diverting			
Spring Creek above diversion	.15	.15	.15
Top of bypass reach	.15	.16	.15
Bypass reach at road crossing	.15	.15	.15
Bottom of bypass reach	.12	.15	.14

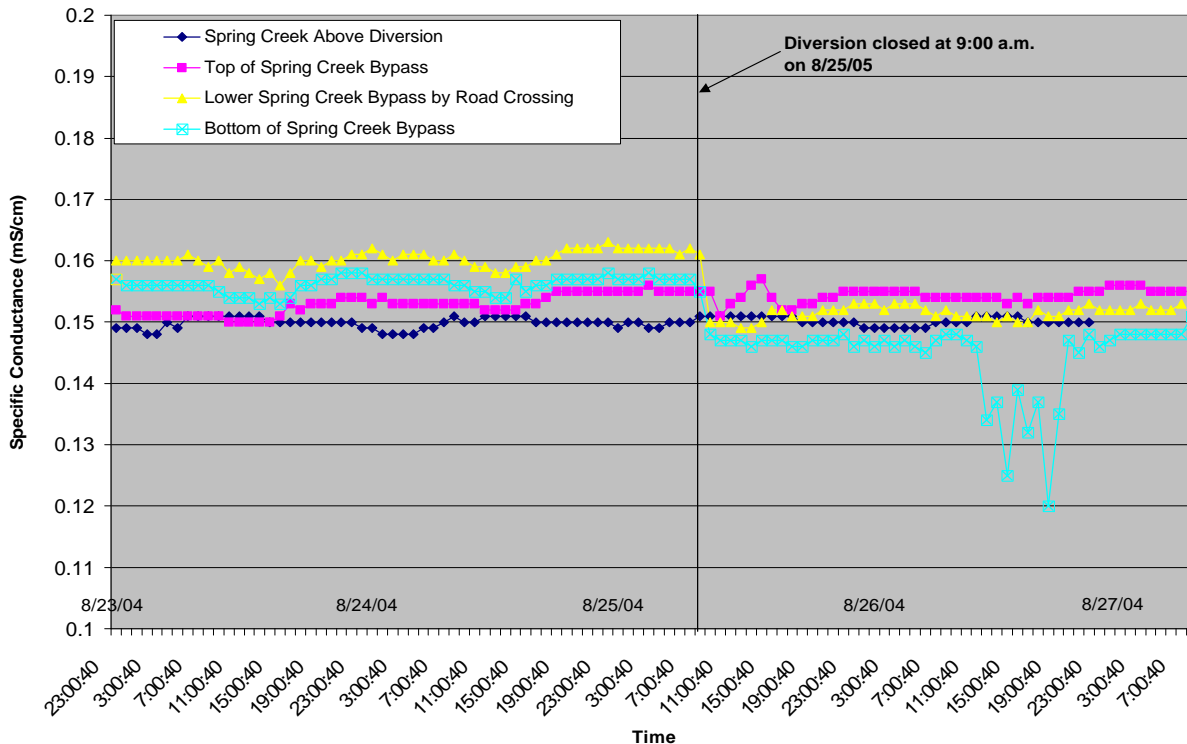


Figure 12.0 Specific conductance recorded at four locations in Spring Creek on 8/23/04 through 8/27/04 under diverted and un-diverted flow conditions in the Spring Creek bypass reach.

### 5.3 Temperature Monitoring

PacifiCorp continuously monitored stream temperatures in both the Spring Creek bypass reach and in Jenny Creek. The following section describes the results of this monitoring. Temperature is presented in general terms (minimum, maximum, and average), and as 7DADM for each site (Table 10). Additional Jenny Creek stream temperature data provided by the U.S. Bureau of Land Management (BLM) is also included in this analysis. The BLM data was collected in Jenny Creek above and below the Spring Creek confluence.

Table 10. Location and data collection period for the five PacifiCorp deployed thermistors used in this analysis.

SITE LOCATION	DATES MONITORED
Top of Spring Creek Bypass Reach.	3/26/04 – 10/19/04
Bottom of Spring Creek Bypass Reach	5/27/04 – 10/19/04
Jenny Cr. above confluence with Spring Cr.	8/12/04 – 10/19/04
Jenny Cr. below confluence with Spring Cr.	4/8/04 – 10/19/04
Jenny Cr. at Mouth	3/26/04 – 10/19/04

#### 5.3.1 General Temperature Analysis

Temperature data from the warmest part of the year (June through September) is presented in Table 11. Average and maximum stream temperatures recorded at all locations were the highest in July. Maximum stream temperatures in both Jenny and Spring Creeks ranged 17.1 to 27.1°C for the June through September period. In general, water temperatures were cooler in Spring Creek than those measured in Jenny Creek. The monitoring site located at the top of the Spring Creek bypass reach had the lowest temperatures with the exception of the September minimum temperature. A minimum temperature of 5.7°C was recorded at the bottom of the Spring Creek bypass reach for this month.

Table 11. Minimum, maximum, and average stream temperatures recorded at five locations in Spring in Jenny Creeks from June through September 2004.

