

Watershed Monitoring Report – Upper Feather River Watershed Water Year 2013



Gia Martynn surveys Last Chance Creek. Spring 2013.

Prepared by Plumas Corporation
Quincy, CA
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Acknowledgements

Twenty-five years of cooperative watershed monitoring has involved many, many individuals and agencies. This report, and the entire series of annual watershed monitoring reports produced by Plumas Corporation for the Feather River Coordinated Resource Management partnership, is the result of work by many individuals dedicated to science-based natural resource management. Many thanks go to FR-CRM partner agencies and those employees who have gone above and beyond their agency's scope to work across jurisdictional boundaries and address landscape-scale monitoring, as well as to many private landowners, who have allowed access and data collection on their properties. Specifically, we would like to thank past and present employees of the Central Valley Regional Water Quality Control Board: Dennis Heiman, Ben Letton; PG&E: Larry Harrison, Donna Lindquist; California Department of Water Resources: Dave Bogener, Todd Hillaire, Kevin Pond, Eric Leister, Scott McReynolds and many others; California Department of Fish and Wildlife: Richard Flint, Amber Coates, Julie Newman; Plumas National Forest: Barry Hill, Joe Hoffman, Tina Hopkins, Antonio Duenas, Don Kozlowski; Natural Resource Conservation Service: Dan Martynn, Terri Rust, Dan Kaffer, Ceci Dale-Cesmat; University of California Cooperative Extension: Holly George and Mike DeLasaux; Meadowbrook Conservation Associates: Mike Kossow and Ken Cawley; Plumas Geohydrology: Burkhard Bohm. Many thanks to those who reviewed this year's report: Terry Benoit, Jim Wilcox, Terri Rust, John Olofson, Kevin Pond, Gia Martynn, Joe Hoffman, Tina Hopkins, Todd Hillaire, and Dennis Heiman.

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Abbreviations Used in this Report

Abv-	Above
Acw-	Above confluence with
Avg-	Average
Blw-	Below
CDEC-	California Data Exchange Center
CRS-	Continuous Recording Station
DG -	Data Gap
DWR-	California Department of Water Resources
EBNFFR-	East Branch North Fork Feather River
EPA-	US Environmental Protection Agency
FRCRM-	Feather River Coordinated Resource Management
Max-	Maximum
Min-	Minimum
MFFR-	Middle Fork Feather River
MR-	Monitoring Reach
NTU-	Nephelometric Turbidity Unit
RAC-	Resource Advisory Committee
SCI-	Stream Condition Inventory

SWAMP-	Surface Water Ambient Monitoring Program
Temp-	Temperature
TMDL-	Total Maximum Daily Load
USFS-	US Forest Service
USGS-	US Geological Survey
WY-	Water year

Introduction

2013 Monitoring Report Summary

This report tiers to Feather River Coordinated Resource Management (FRCRM) monitoring reports from 1999 through 2012. The FRCRM is currently undergoing structural changes, hence the title of the report no longer connotes representation of the FRCRM. This report and all previous reports have been prepared by Plumas Corporation. Plumas Corporation will continue to coordinate the monitoring program and seek input from partner agencies as long as funding is available. This and past reports include the effort of many partners, and the program would not be as effective without partner participation.

The 2013 Water Year (October 1, 2012- September 30, 2013) was a below-average water year; the second below-average year in a row. Data from the California Dept of Water Resources report 89% of normal historic precipitation for the Northern Sierra Precipitation Eight Station Index; and nine of the ten precipitation stations typically used in this Monitoring Report show an average of 81% of normal historic precipitation for the Feather River Basin. The water year was characterized by above normal precipitation through December, with dry conditions early in 2013, and insufficient spring precipitation amounts to bring the total precipitation up to normal levels (see Figure 2). Summer air temperatures were average.

This report includes data from continuous recording flow stations operated by Plumas Corporation, as well flow stations operated by the US Geological Survey (USGS), California Department of Water Resources (DWR), and US Forest Service (USFS).

Most important findings in this monitoring report:

- On both Last Chance Creek at Doyle Crossing and Red Clover Creek at Notson Bridge, the highest annual 7-day average of maximum daily water temperatures was lowered by 5°F after 2006, versus before 2006. See p.17.
- An analysis of precipitation from five annual precipitation (rain tube) stations located on the eastside of the Feather River watershed was conducted to see if the Feather River watershed ten-station precipitation amounts used in Table 3 for all of the past annual watershed monitoring reports is representative of the eastside, where most of the meadow restoration project work has taken place. The analysis showed enough of a difference to warrant including average precipitation from the five eastside stations along with the ten-station average we have used in past reports. See Table 4 and Appendix A for the calculations of the two sets of precipitation data.
- A summary of April 1 snowpack data is included in the report this year, because it was felt that annual precipitation does not tell the full story. Since 2000, most years have had below average snowpack. The period of record for the snow pack dates back to the early 1950s for the Rowland and Antelope Ridge stations, and early-mid 1960s for the other stations. Both annual precipitation and snow pack will be used in future reports. See Figure 3.

Data Issues

Scant monitoring resources have required Plumas Corporation and partners to prioritize which stations would be continued into the future. Annual costs for operating each station are approximately \$3,500.

- Lights Creek: The pressure transducer failed on April 30. Further operation of the station would require an investment of approximately \$5,000 in hardware and installation. Because there has been no partnership watershed restoration in this watershed, monitoring partners decided to decommission this station.
- Last Chance Creek at Million Dollar Bridge: The station was installed in late 2003 as part of the UC Davis Last Chance Creek modeling effort. Restoration work was completed before the station was installed, so there are no pre-project data for comparisons. The channel does not flow year-round. 2013 data are from Nov 26, 2012 through June 3, 2013. This station will be discontinued, and the hardware will be removed from the site in summer 2014.
- Indian Creek at Taylorsville Bridge: This has always been a difficult site due to active streambed dynamics. The pressure transducer has not yet successfully been placed in the low flow channel without being buried by sediment. The site collects high flow data, with intermittent data recorded from November through April for the 2013 water year. The turbidity sensor also has not functioned since it got buried in February 2006. Despite the difficult bed conditions, the data were deemed important enough to install a new low flow and turbidity sensor on November 21, 2013 (not early enough for 2013 low flows). It is hoped that the sensor can collect low flow and turbidity data in the 2014 water year.
- Upon annual data correction, it was discovered that the pressure transducer at Notson Bridge had reported erroneous data since March 2013, so no 2013 Red Clover low flow data are available from the station. The transducer was replaced in late 2013.
- Wolf Creek: Beaver activity at this site continues to confound efforts to correlate stage readings with flows.
- The DWR weather station at Doyle Crossing has not functioned since May 11, 2012, except for a few temperature readings in July 2013. (The station has since been repaired, and began telemetering data to CDEC in January 2014.)
- A lack of high spring flows resulted in inadequate high flow calibration measurements; therefore, high flow data should be considered estimates.
- The Plumas National Forest installed continuous stage recorders on Little Last Chance Creek in Nov 2010; Spanish Creek at the lower Spanish Ranch Bridge; and Sulphur Creek at McKenzie Creek (both in July 2012). These stations are included in this report, as well as the 2012 Watershed Monitoring Report.

About the Upper Feather River Watershed Monitoring Program

The FRCRM began in 1985 as a partnership of public agencies, private sector groups, and local landowners, in response to widespread erosion and channel degradation in the Feather River watershed. One hundred and forty years of intensive human use has contributed to a watershed-wide stream channel entrenchment process. The FRCRM was able to initiate systematized monitoring in the Feather River watershed in 1999 to establish baseline data for assessing long-term trends in watershed condition and the potentially significant effects of restoration projects on watershed function. Most of the monitoring effort is concentrated in the Indian Creek subwatershed because of its highly degraded upper watershed condition, and high potential for benefit from restoration with many linear miles of channels in alluvial settings. Monitoring site locations follow a nested approach. Please see the diagram at the end of the report that shows monitoring station locations with project locations.

One of the values of the monitoring program lies in the longevity of the data. In the face of structural changes of the partnership, those involved in this large scale watershed monitoring effort continue to work together and contribute resources to the program because of the usefulness of the data in managing water resources and aquatic/riparian ecosystems.

Background information such as an overview of the watershed, monitoring program objectives, more detailed earlier data, and protocols can be found in the FRCRM watershed monitoring reports from 2003 and 2005. Reports can be found on the monitoring page of Plumas Corporation's website at plumascorporation.org. The monitoring network was installed in 1999 and data have been collected from 2000-2013.

Initial funding for the watershed monitoring program was provided to Plumas Corporation through a Clean Water Act 319(h) grant (Aug 1998 to Dec 2000). Subsequent funding sources have been: the California Surface Water Ambient Monitoring Program (SWAMP); the Plumas Watershed Forum; US Forest Service Resource Advisory Committee, Title II funds; the Rose Foundation; the Norcross Foundation; and Esri has contributed GIS software. Partner agencies (Plumas National Forest, University of California Cooperative Extension, California Department of Fish and Wildlife (previously Calif. Dept. Fish and Game), Feather River College, California Department of Water Resources, Central Valley Regional Water Quality Control Board, and the Natural Resource Conservation Service) have provided valuable contributions such as data collection, data, equipment, and review.

Monitoring Program Description

Three of the main HUC 3 (Hydrologic Unit Code 3) subwatersheds of the Feather River basin are covered under this monitoring program. The South Fork Feather River and West Branch Feather River are not included:

- Indian Creek
 - Spanish Creek
- } East Branch North Fork Feather River (HUC #18020122)

- Middle Fork Feather River (HUC #18020123)
- North Fork Feather River (HUC #18020121)

Data Collected at the Continuous Recording Stations:

- **Stage** (calibrated to flow)
- **Water Temperature**
- **Air Temperature** (except at Wolf Creek and DWR Weir)
- **Turbidity** (NTU's) - Currently only at Indian Creek at Taylorsville (re-installed in Nov 2013)

The following table summarizes the history of Continuous Recording Stations operated by Plumas Corporation and other selected stations. Flow stations operated by other agencies that are no longer operational are not included. Weather stations are not included in the table.

Table 1. Continuous Recording Station Data Histories.

Station	Water Year = 10/1 through 9/30													
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
EAST BRANCH NORTH FORK FEATHER RIVER														
Indian Creek at DWR Weir	Start 11/5	All	DG*: 2/4-2/6	All	All	All	All	DG: 6/1-9/30	DG: 9/10-9/30	DG: 10/1-12/9	DG: 8/24-9/30	Start 10/7	All	All
Indian Creek at Flournoy Bridge	Start 11/5	All	DG: 10/4-10/9	DG: 8/15-9/30	Start 12/5	DG: 10/6-10/16, 6/7-9/30	DG: 10/1-12/18, 3/1-9/30	DG: 10/1-2/8, 2/14-3/6, 4/9-4/11, 5/7-8/7	All	All	DG: 7/31-9/30	DG: 11/12-7/28	All	All
Indian Creek at Taylorsville **High Flows Only	1/16-5/29	none	~12/31-5/7	~12/14-6/8	~12/6-5/12	~1/27-6/11	~11/23-7/7	none	~1/5-5/21	~1/24-6/9	~2/16-6/9	~12/4-7/11	3/14-5/17	11/30-4/22
Indian Cr blw Arlington Bridge (DWR) - Intended to replace abandoned USGS gage			Start 12/28/01	All	All	All	All	All	All	All	All	All	All	All
Last Chance at Doyle Xing	DG: 11/19-1/6, 2/25-3/17	All	All	All	DG: 9/5-9/30	DG: 10/1, 1/7-1/18	All	All	All	All	All	DG: 11/3-7/17	All	All
Last Chance at Million \$ Br **High Flows Only	-	-	-	-	12/9- 5/27 Preliminary	none	~11/8-5/24	~12/10-5/9	~1/23-6/1	~1/29-5/13	~1/13- 6/8	~12/6- 7/10	none	11/26 - 6/23; discontinue
Lights Creek	Start 12/28	DG: 7/30-9/30	DG: 8/12, 8/14-9/11, 9/18-9/23, 9/29-9/30	DG: 10/1-10/11, 10/25-10/23	All	DG: 12/22-1/11, 3/30-9/30	DG: 1/24-2/3, 6/10-7/7, 7/20-9/30	DG: 10/1-2/9, 5/9-8/7	DG: 7/3, 7/7-7/10	All	All	All	All	Data thru 4/30; then discontinue
Red Clover Creek at Notson Bridge	Start 10/23, DG: 7/5-8/10	All	DG: 11/27-5/1	All	All	All	DG: 10/8-11/18	All	error-calculated flow only	Start 12/10	Start 10/13	All	All	10/1-3/14 only, then sensor error

Table 1 continued next page

Station	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Wolf Creek: at Main St Br til 11/2009, thence at the Ballfield Bridge	Data from 12/21-7/19	DG: 10/1-11/13, 1/10-1/12, 4/5-4/18, 4/22-5/3, 8/20-8/23	Start 2/20	DG: 12/16, 12/28, 1/13-1/14, 3/15	DG: 2/17-2/19	DG: 11/1-11/3, 9/3-9/30	All	All	All	taken out & moved to Ballfield Bridge on 11/09	All	All	DG: 3/30	All
Spanish Cr at Lower Spanish Ranch Br (PNF)	-	-	-	-	-	-	-	-	-	-	-	-	Start July	Data available through 7/18
Spanish Creek at Hwy 70 Bridge	-	-	-	DG: 12/14-12/16, 12/27-12/29, 8/4-8/26	All	All	DG: 10/1-11/10	none	Start 10/26	DG: 5/29-7/30	Data from 10/1-12/21 only, then abandoned due to new USGS station abv Quincy Community Services District, installed and operational since 11/2009			
Spanish Cr abv QCSD plant USGS	All data from Nov 2009 through present													
Spanish Cr at Keddie (USGS)	Data available since 1933 – see USGS website													
MIDDLE FORK FEATHER RIVER														
Little Last Chance (PNF)												Installed Nov	All	data available thru 7/18
Middle Fork Feather River abv Portola (DWR)	-	-	-	-	-	-	-	Start 10/31/06						
Sulphur Creek						Start 3/9	DG: 11/9, 1/1-9/30	taken out	-	-	-	-	-	-
Sulphur DS of McKenzie (PNF)													Start July	All

*DG = Data Gap All = All year-round data

Plumas Corporation Stations

At the stations operated by Plumas Corporation, stream flow stage, air and water temperature are recorded every 15 minutes by Campbell CR10X data loggers, and then stored as hourly averages and summarized into daily files at the end of each water year (Oct 1 – Sept 30). To continuously record turbidity, an Analite 195 laser sensor (a nephelometric probe) was installed on Indian Creek at Taylorsville Bridge (2001-09 and re-installed in Nov 2013) and on Spanish Creek (2001-06 only). The data loggers are

capable of storing up to six months of data. Plumas Corporation staff and contract technicians download data periodically. Because of periodic channel shifts at most of the stations, monthly calibration measurements are also required. Plumas Corporation staff are responsible for capturing discharge measurements over the range of flows at each station in order to maintain and update the rating tables. Rating tables are reviewed and/or updated annually by Sagraves Environmental Services, Red Bluff. Jim Wilcox's precipitation data are from his gage located in Genesee, and is used for many of the flow charts. It is recorded daily and is considered to be the most reliable of the gages in the area.