LOCATION	June			July		
	Min	Max	Avg	Min	Max	Avg
Top of Spring Cr. Bypass Reach	7.6	19.3	11.5	9.1	20.3	12.7
Bottom of Spring Cr. Bypass Reach	7.6	21.4	12.9	9.8	22.4	14.2
Jenny Cr. above confluence with Spring Cr.	NA	NA	NA	NA	NA	NA
Jenny Cr. below confluence with Spring Cr.*	12.2	21.9	17.1	17.2	24	20.4
Jenny Cr. at mouth	12.2	22.7	17.7	16.9	24.6	20.6
LOCATION	August			September		
	Min	Max	Avg	Min	Max	Avg
Top of Spring Cr. Bypass Reach	9	19	12.4	6.6	17.1	10.5
Bottom of Spring Cr. Bypass Reach	9.1	20.7	12.8	5.7	18.7	11.4
Jenny Cr. above confluence with Spring Cr.	13.5	26.8	19.9	8.1	21.4	14.5
Jenny Cr. below confluence with Spring Cr.	13	27.1	19.4	8.6	21.8	14.9
Jenny Cr. at mouth	14.7	23.7	19.1	9.6	19.9	14.5

\* Data not available until 8/12/04

### 5.3.2 Seven-Day Moving Average of the Daily Maximum Temperatures

#### 5.3.2.1 Spring Creek

The 7DADM in Spring Creek gradually increased in June, peaked in July and began to decline in August (Figures 13). The 7DADM temperatures were slightly higher at the bottom of the Spring Creek bypass reach than at the upper Spring Creek monitoring site. This indicates a general warming of the water in Spring Creek as it travels downstream.

#### 5.3.2.2 Jenny Creek

Temperature monitoring at the Jenny Creek above Spring Creek confluence site did not begin until August. However, the 7DADM temperatures for the two Jenny Creek sites located above and below the confluence of Spring Creek show similar trends and values (Figure 14). Data indicates that in Jenny Creek, both above and below the confluence with Spring Creek, 7DADM temperatures exceeded 25°C during the warmest portion of the year. Temperatures were slightly cooler at the mouth of Jenny Creek and the 7DADM never reached 25°C.

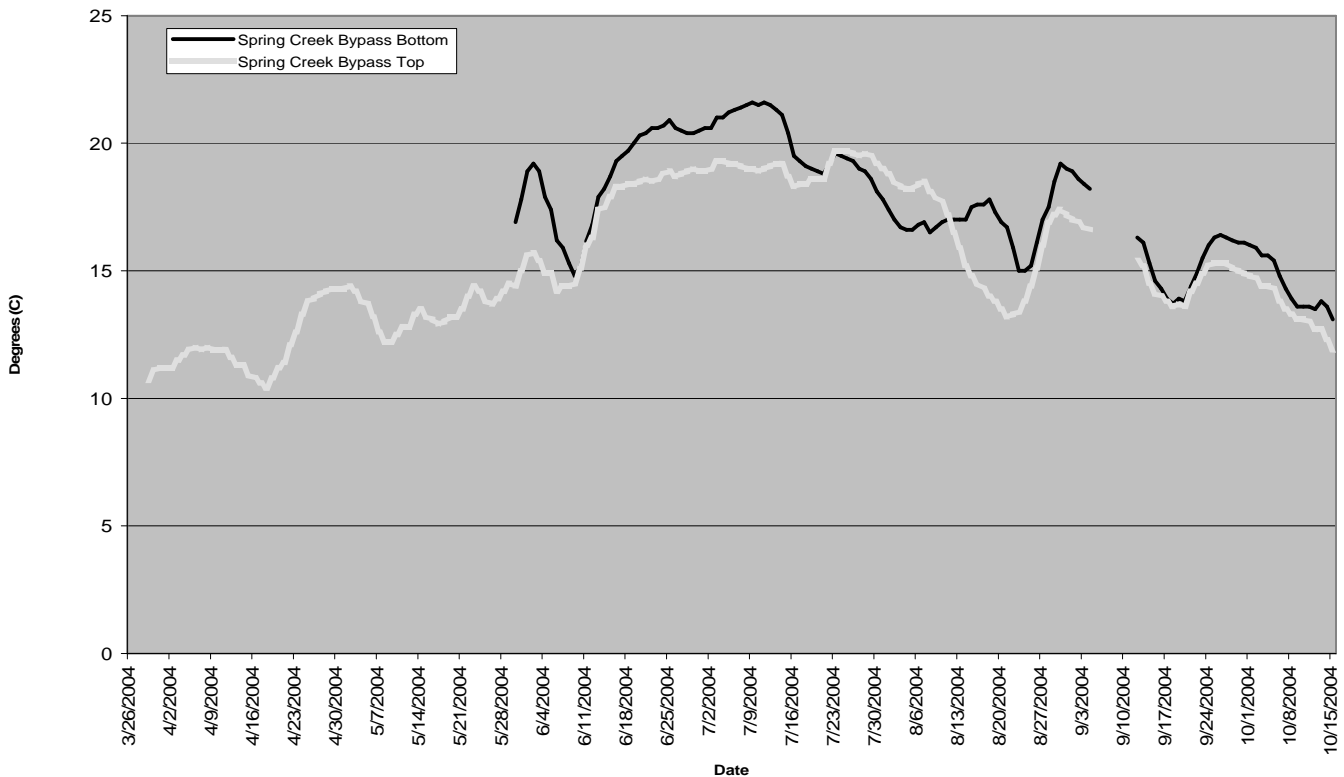


Figure 13.0 7DADM temperatures recorded in the Spring Creek bypass reach in 2004.



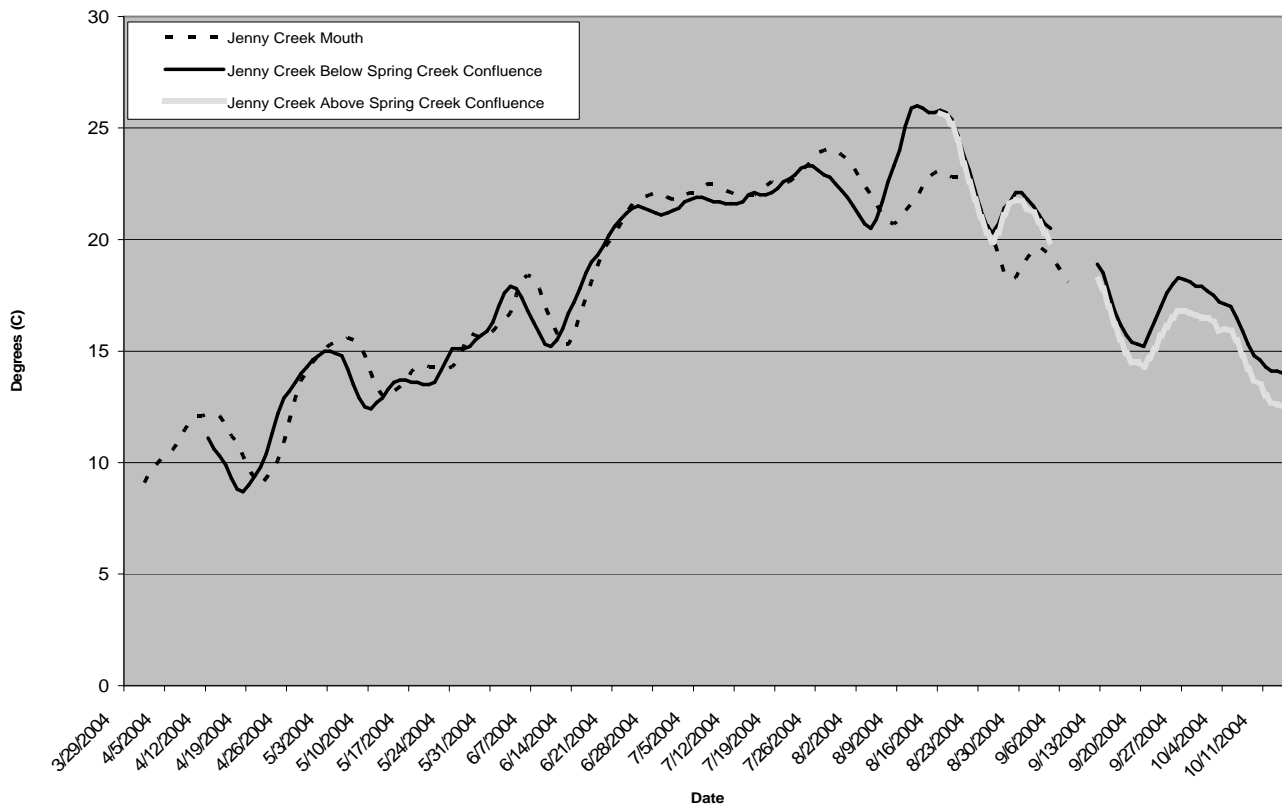


Figure 14.0 7DADM temperatures recorded in three locations in Jenny Creek in 2004.

### 5.3.3 Analysis of BLM Jenny Creek Temperature Data

Multiple years of stream temperature data collected by the BLM at two locations in Jenny Creek were used to describe trends in daily maximum stream temperatures. Data was collected at a location above the confluence of Spring Creek (below Oregon Gulch at Box O Ranch) and below the confluence with Spring Creek. For this analysis only data collected between April 25 and October 15 for each available year of data was used.

Generally, the 7DADM temperatures exceeded 15°C starting in the middle of June and continued through the end of September at both locations (Figures 15 and 16). In all years at both sites 7DADM temperatures always exceeded 18°C by the middle of June reaching 20°C by the end of June.

**7 Day Moving Average of the Daily Maximum Temperatures Recorded Below Oregon Gulch at Box O Ranch (Above the Confluence with Spring Creek)**

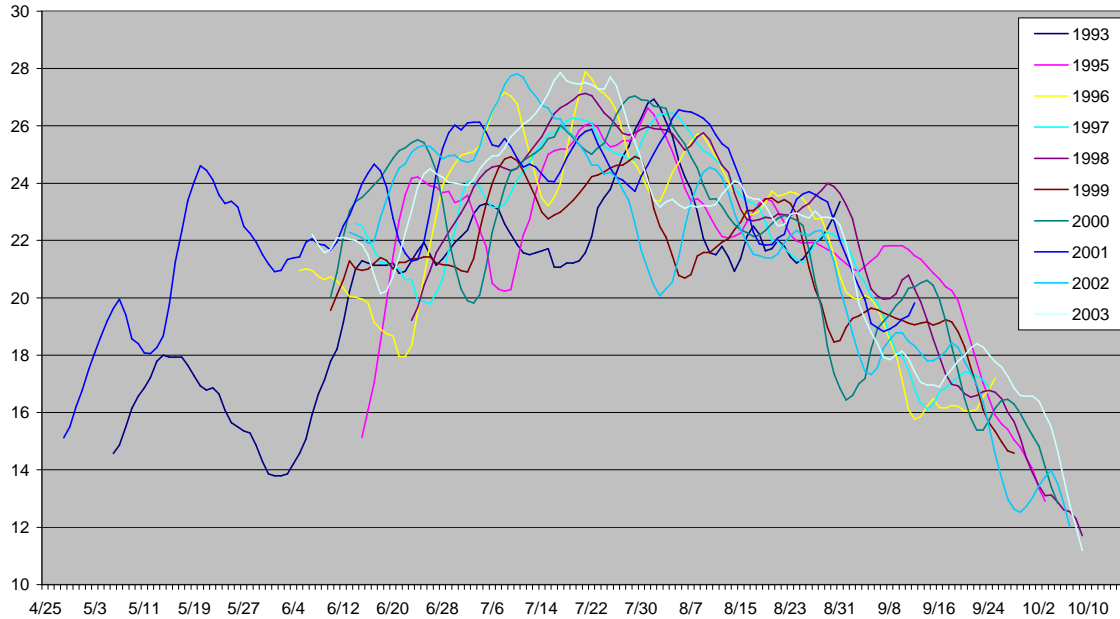


Figure 15.0 7DADM temperatures recorded in Jenny Creek below Oregon Gulch at the Box O Ranch (above the confluence with Spring Creek). Data provided courtesy of BLM.