Plumas Corporation also periodically collects data at 19 Monitoring Reach sites. Most of the data collection has followed the Forest Service Region 5 Stream Condition Inventory (SCI) protocol. 2011 is the most recent year that data have been collected at some of these sites. Monitoring Reach data are not included in this 2013 Water Year report.

DWR Stream Flow & Weather Stations

DWR maintains four weather stations and two flow stations in the Feather River watershed to assist in managing the water resources. The DWR flow stations are located on Indian Creek below Indian Falls (ICR) and on the Middle Fork Feather River near Portola (MFP). DWR also provides the cooperative funding to keep the Spanish Creek near Keddie USGS gage in operation. Four weather stations installed by DWR in the Indian Creek watershed include Doyle Crossing (DOY) in 2000, Jordan Peak (JDP) in 2005, Thompson Valley (TVL) in 2006 and Taylorsville (TAY) in 2007. All of the DWR weather stations and flow stations are accessible on the DWR California Data Exchange Center (CDEC) website at cdec.water.ca.gov. Stream discharge and stage height are recorded at the DWR flow stations, while the DWR weather stations record precipitation, temperature, relative humidity, wind speed, wind direction, solar radiation and atmospheric pressure. The weather station at Doyle Crossing has not functioned since May 2012, and the data are questionable from the Jordan Peak and Thompson Valley stations. (The Jordan Peak wind shield appears to not be sufficient, as observed snow fall does not register in the gage. Likewise, precipitation at the Thompson Valley gage does not appear to correlate with observations near the station.) This 2013 watershed monitoring report includes an analysis from five additional annual precipitation weather stations that are located on the eastside of the watershed and are operated by DWR.

USFS Stream Flow Stations

The USFS installed three continuous recording flow stations in the Feather River watershed in 2011. These stations are located on Little Last Chance Creek above Lookout Creek, Sulphur Creek below the confluence with McKenzie Creek, and Spanish Creek at the lower Spanish Ranch Bridge. Water pressure and temperature and atmospheric pressure and temperature are being continuously recorded using HOBO U20-001-04 loggers. These flow stations are operated and calibrated by the Plumas National Forest, Beckwourth Ranger District.

Table 2. Watershed Area above Plumas Corporation Continuous Recording Stations

Watershed Areas above Plumas Corporation Continuous Recording Stations (for station location see Figure 1)	
Station	Area (acres)
Last Chance at Doyle Crossing	61,746
Red Clover at Notson Bridge	69,121
Indian Creek at DWR Weir	72,619
Indian Creek at Flournoy Bridge	281,132
Indian Creek at Taylorsville	343,193
Lights Creek at Deadfall Bridge	67,722
Wolf Creek at Ball Field Bridge	31,945

Figure 1. Plumas Corporation's Continuous Recording & Monitoring Reach Locations.

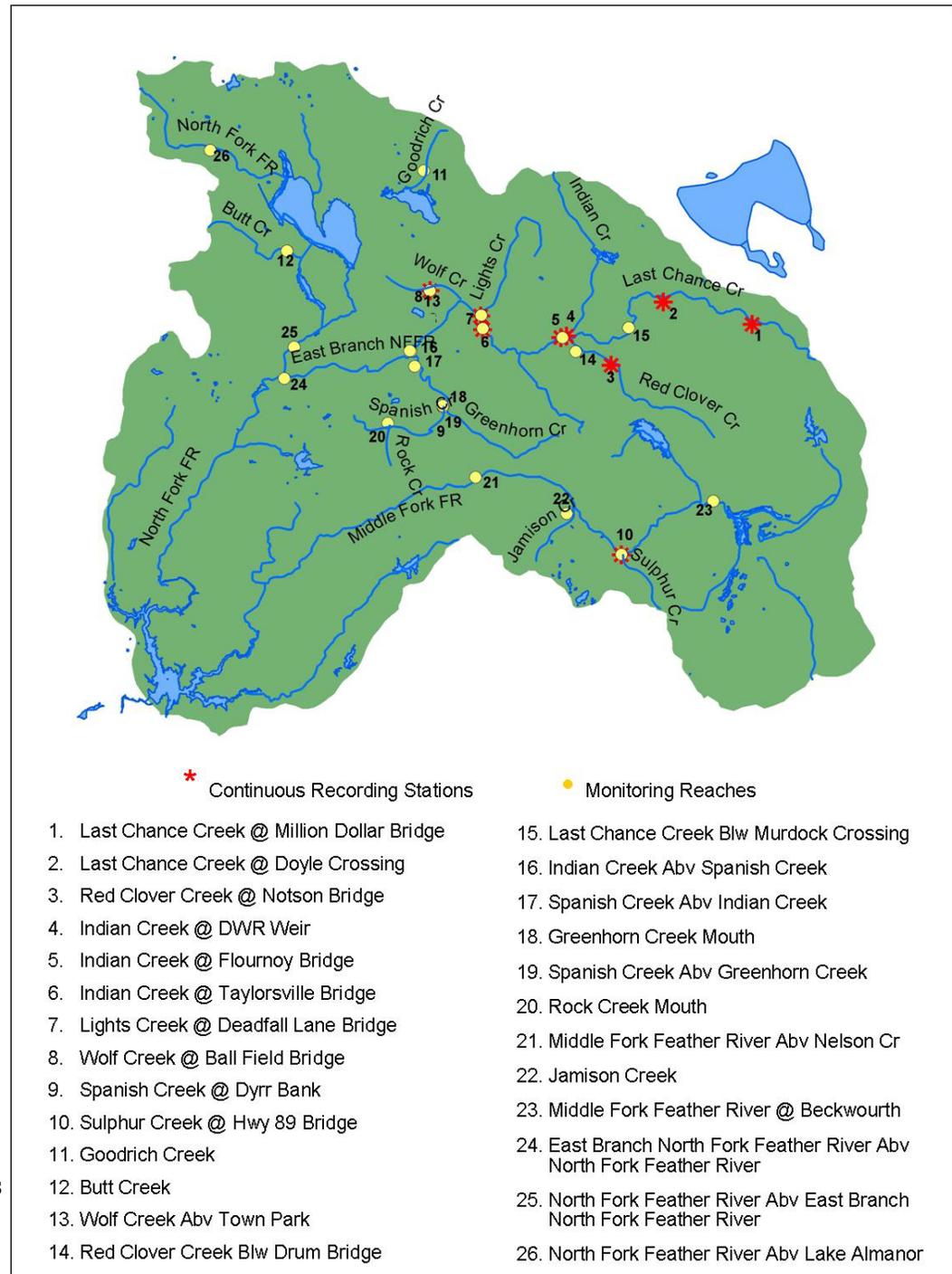


Table 3. Upper Feather River Watershed Monitoring Sites

<u>Map #</u>	<u>Monitoring Site by Subwatershed</u>	<u>Monitoring Type</u>	<u>Yrs Surveyed/ of Operation</u>
	North Fork Feather River (NFFR) watershed		
26	NFFR @ Domingo Springs (abv Lake Almanor)	MR*	99, 01, 03
	NFFR@ Seneca (blw Lake Almanor)	MR	99, 01, 03
25	NFFR @ acw East Branch NFFR	MR	99, 01, 03
12	Butt Cr (abv 307 Br)	MR	99, 01, 03
11	Goodrich Cr	MR	99, 01, 11
24	East Branch mouth (acw NFFR)	MR	99, 01, 03, 11
17	Spanish mouth (acw Indian)	MR	99, 01, 03, 11
	Spanish Creek @ Keddie abv Blackhawk Cr.	CRS (USGS)	1933- present
19	Spanish Cr acw Greenhorn Cr	MR	99, 01, 03, 11
	Spanish Cr @ Spanish Ranch Br	CRS (USFS)	12/11- present
18	Greenhorn Cr acw Spanish Cr	MR	99, 01, 03, 11
9	Spanish @ Quincy	CRS (USGS)	09- present
9	Spanish @ Dyrr Bank (Hwy 70)	CRS [†]	2003-09
20	Rock Cr mouth	MR	99, 01, 03, 11
16	Indian Cr acw Spanish Cr (PlumasCorp) blw Indian Falls (DWR)	MR & CRS (DWR)	99, 01, 03, 11/ 07-present
13	Wolf Cr @ Main St Bridge in Greenville moved to:	CRS	2000-2009
13	Wolf Cr @ Ball Field Bridge in Greenville	MR & CRS	99, 01, 03 & 11/09-present
7	Lights Cr @ Deadfall Lane Br	MR & CRS	99, 01, 03 & 11/99-present
6	Indian Cr @ Taylorsville (TAY)	MR & CRS & Weather Station (DWR)	99, 01, 03 & 11/99-present & 2007-present
5	Indian Cr @ Flournoy (bcw Red Clover)	MR & CRS	99, 01, 03, 11/99-present
4	Indian Cr @ DWR weir (acw Red Clover)	CRS	99-present
	Red Clover Cr @ Chase Bridge	MR	99, 01, 03, 09
	Thompson Valley (TVL)	Weather Station (DWR)	06-present
14	Red Clover Cr @ Drum Bridge	MR	99, 01, 03
3	Red Clover @ Notson Bridge	CRS	99-present
15	Last Chance (LC) Cr @ Murdock	MR	99, 01, 03
2	Last Chance (LC) Cr @ Doyle Crossing (DOY)	CRS & Weather Station (DWR)	99- present & 00-present
	McClellan Cr	MR (DWR)	97, 01, 05, 10

* Monitoring Reaches (MR) refers to those surveyed by Plumas Corporation unless otherwise noted in parentheses.

† Continuous Recording Stations (CRS) are maintained and operated by Plumas Corporation unless otherwise noted in parentheses.

Table 3 Cont.

<u>Map #</u>	<u>Monitoring Site by Subwatershed</u>	<u>Monitoring Type</u>	<u>Yrs Surveyed/ of Operation</u>
	Cottonwood Cr @ Big Flat	CRS abv & blw Big Flat	94-present
	Little Stoney Cr	MR (DWR)	97, 01, 05, 10
	Willow Cr	MR (DWR)	97, 01, 05, 10
	LC @ Alkali Flat low water crossing	MR (DWR)	97, 01, 05, 10
	Ferris Cr	MR (DWR)	97, 01, 05, 10
1	LC @ Million Dollar Bridge	CRS	04-present
	LC @ Bird-Jordan	MR (DWR)	97, 01, 05, 10
	Jordan Peak (JDP)	Weather Station (DWR)	05-present
	Middle Fork Feather River (MFFR) watershed:		
21	MFFR abv Nelson Cr	MR	99, 01, 03, 11
	MFFR @ Sloat	staff gage	2003- present
22	Jamison Cr @ 23N37 Br	MR	99, 01, 03, 11
	Little Last Chance	CRS (USFS)	Dec 2011-present
10	Sulphur Cr @ Hwy 89 (Clio)	MR	99, 01, 03, 11
	Boulder Cr	staff gage	2003- 08
	Barry Cr	staff gage	2003- present
	Sulphur @ Lower Loop Bridge	staff gage	2003- present
	Sulphur below confluence with McKenzie Cr	CRS (USFS)	Dec 2011-present
	Sulphur @ Upper Loop Bridge	staff gage	2003- present
23	MFFR blw A23 Br (Beckwourth)	MR	99, 01, 03, 11
	MFFR near Portola (MFP)	CRS (DWR)	06- present

2013 Monitoring Program Findings

Climatic and Watershed Context

New to the watershed monitoring report this year is a brief analysis of the “Percent of Historic Average annual precipitation for the entire Feather River Basin from CDEC” column in Table 4, to annual precipitation (1998-2013) from five rainfall storage gages (rain tubes) operated by DWR that are located only in the eastern portion of the Feather River watershed. The analysis confirmed suspicions that the ten stations used to describe average annual precipitation in the entire Feather River basin do not always reflect average annual precipitation on the east side of the watershed, where a large part of the meadow restoration effort has been focused. In normal/wet years the precipitation on the eastside was 12% less than the ten station average. In dry years, the eastside stations recorded only 2% less than the ten stations. Both the ten-station average and the eastside station average will be used in future reports. There also appeared to be a decrease in the running average from 1998 to 2013 at the eastside stations. See Appendix A.