**7 Day Moving Average of the Daily Maximum Temperatures Recorded Below the Confluence with Spring Creek**

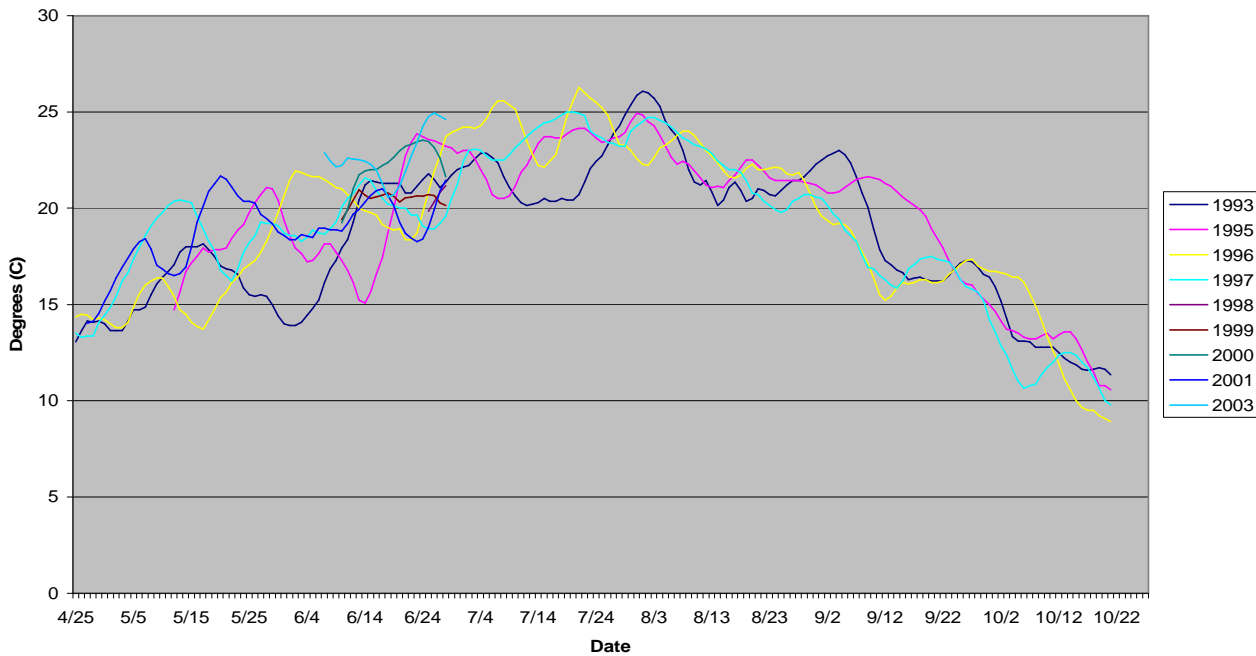


Figure 16.0 7DADM temperatures recorded in Jenny Creek below the confluence with Spring Creek. Data provided courtesy of BLM.

Since the BLM data were collected when PacifiCorp was not diverting water from Spring Creek, a comparison was made between the above and below Spring Creek confluence sites for several years to describe thermal conditions absent PacifiCorp's operations. Only the warmest portion of the year was examined (June – September) and the years 1995 to 1997 were selected for comparisons since these data sets were the most complete.

7DADM temperature values for the two sites were graphed and the change in temperature at the two sites calculated (Figure 17.0). The temperature difference ranged from 0.55 to negative 0.2°C and typically averaged approximately negative 0.7°C. The maximum temperature difference in 7DADM temperatures noted ( 2°C ) between the two sites over the three years of analysis was a single occurrence in 1995.

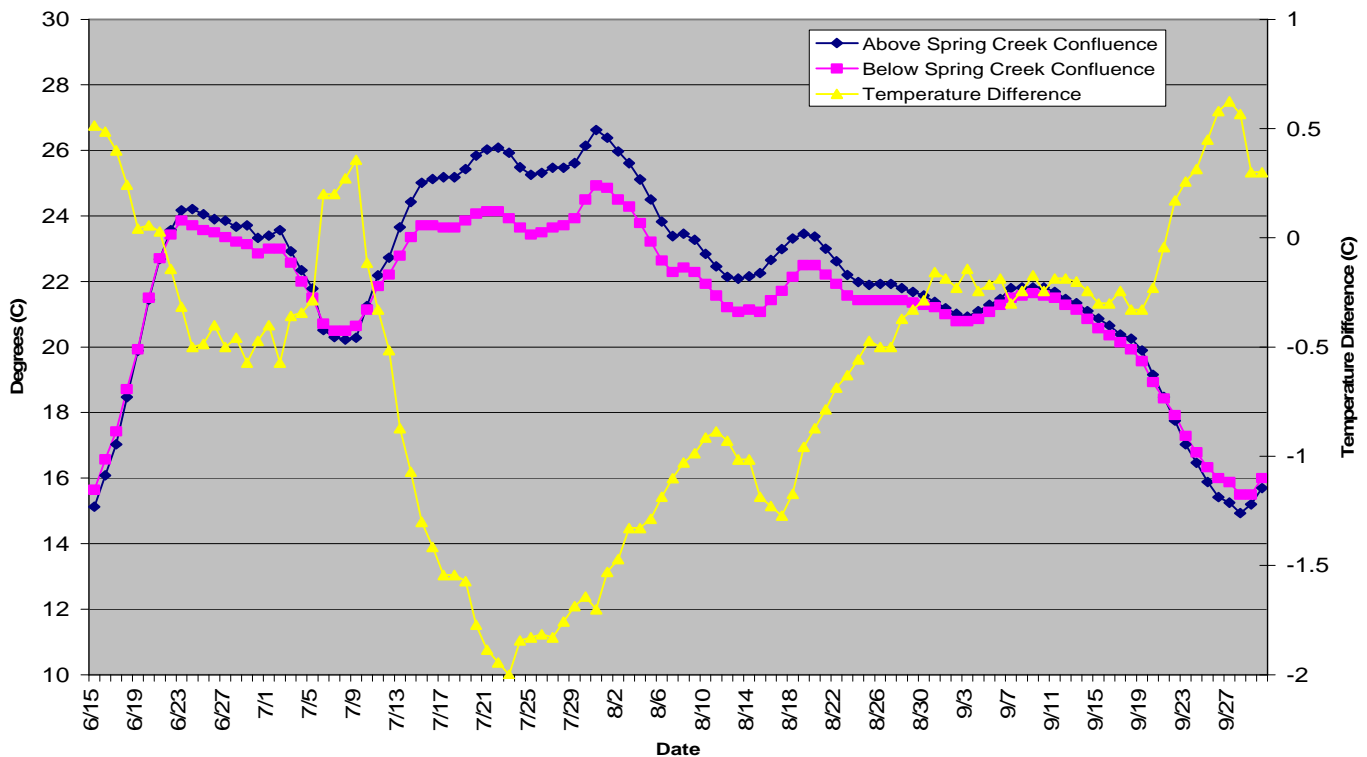


Figure 17.0 7DADM temperatures from 1995 recorded in Jenny Creek both below and above the confluence with Spring Creek. Data provided courtesy of BLM. The secondary axis displays the difference in 7DADM stream temperatures between the two sites.

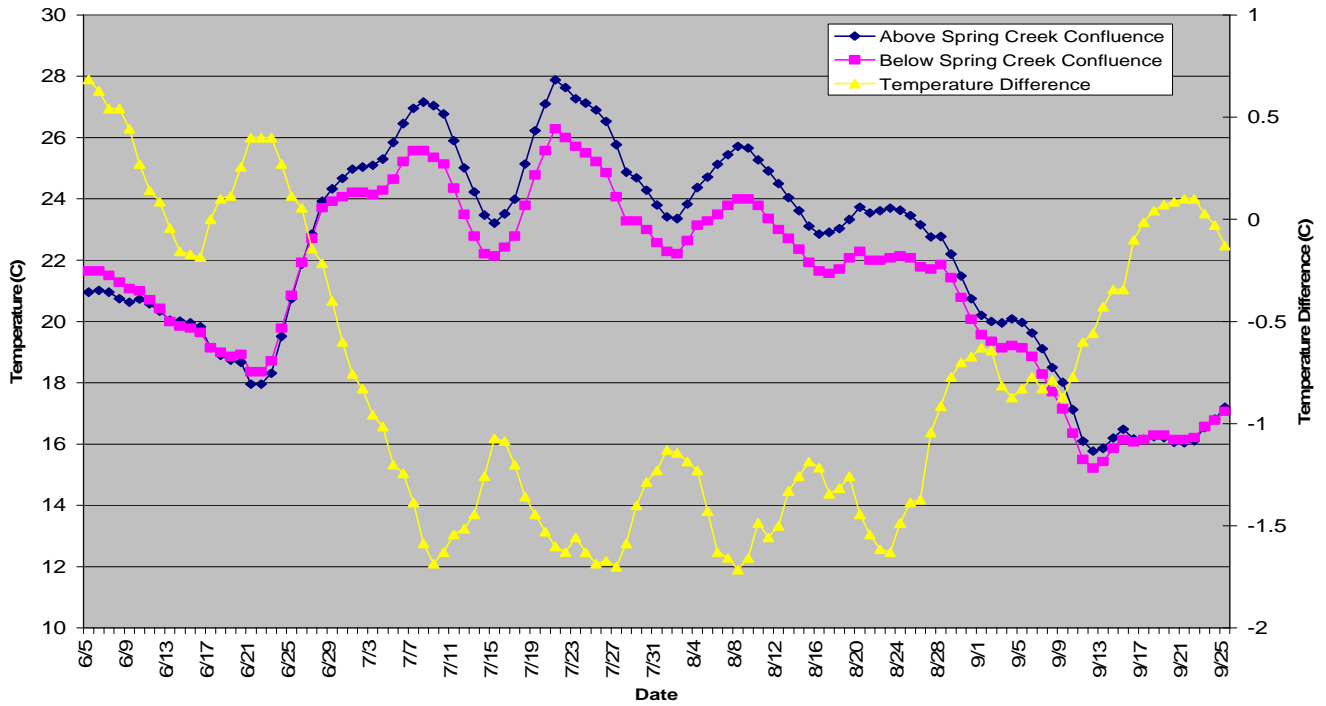


Figure 18.0 7DADM temperatures from 1996 recorded in Jenny Creek both below and above the confluence with Spring Creek. Data provided courtesy of BLM. The secondary axis displays the difference in 7DADM stream temperatures between the two sites.