Table 4. Precipitation and Summer Air Temperature Averages

Water Year (10/1-9/30)	Percent of Historic Average annual precip for the entire Feather River Basin from CDEC*	Percent of Historic Average annual precip for five eastside stations**	Total annual precip (inches) in Genesee (Wilcox data only)***	Summer Average Air Temperature ⁺ June 1-Sept 30
1996			59.25	
1997			61.6	
1998	144%	124%	60.9	
1999	99%	109%	47.2	
2000	101%	84%	43.3	61.4
2001	56%	41%	21.2	63.0
2002	77%	73%	33.3	62.3
2003	111%	79%	50.7	63.2
2004	83%	77%	41.15	61.7
2005	109%	80%	45.5	60.5
2006	154%	125%	66.25	62.3
2007	60%	62%	31.05	61.5
2008	68%	68%	25.4	62.9
2009	84%	97%	38.05	62.6
2010	101%	83%	33.85	61.4
2011	142%	141%	56.60	64.9
2012	79%	64%	33.85	63.4
2013	81%	93%	43.6	62.2
AVERAGES	Average annual = 45” (40-50 yr avg as reported on DWR Quantitative Precipitation Forecasts)	Averages Vary: 21.38” running avg of all 5 stations in 1998 to 20.21” running avg in 2013	Column average = 44.0”	Column average = 62.4”

* Averages derived by DWR from all stations reporting water year precip and averages in the watershed. The ten stations in the Feather River watershed are: Plumas Eureka Park, Sierraville, Vinton, Portola, Chester, Strawberry Valley, Brush Creek, Greenville, Quincy, and Nicolaus. In 2012, 7/10 stations reported averages (Plumas Eureka Park, Greenville, and Nicolaus did not report). In 2013, all stations but Nicolaus are included in the 81% of average reported above.

** The values in the Genesee Precip column are unrelated to the Percent of Historic Average Annual Precip values.

⁺ Average derived from DWR weather stations at Antelope Lake, Doyle Crossing, Grizzly Ridge, and Quincy. Data are missing from Doyle Crossing in 2000, 2012 & 2013; Grizzly Ridge in 2001; and Antelope Lake in 2007 & 2013. The 2013 figure is an average of daily average air temperatures from three stations: DWR’s Quincy and Grizzly Ridge stations, and Plumas Corp’s Notson Bridge Continuous Recording Station.

***The five eastside annual rainfall storage gages and installation years are: Red Clover Valley(1965), Last Chance Cr(1969), Clarks Cr(1959), Upper Indian Cr(1969), and Little Last Chance Cr(1960)

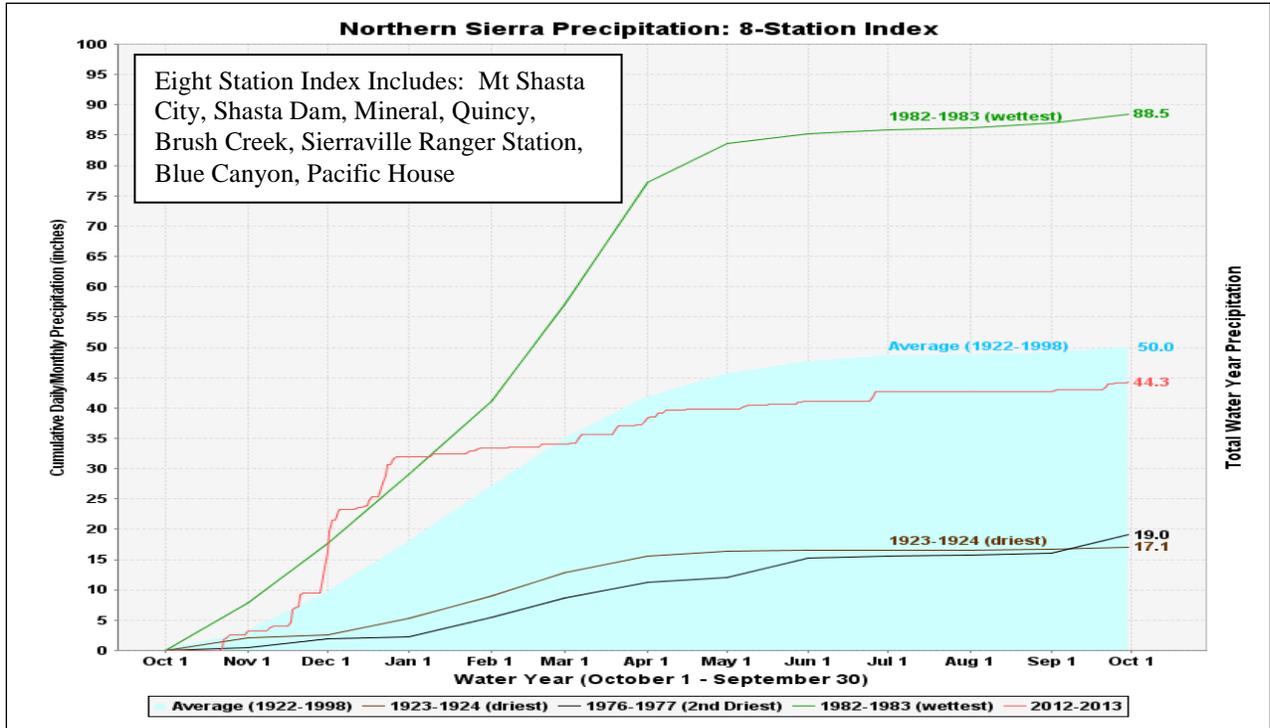


Figure 2. Source: http://cdec.water.ca.gov/cgi-progs/prevprecip1/PLOT_ESI DWR Historic Precipitation for the Northern Sierra. 2013WY in red. Note that these stations are different than the stations reporting averages for the Feather River watershed in Table 3. Quincy and Brush Creek are the only two stations common to both.

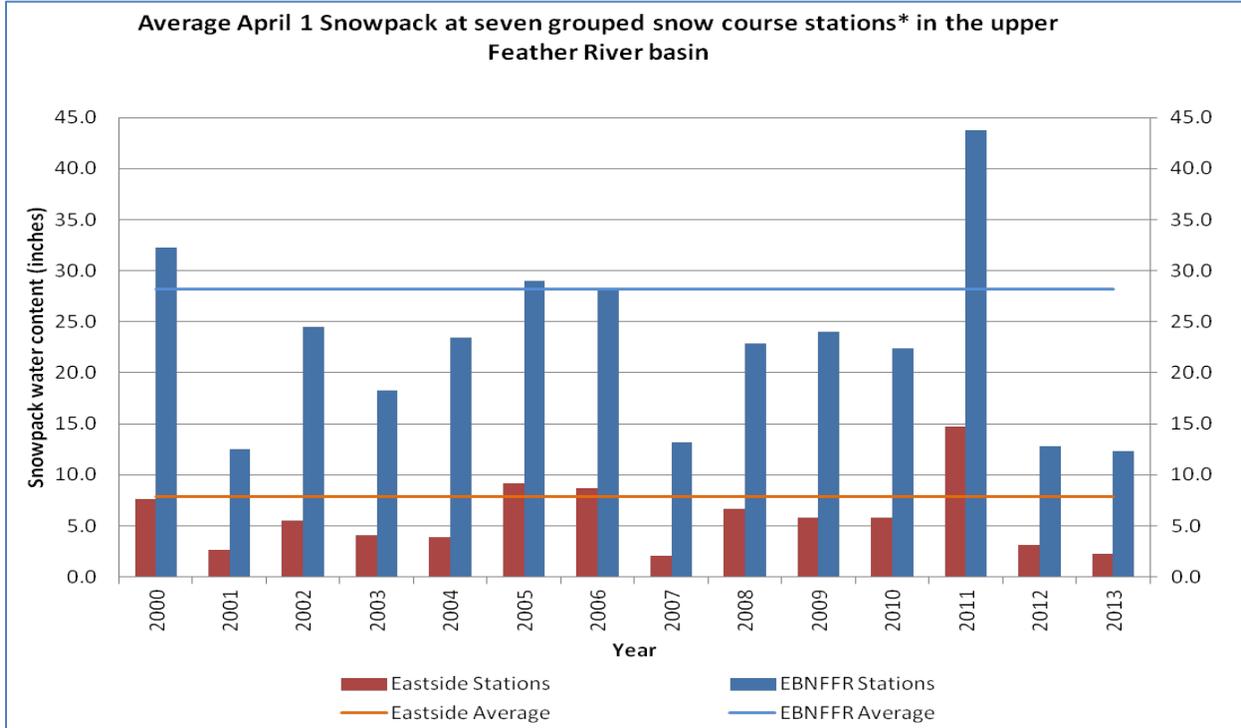
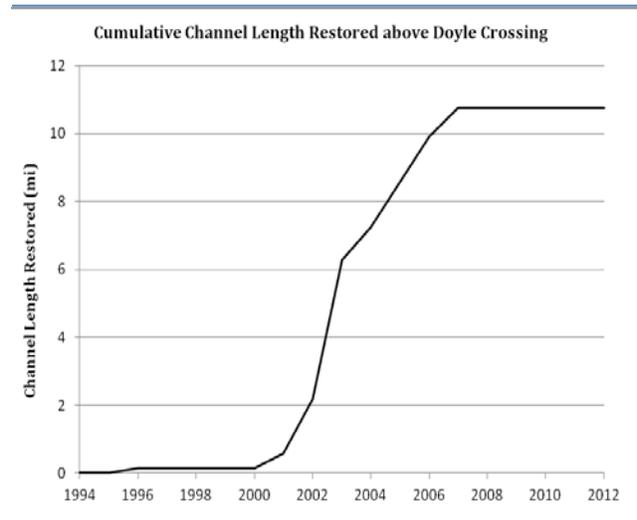
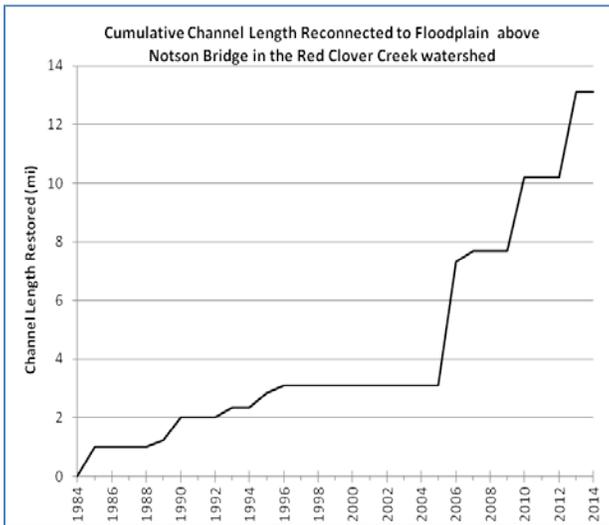


Figure 3. Average April 1 snowpack at stations throughout the upper Feather River. *Four eastside stations are Abbey, Rowland, Antelope Ridge, and Frenchman Cove, installed 1950-1963. Three East Branch North Fork Feather River (EBNFFR) stations are Kettle Rock, Mt. Hough and Grizzly Ridge, all installed in 1965.

New to the report this year is April 1 snow pack data (Figure 3 above). These data were added to provide additional information on annual precipitation data. The April 1 snowpack gives some indication of the snow pack available for snowmelt run-off. The average lines in Figure 3 are the averages for the period of record for those groups of stations. Since 2000, for both groups of stations, most years are below average - perhaps indicating a decline in the average.

Figures 4 a and b below display when restoration activities occurred on Red Clover (4a above Notson Bridge) and Last Chance (4b above Doyle Crossing) creeks. Continuous recording flow stations were installed in 2000. On Red Clover Creek, while work had been completed prior to 2000, 1996-2005 can be used as the pre-project condition, since no work was accomplished from 1996 through 2005, and most of the work was accomplished after 2005. The pre-project condition is somewhat less clear on Last Chance Creek.



Figures 4a (Notson) and 4b (Doyle). Depiction of cumulative channel length restored with floodplain reconnection over time in the Red Clover Creek (4a), and the Last Chance Creek (4b) watersheds.

Water Temperature

Introduction

The Central Valley Regional Water Quality Control Board has identified water temperature as a water quality concern in the Feather River watershed. A variety of parameters were used to compare water temperature between sites and between years. Figures 5-8 display water temperatures from Plumas National Forest (PNF) and Plumas Corporation recording stations. With each new year of data, the challenge of displaying the data over time becomes greater. Water temperature data from the PNF Sulphur Creek and Spanish Creek stations have been added to the graphs where possible (data after mid-July 2013 from PNF's Little Last Chance Cr station have not yet been downloaded, so this station has not been included).

Trendline equations were presented in the 2012 report, with very low R^2 values indicating the lack of a trend with any of the temperature data. Trendlines were not analyzed for this report.