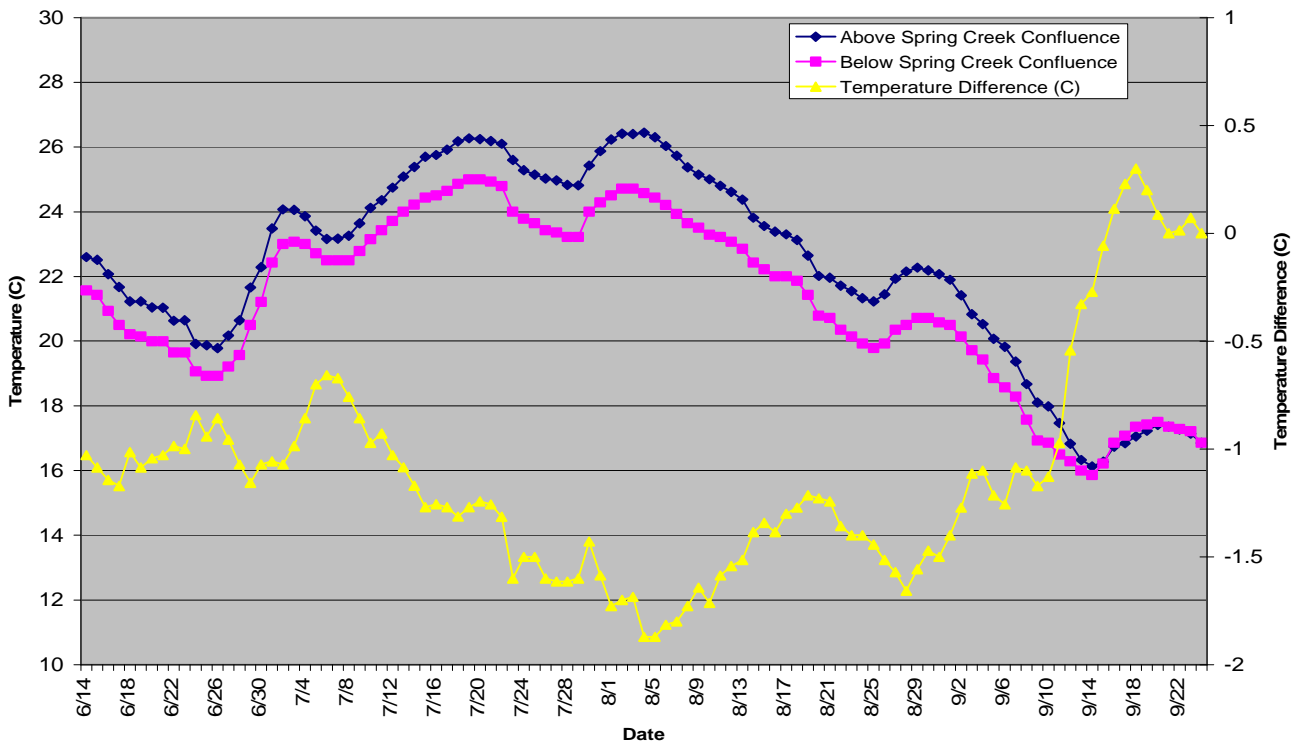


Figure 19.0 7DADM temperatures from 1997 recorded in Jenny Creek both below and above the confluence with Spring Creek. Data provided courtesy of BLM. The secondary axis displays the difference in 7DADM stream temperatures between the two sites.

## 6.0 DISCUSSION

### 6.1 General Water Quality Monitoring

The water quality data collected during the August 8, 2004 monitoring event shows that Spring Creek provides minor contributions to the overall water quality in Jenny Creek. When PacifiCorp stopped operating the Spring Creek diversion, there were minor improvements in DO and water temperature below the Spring Creek confluence in Jenny Creek. However, the actual benefit to Jenny Creek appears to be localized. Data collected at the mouth of Jenny Creek shows that operations of the Spring Creek diversion have very little, if any influence on water quality at this site. Spring Creek influence on Jenny Creek may be highly localized to the area near their confluence.

Analysis of the data shows that the undiverted Spring Creek flows, during the August 23, 2004 monitoring, had minor effects on DO, pH and specific conductance but did reduce temperatures in the lower portion of the Spring Creek bypass reach. Reduced flows in the Spring Creek bypass reach allow for thermal heating to occur, thus influencing the diel swing in most parameters. However, all measured parameters recorded during this monitoring period were within an acceptable biological range during diverted and undiverted flow conditions.

### 6.2 Temperature Monitoring

Data collected at the four PacifiCorp temperature monitoring sites, two in both Jenny and Spring Creeks, shows that the 7DADM temperatures are elevated by June, peaked in July and began to decline in August. Water temperatures were typically warmer in Jenny Creek; the 7DADM exceeded 25°C during the warmest portion of the year. The upper Spring Creek bypass reach never reached 20°C, providing the lowest 7DADM of all sites monitored.