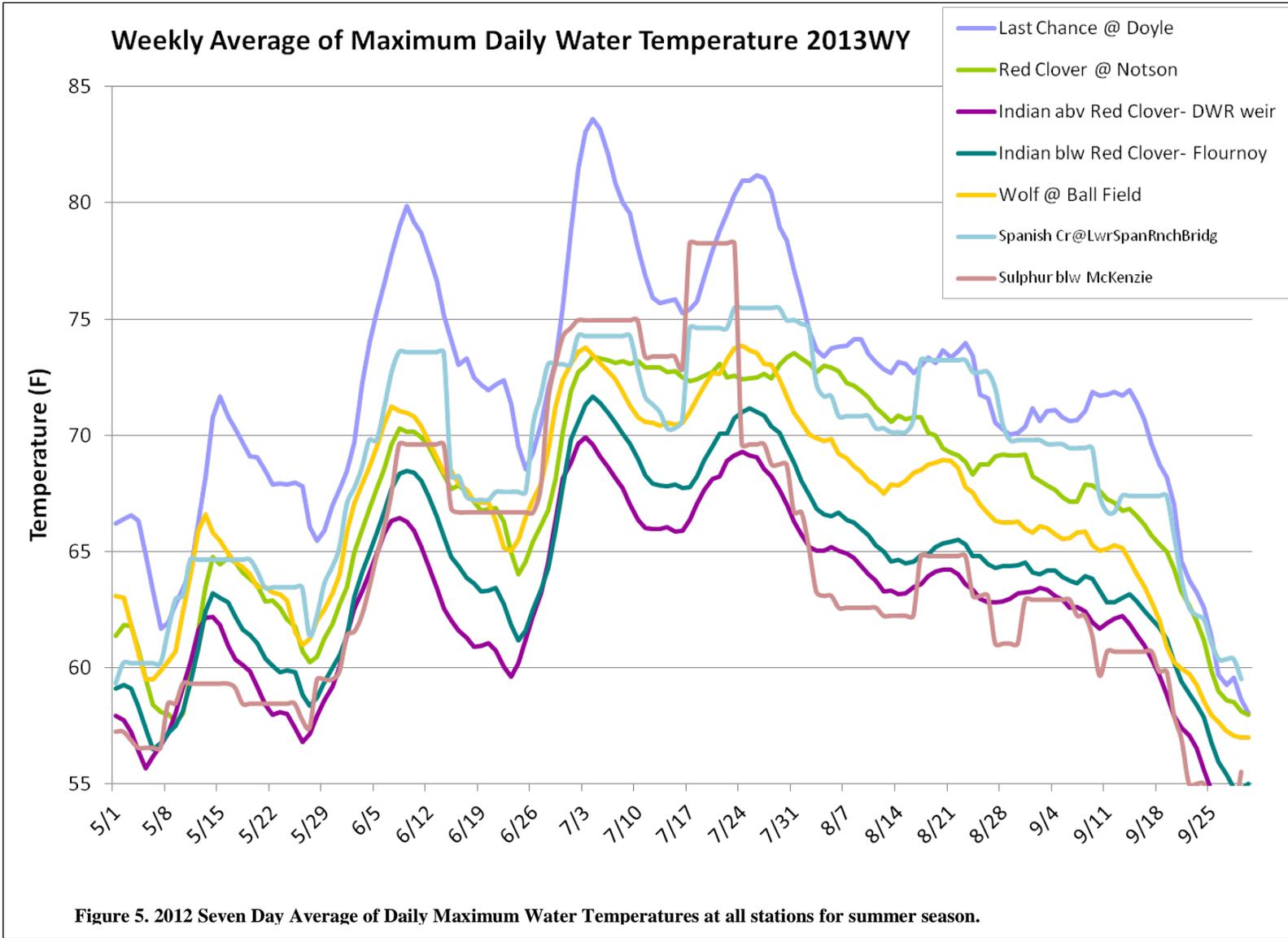
Maximum Weekly Average Temperature (MWAT)

Figure 5 displays the seven-day average of daily maximum water temperatures for the summer months. Figure 6 displays the one-time maximum of the seven day averages.

The Lights Creek station is now discontinued; however, Sulphur Creek below McKenzie Creek and Spanish Creek at the Lower Spanish Ranch bridge have been added (operated by the Plumas National Forest), with data from these stations summarized in this annual report beginning in 2012. Both of these stations appear comparable to the longer term stations, with a noticeably wide seasonal temperature fluctuation at Sulphur Creek. Data from these stations are only included in Figure 5 to maintain chart readability, and consistency with a comparison of Indian Creek watershed stations. Neither of these stations is in the Indian Creek watershed. (It is not understood why the curves from the Hobo U20-001-04 sensors are leveled off. The specification resolutions of the Hobo sensors are comparable to the Campbell CR10X sensors.)

In Figure 6, what appeared to be an overall decrease in maximum water temperatures at many stations in 2011 and 2012 was no longer visually apparent in 2013. The lower temperatures in 2011 may have been due to higher flows in that year with 142% normal precipitation, and a lag effect in 2012 as groundwater stored in 2011 was being released. This effect does not appear to have continued into 2013 across the board.

However, a comparison of the data before and after 2006 (pre- and post-restoration project conditions) showed a significant decrease in the max 7-day average water temperature by 5.6° Fahrenheit on Red Clover Creek at Notson Bridge, and 5.0°F on Last Chance Creek at Doyle Crossing. At the 95% confidence interval there was no difference on Indian Creek at the DWR weir nor on Wolf Creek. Neither Indian nor Wolf Creek have undergone extensive meadow floodplain restoration similar to the scale that has occurred on Red Clover and Last Chance, however, it is always difficult to assign cause and effect. The difference was not due to air temperatures, as there was no significant difference in air temperatures in a pre- to post-2006 comparison. The sensors had also remained at the same locations (except for Wolf Creek). Wolf Creek had also experienced substantial inset floodplain restoration ending in 2002 that resulted in additional shade to the channel.



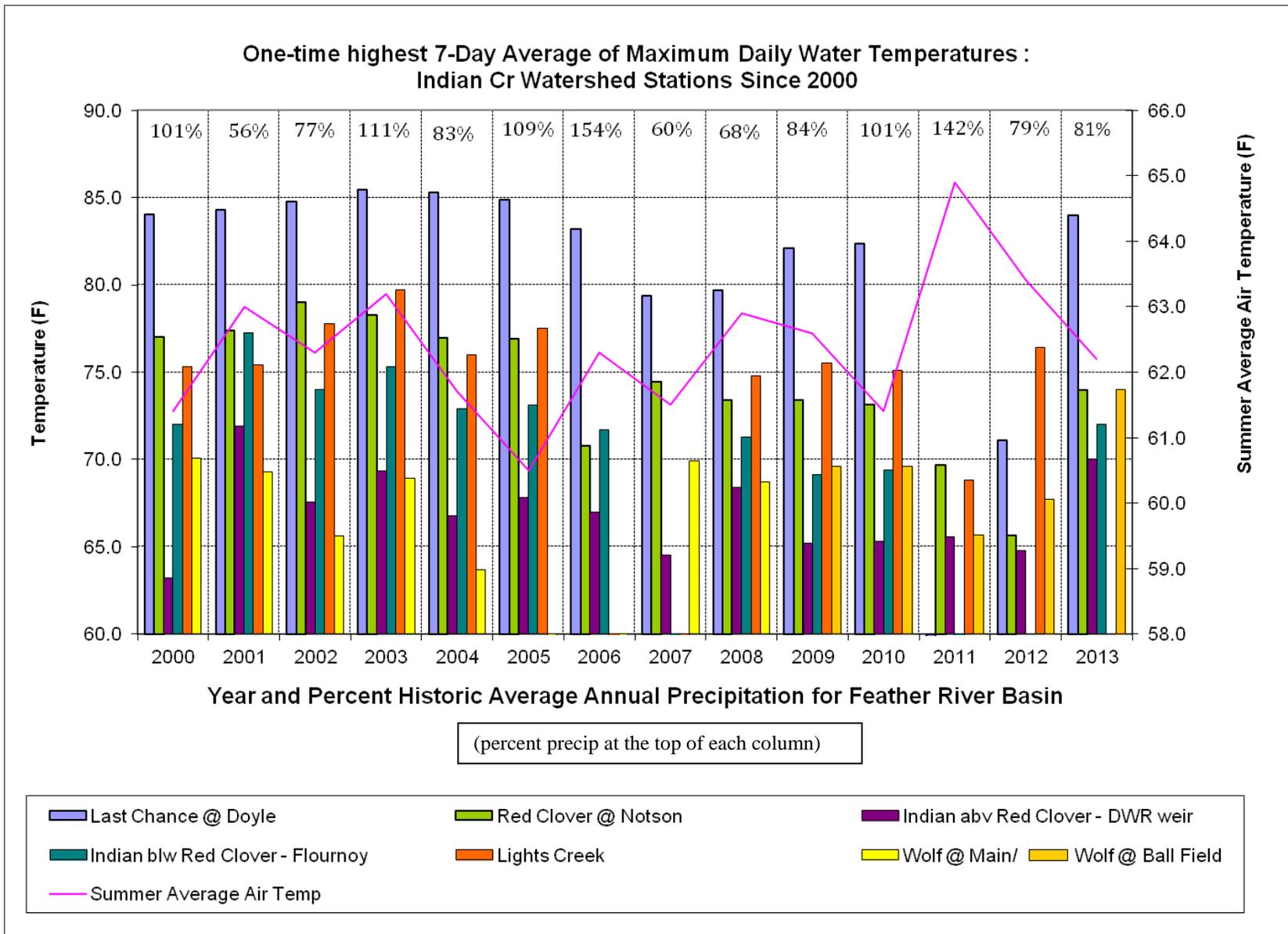


Figure 6. One-time highest value of the Seven Day Average of Maximum Daily Water Temperatures in 2000-2013 for all Indian Creek watershed stations.

Daily Maximum Water Temperature >70°F

Figure 7 displays the number of days with at least one hour of water temperature greater than 70°F for all of the Indian Creek watershed stations. Lights Creek had no low flow period data in 2013. 70°F (21.1°C) is the total maximum daily load (TMDL) criteria set for temperature by the State of California for the North Fork Feather River 303(d) temperature listing, and is also biologically important for cold water fisheries. Visually, there appears to be a general downward trend in the number of days with temperatures exceeding 70F, however, this trend has not been statistically tested.

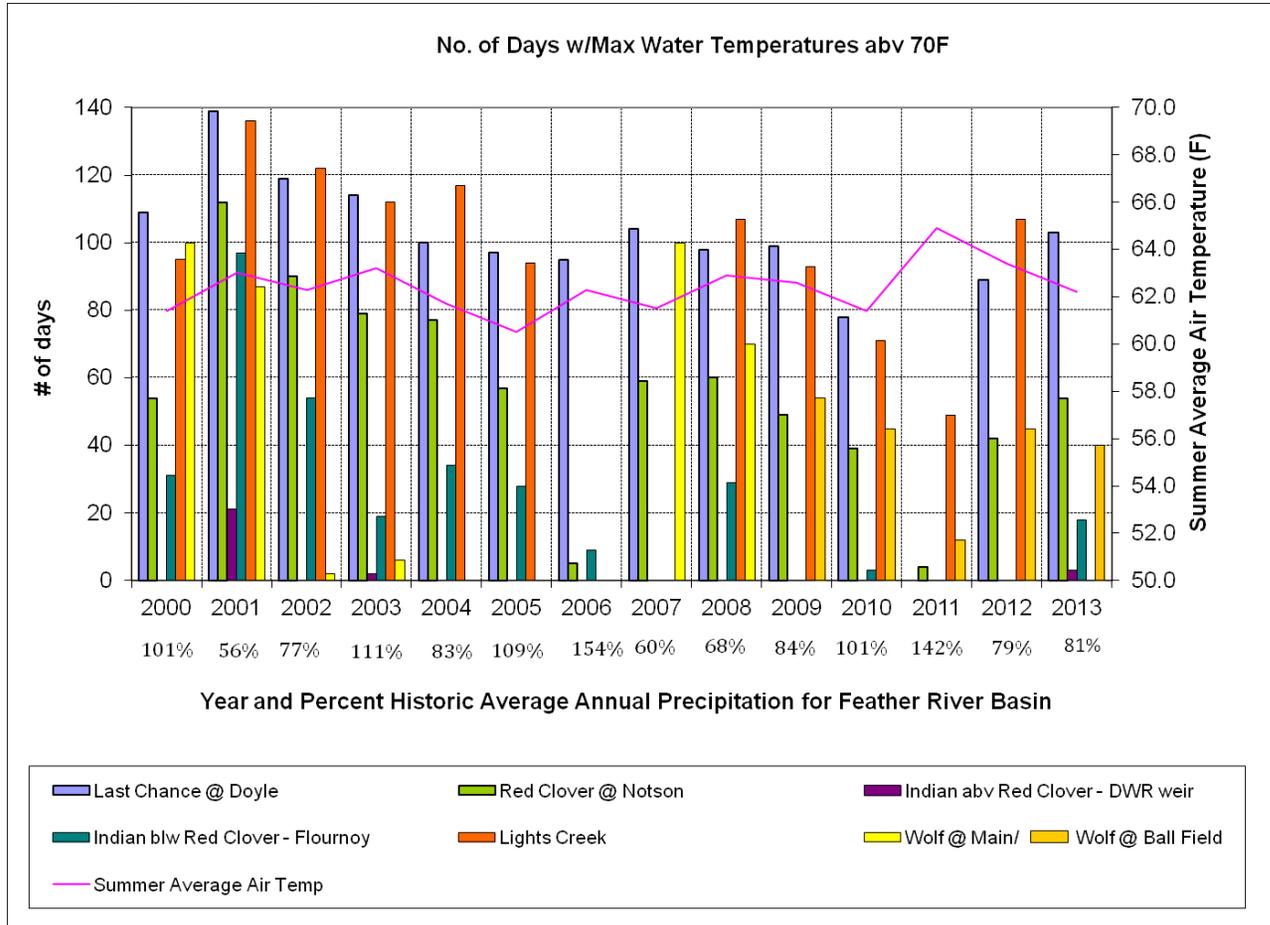


Figure 7. Number of days with maximum water temperature above 70F recorded in 2000-2013 for all stations in the Indian Creek watershed.

Maximum summer diurnal water temperature fluctuation

Figure 8 displays the maximum diurnal water temperature fluctuation. This is calculated by finding the difference between the maximum and the minimum water temperature in a 24-hour period (diurnal fluctuation). Then, a running seven day average of the diurnal fluctuation is calculated for June 1- Sept 30. Afterward, the maximum value of the averages is taken. This parameter is heavily dependent on air temperatures and insolation. The downward trend that Wolf Creek exhibited early in the aughts, does not appear to have continued. No other trends have been statistically investigated.

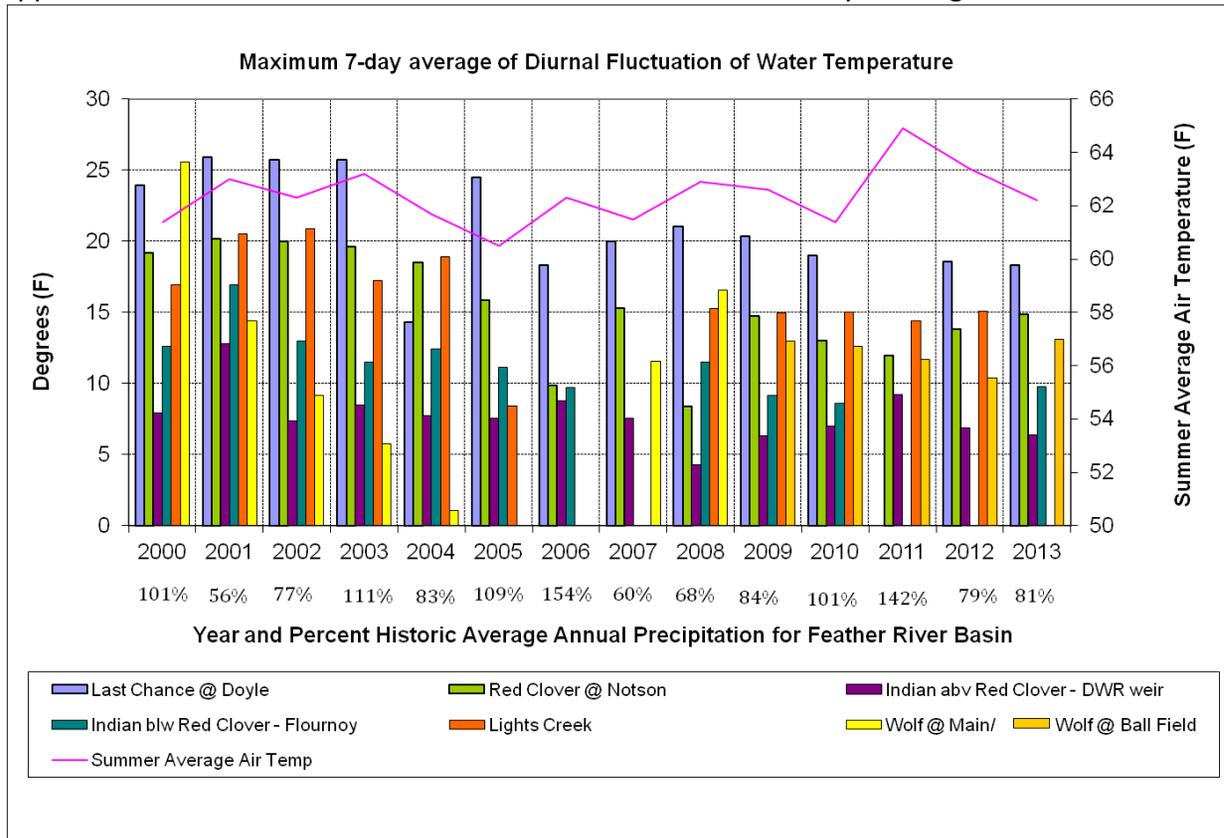


Figure 8. One-time highest value of the 7-day average of water temperature diurnal fluctuation recorded in 2000-2012 for all Indian Creek watershed stations.

Stream Flows

A primary purpose of a nested network of stream flow stations is to detect hydrologic change at increasing watershed scales. Data have been collected at these stations since 2000. Stations are located from ten to thirty miles downstream of project focus areas. The expectation is that potential surface and sub-surface base flow changes resulting from restoration would be detected in downstream areas of the watershed. The Indian Creek at DWR weir station is located below Antelope Dam. Releases from Antelope dam are regulated year-round, thus this station does not represent natural flow conditions. Summarized data for 2013 were not yet available from DWR's Indian Creek below Indian Falls station.

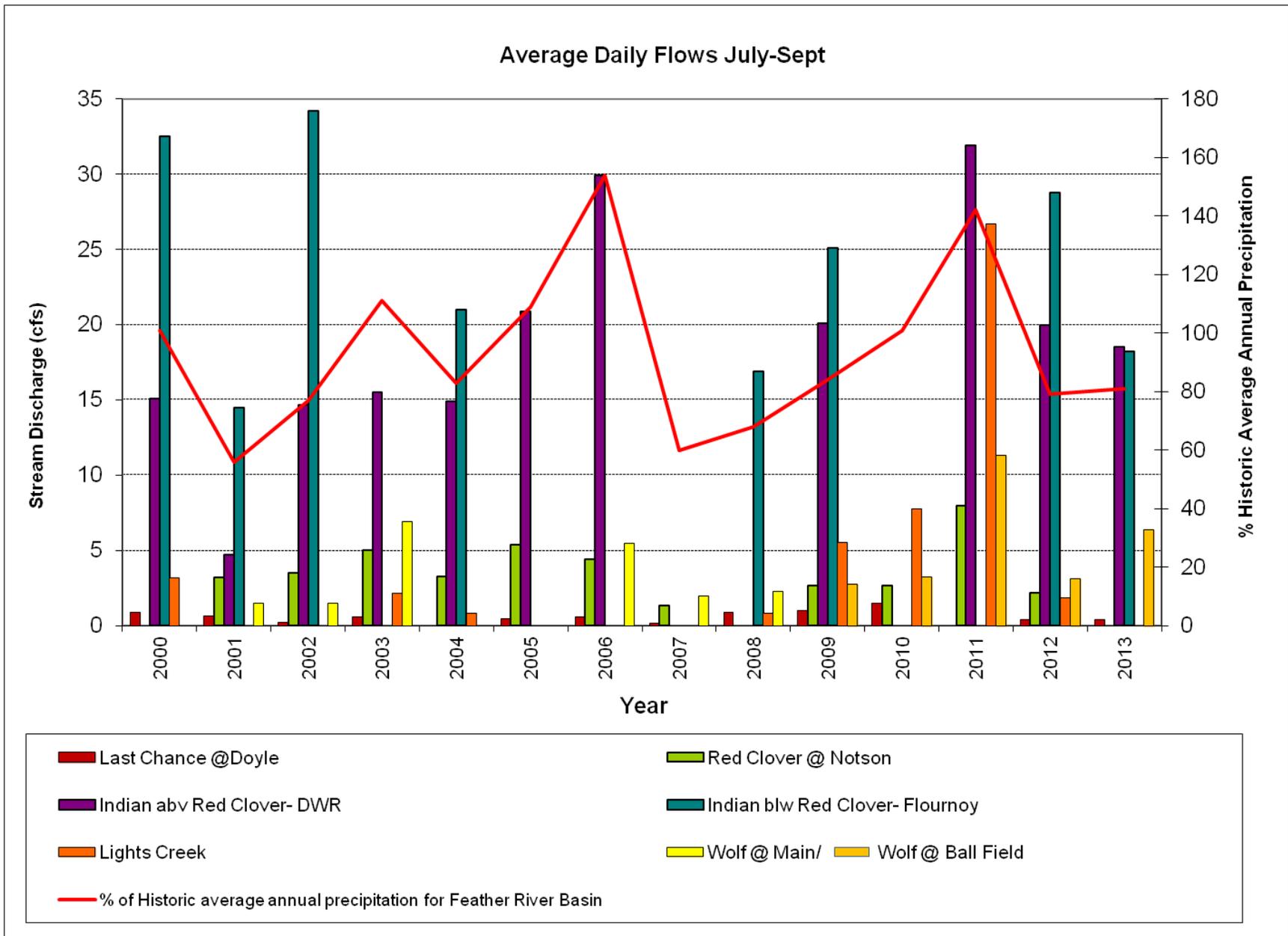


Figure 9. Average Summer Stream Flows from 2000-2012 at Plumas Corporation Indian Creek flow stations.

August and September Flow Volumes for Last Chance and Red Clover Creeks

Due to the increasing interest in late season water volumes emanating from the upper watershed, these monitoring reports have begun reporting a year-to-year volume of flow for August and September from the Notson and Doyle stations. Due to a transducer sensor error, data from Red Clover Creek at Notson Bridge are not available for 2013. The 2012 Watershed Monitoring Report included a more specific comparison of these flow volumes in 2002 and 2012 because of the similarities of these water years, and the pre- and post-restoration conditions between these years. Both Notson and Doyle showed increases in flow in 2012 compared to 2002. The question remains as to whether or not that increase is statistically significant. Ken Cawley's statistical analysis of FR-CRM station flow data through 2010, however, found no correlation (positive or negative) between stream restoration and base flow at either Notson Bridge or Doyle Crossing. Plumas Corporation continues to seek funding to extend the analysis into more recent years.

The following figure displays the acre-feet of water in Last Chance Creek at Doyle Crossing from August 1 through September 30 in water years 2000 through 2013. The volume is calculated by summing the daily average stream flows in August and September (in cfs), and multiplying by 1.9835 (A flow of 1 cfs for 24 hours equals the volume of 1.9835 acre-feet of water).

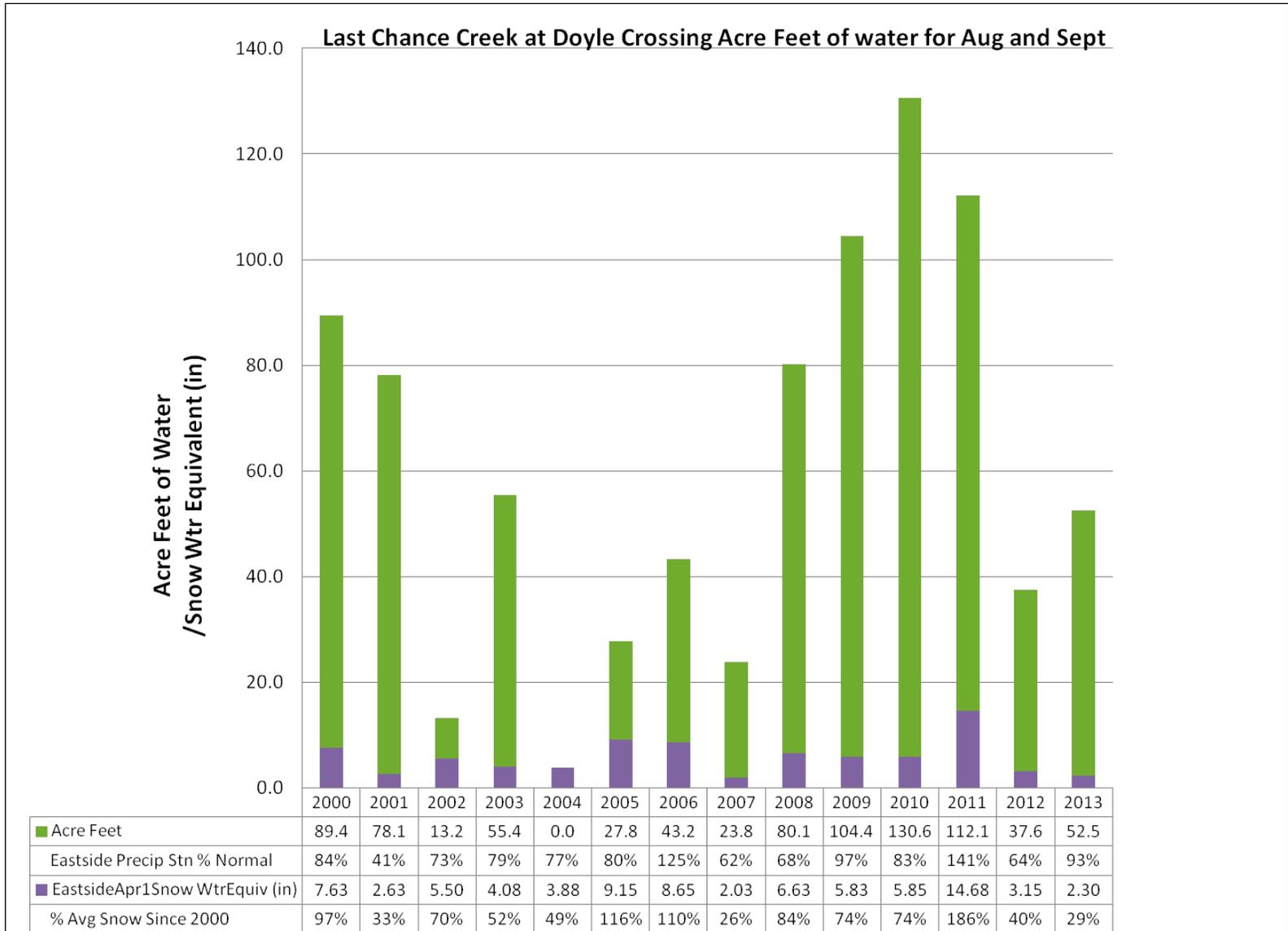


Figure 10: Late season flow volumes on Last Chance Creek at Doyle Crossing with annual precipitation and snow water equivalent data. Low flow data are unavailable for 2004 after September 5 due to equipment malfunction.