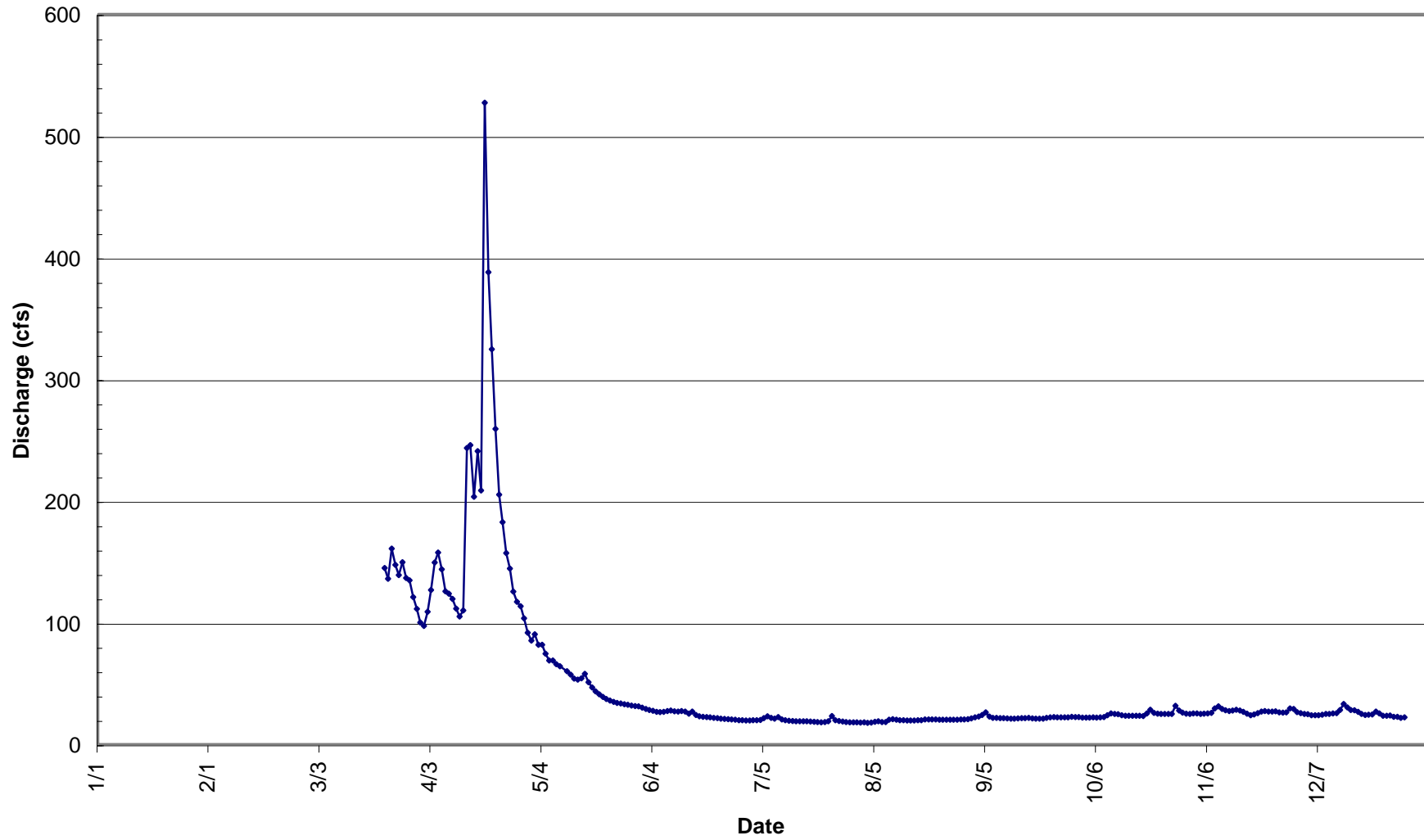
Based on the analysis of the BLM temperature data, elevated temperatures in Jenny Creek are sustained through August and generally decline in September. The 7DADM temperatures increased rapidly in the months of May and June, which is consistent with the data collected at the PacifiCorp monitoring sites. The 7DADM temperatures at the site above the Spring Creek confluence routinely exceeded 26°C during the warmest portion of the year, even reaching 28°C in some of the years monitored. The site below the confluence did not exceed 26°C, although there is less data from this site for this portion of the year to use for comparison (only four years compared to 10).

A comparison of the data collected above and below the Spring Creek confluence in 1995, 1996, and 1997 suggests the influence of Spring Creek on lowering Jenny Creek stream temperatures at the sites monitored. The average temperature difference between these sites is 0.5, 0.8, and 1.1°C for 1995, 1996, and 1997 respectively.