Watershed Hydrographs

The following figures display Daily Average Stream Flow from continuous recording stations in WY2013 with precipitation data taken at the closest representative weather stations. More than one station hydrograph is displayed in some charts when appropriate. Note that Y axis scales vary between graphs to increase readability. There appears to be a discrepancy between the relatively new gage on Spanish Creek at the Lower Spanish Ranch Bridge, and the USGS gage near the QCSD plant. The upstream gage (Spanish Ranch Bridge) shows consistently higher flows, which does not intuitively make sense, although it is difficult to tell where/if there may be an error. The USGS data are provisional. The Spanish Ranch Bridge has relatively few calibration measurements.

Please Note: Due to the low spring run-off, there were insufficient high flow calibration measurements! High flows should be considered only as estimates.

Wolf Creek at Ball Field Bridge - 2013

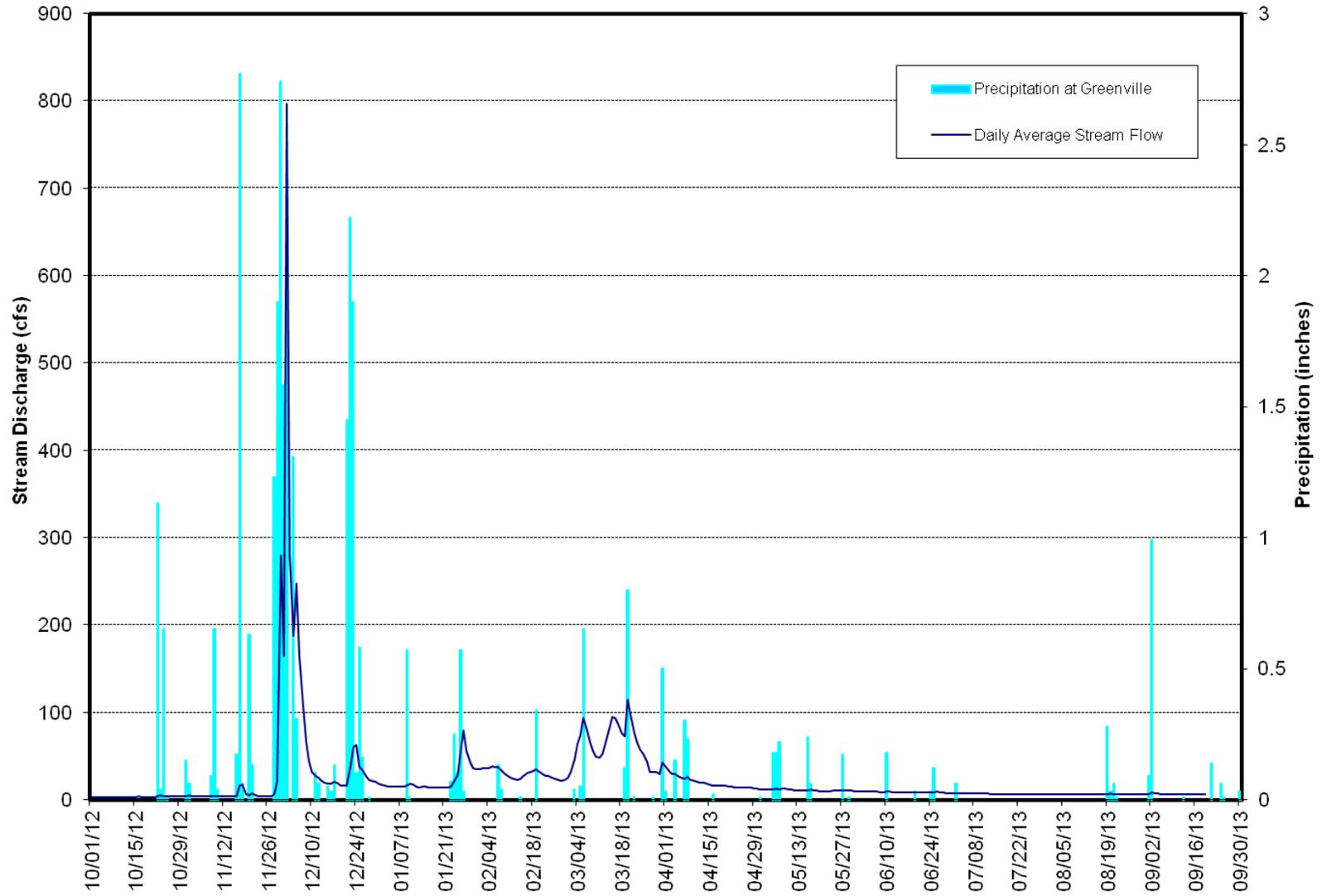


Figure 11: Wolf Creek at Ball Field Bridge Hydrograph 2013WY. High flows are only estimates.

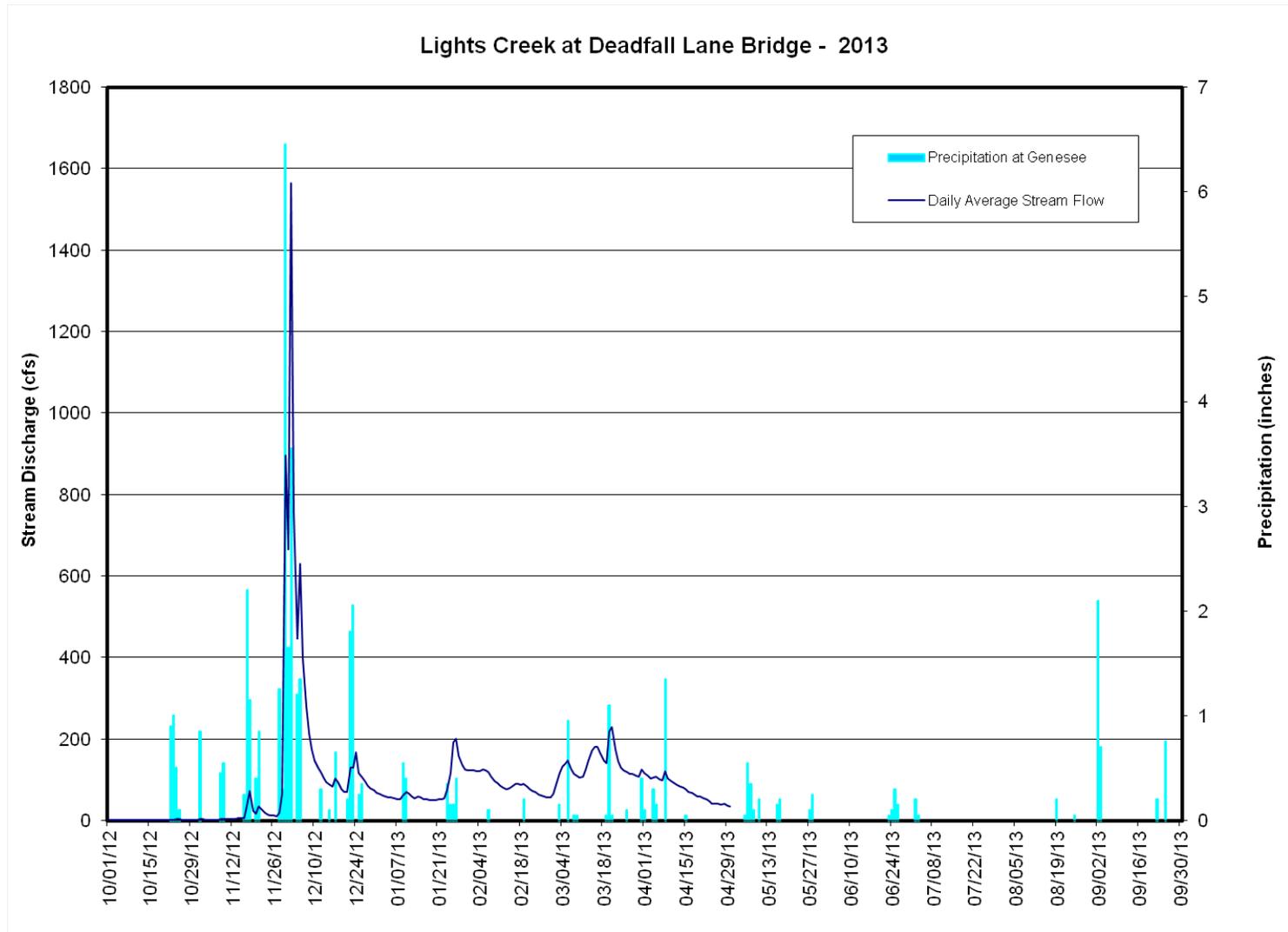


Figure 12: Lights Creek at Deadfall Lane Bridge Hydrograph 2013WY. High flows are only estimates. Station failed in April and is discontinued.

Indian Creek at DWR Weir abv Red Clover Creek - 2013

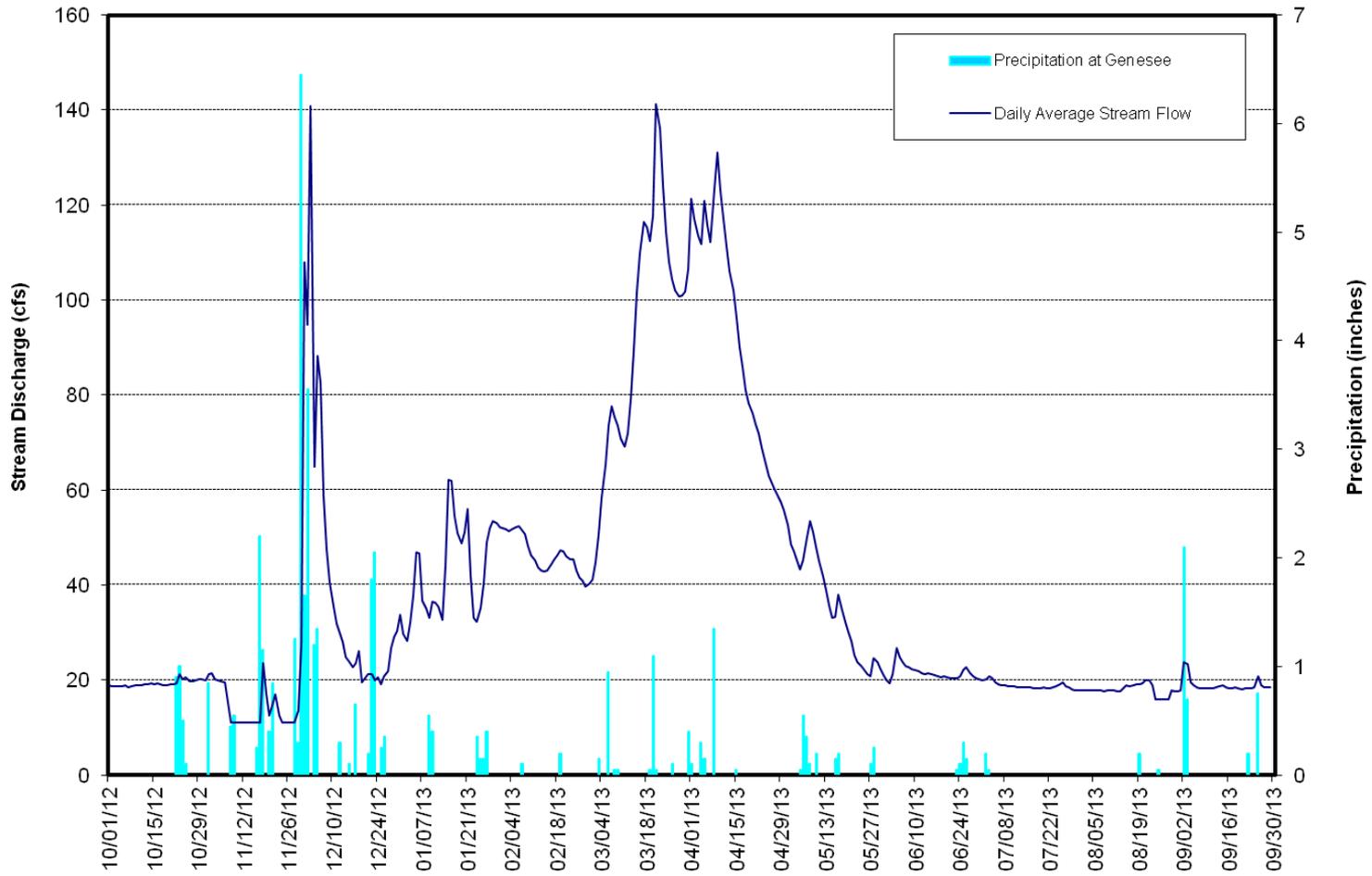


Figure 13: Indian Creek at DWR Weir Hydrograph 2013WY. Gage affected by operations of Antelope Lake. High flows should be considered estimates only.

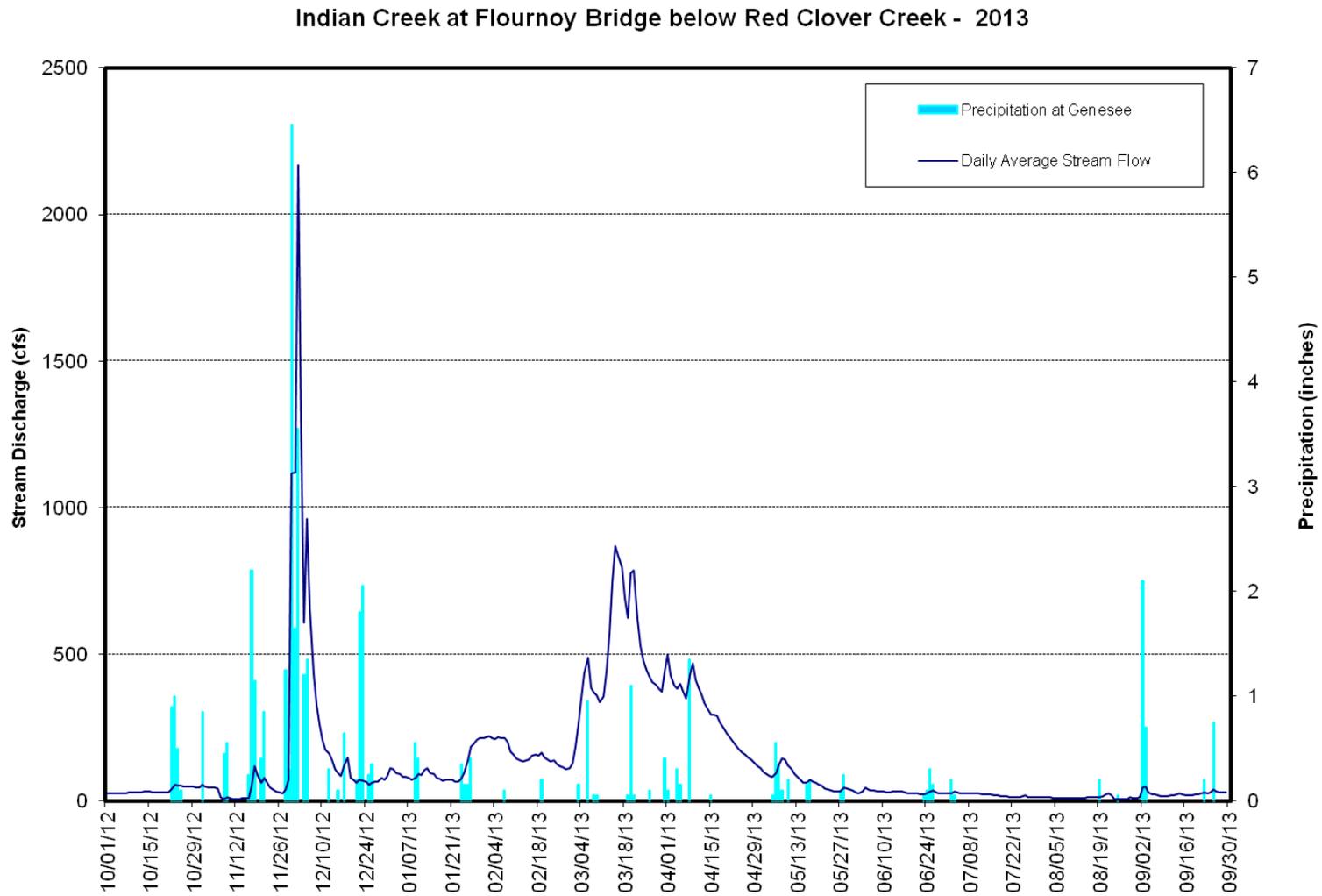


Figure 14: Indian Creek at Flournoy Bridge Hydrograph 2013WY. High flows should be considered estimates only.

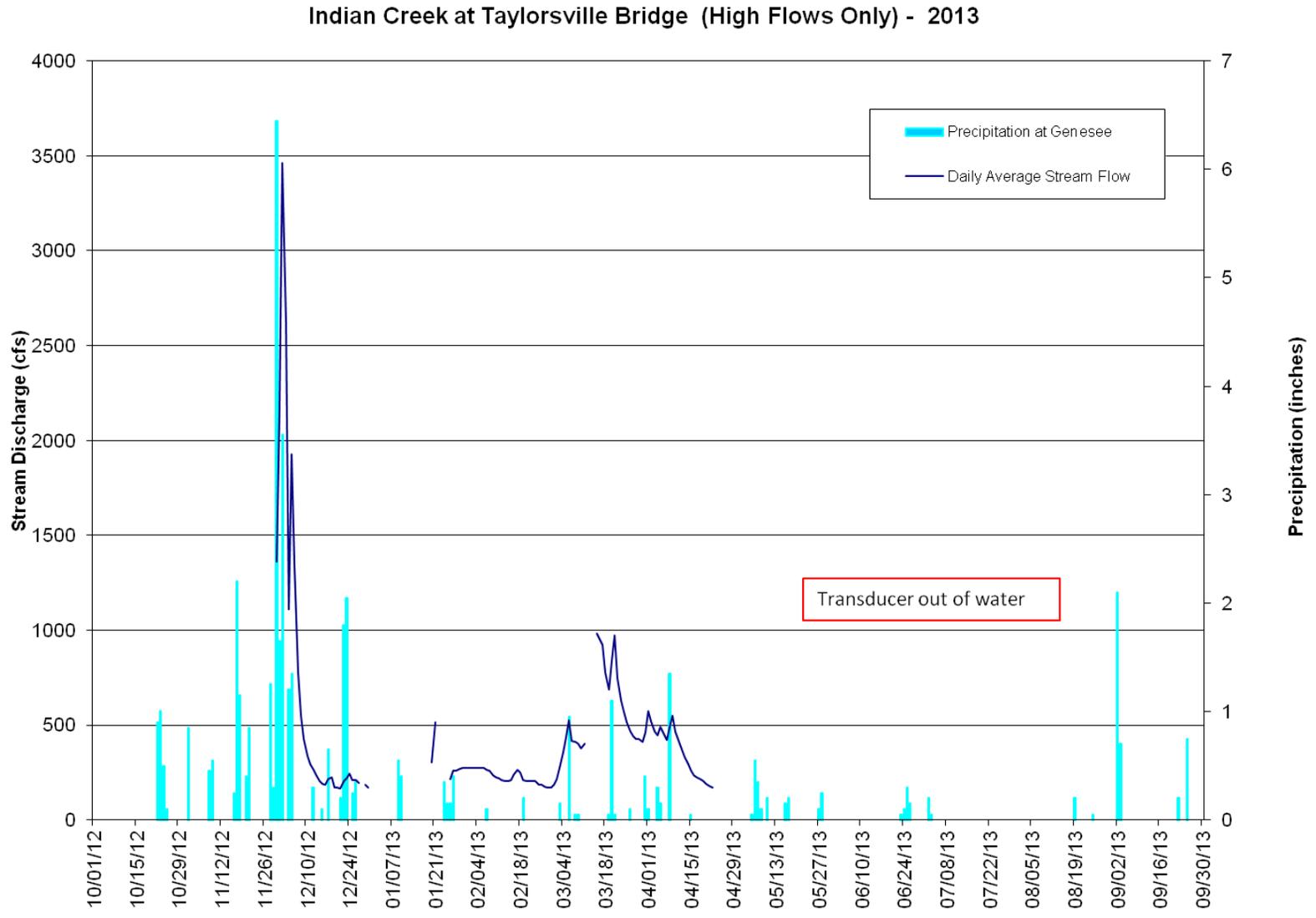


Figure 15: Indian Creek at Taylorsville Bridge Hydrograph 2013WY – High flow station only, but high flows are estimates.

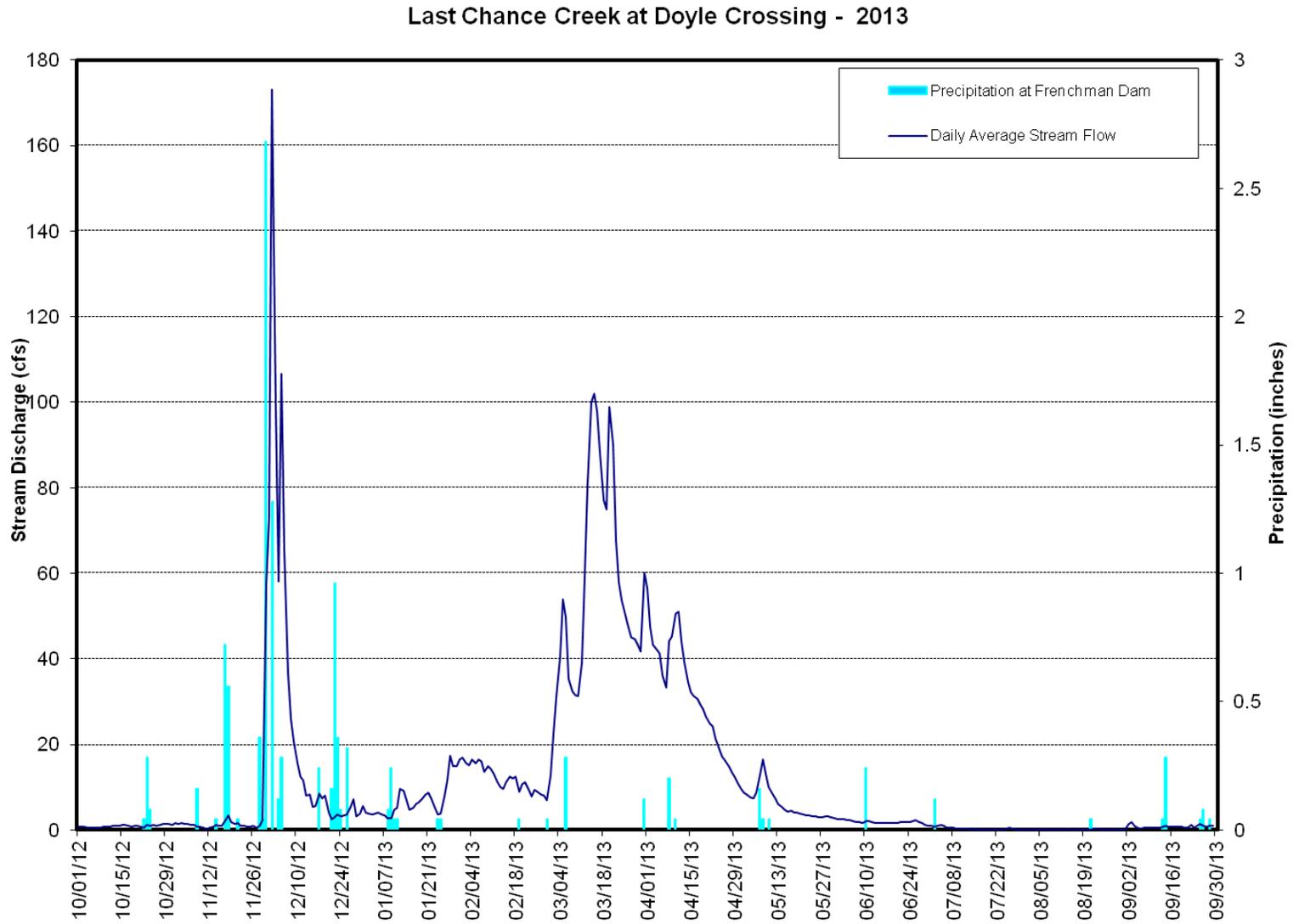


Figure 16: Last Chance Creek at Doyle Crossing Hydrograph 2013WY. High flows are estimates only.

Red Clover Creek at Notson Bridge - 2013

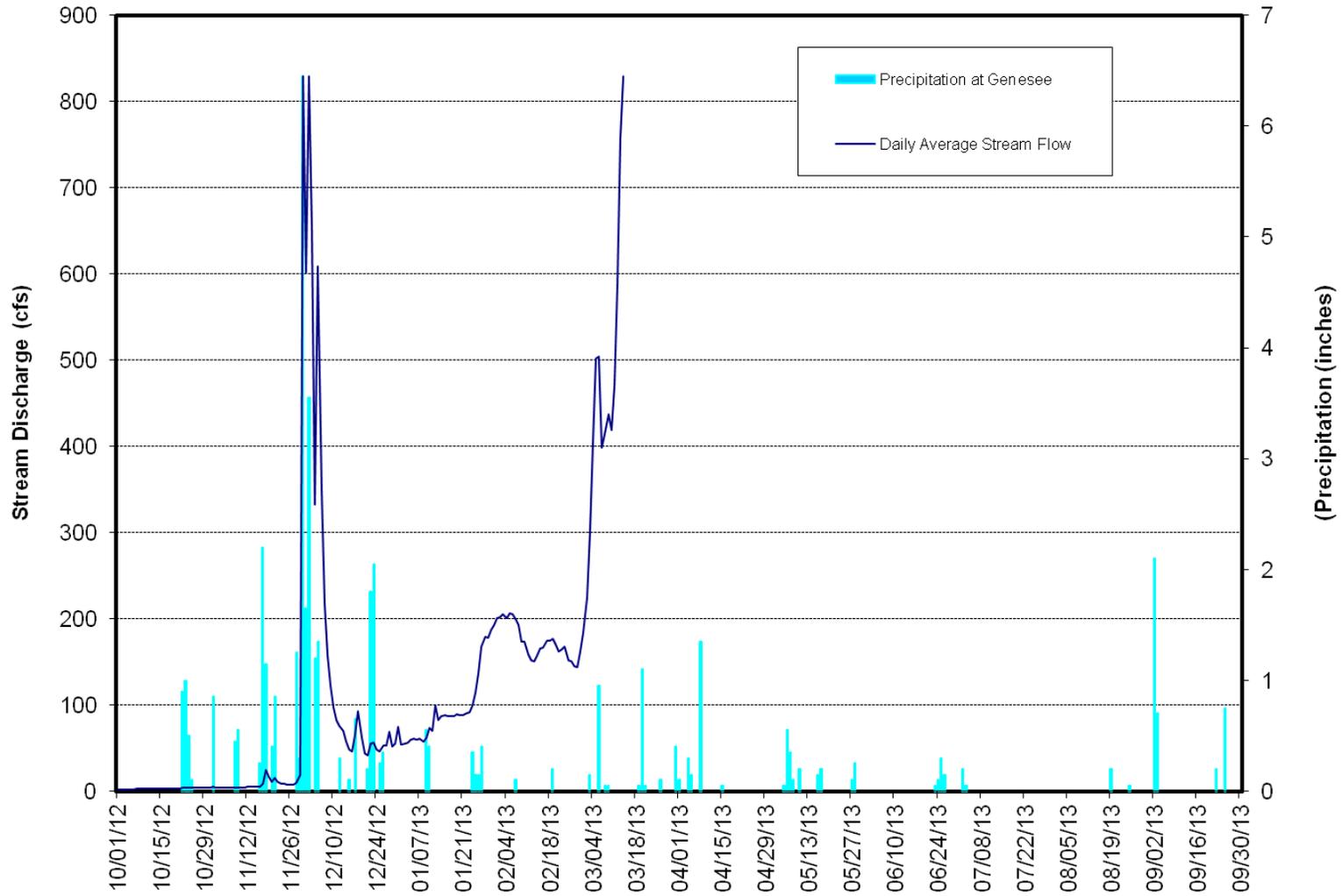


Figure 17: Red Clover Creek at Notson Bridge Hydrograph 2013WY. High flows are estimates. Transducer error from March through end of water year.