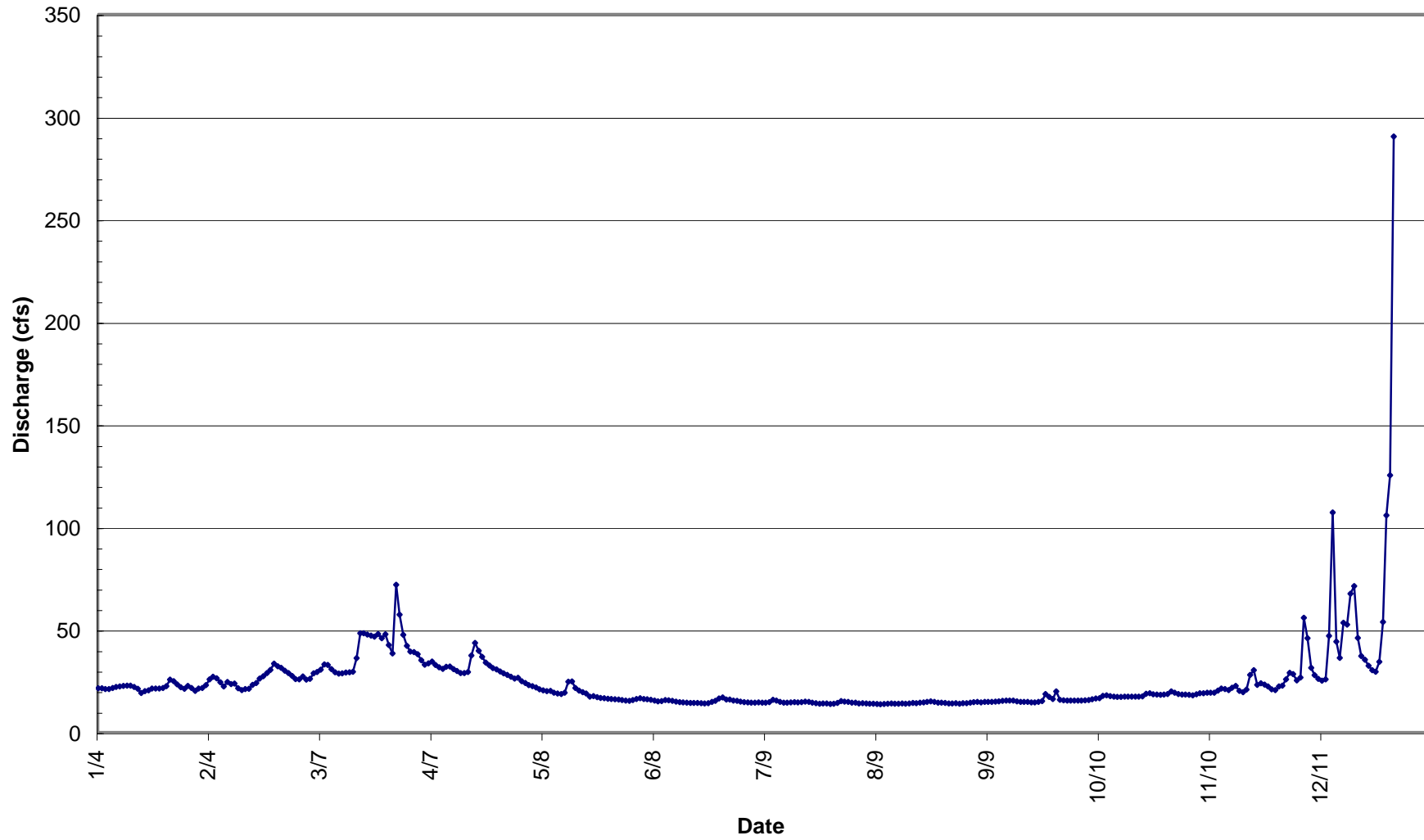
## APPENDIX A

Jenny Creek Monthly Discharge for Years 2000 Through 2003

### Jenny Creek 2000 Average Daily Discharge

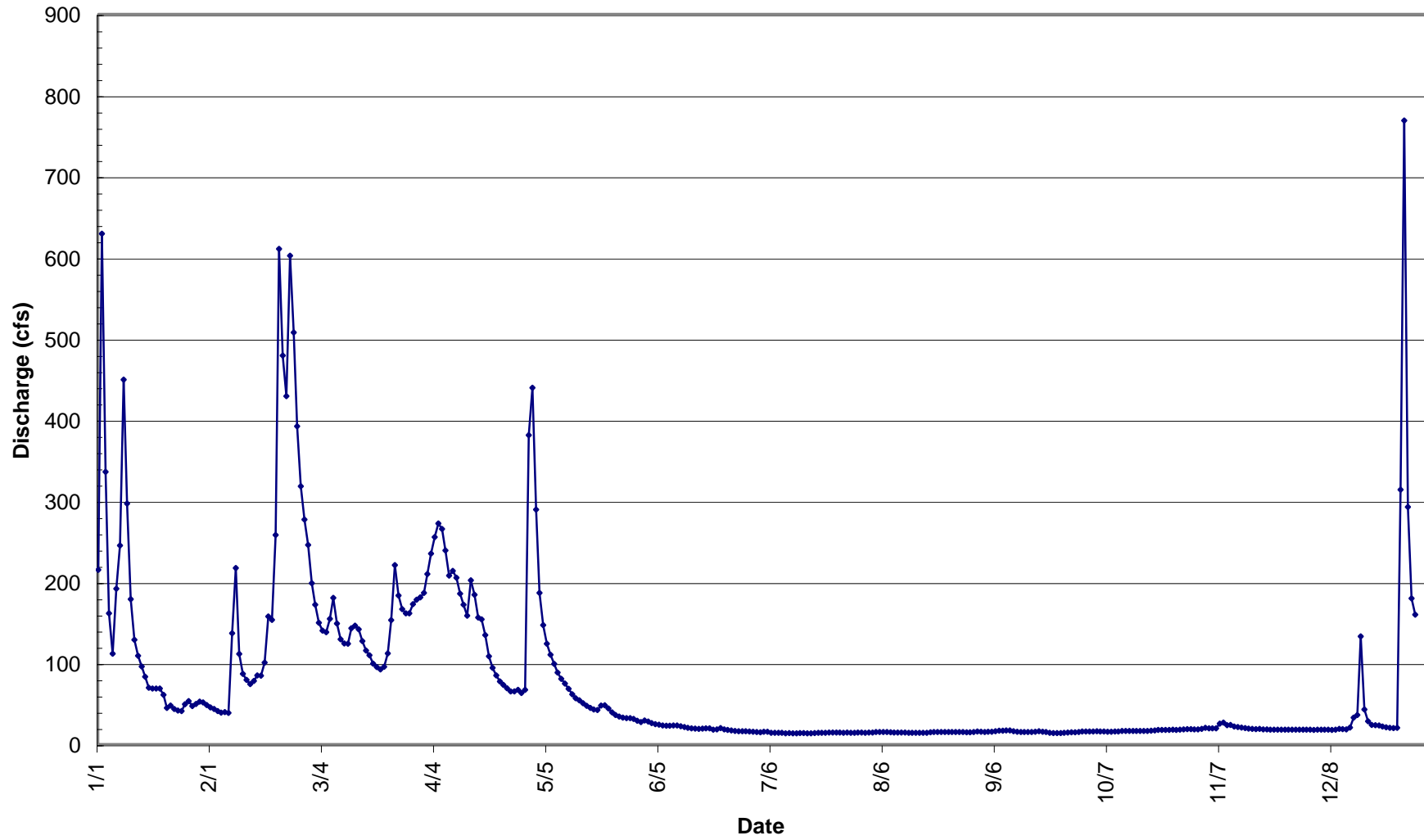


# Jenny Creek 2001 Average Daily Discharge





# Jenny Creek 2002 Average Daily Discharge



# Jenny Creek 2003 Average Daily Discharge