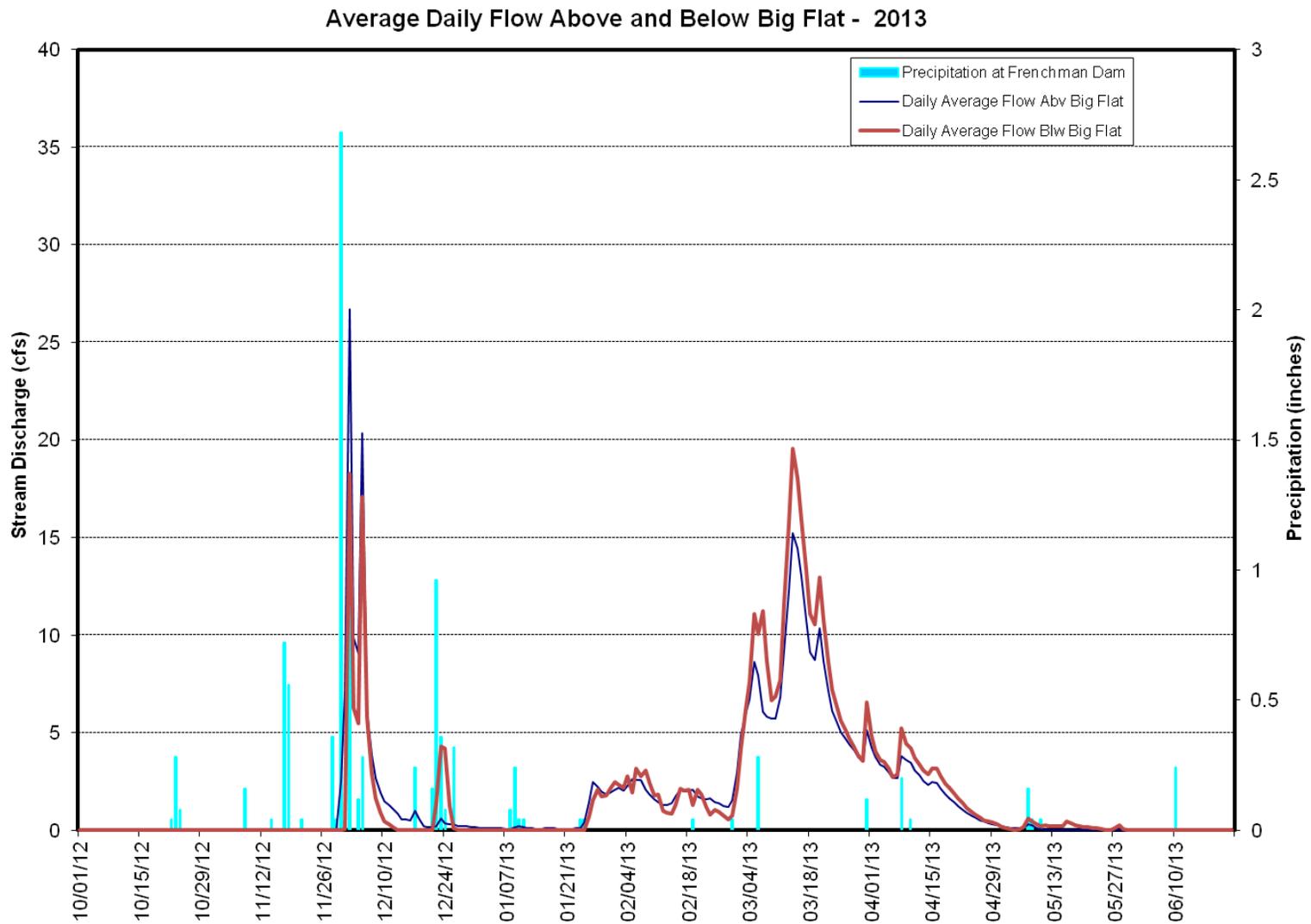


Figure 18: Cottonwood Creek above and below Big Flat project area hydrograph 2013WY. High flows are estimates.

Last Chance Creek at Million Dollar Bridge - 2013

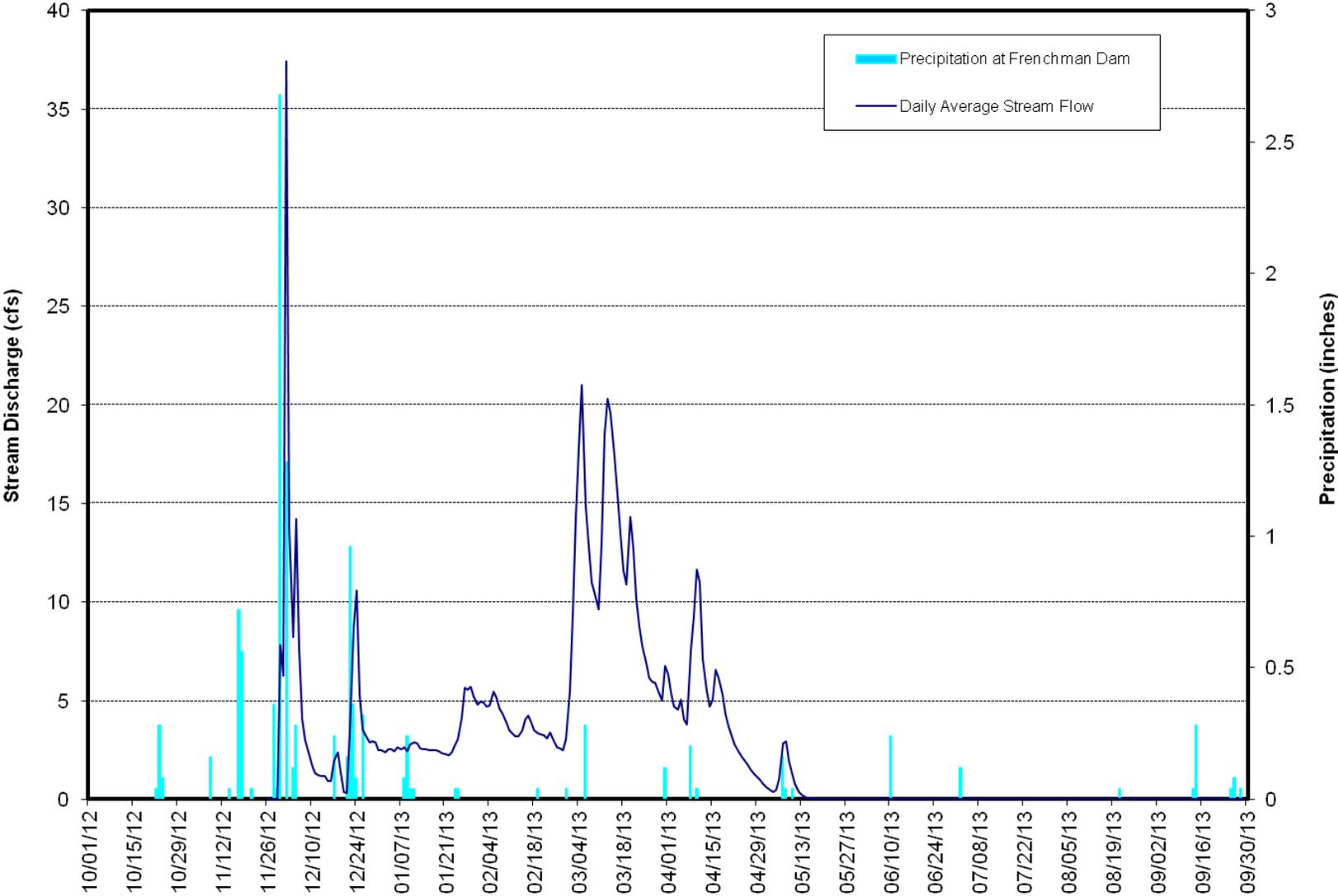


Figure 19: Last Chance Cr at Million Dollar Bridge hydrograph 2013WY. High flows are estimates.

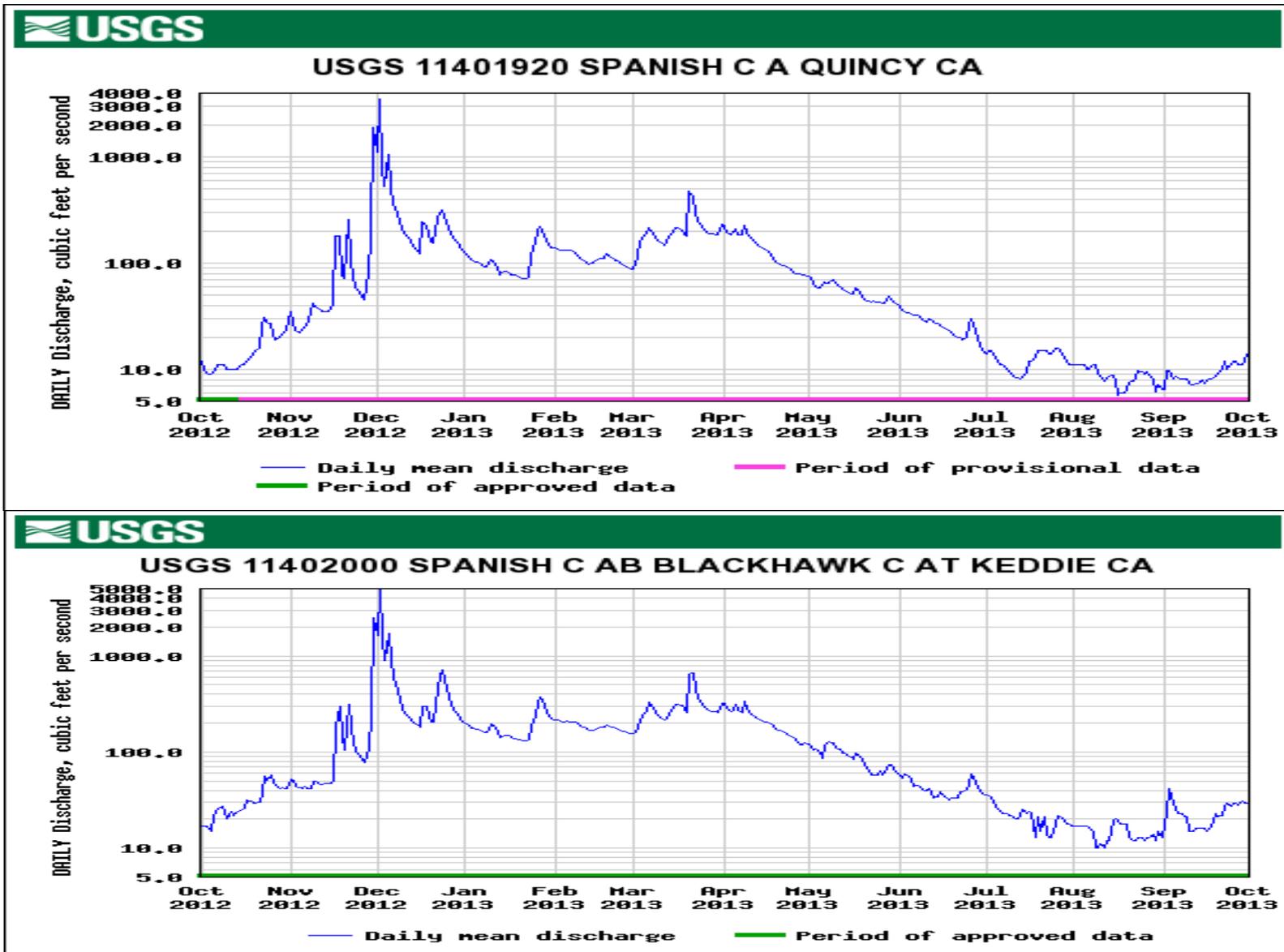


Figure 20: Two Spanish Creek USGS gages. The Quincy station is at the QCSD plant. The Keddie station includes the Greenhorn Cr, etc watersheds.

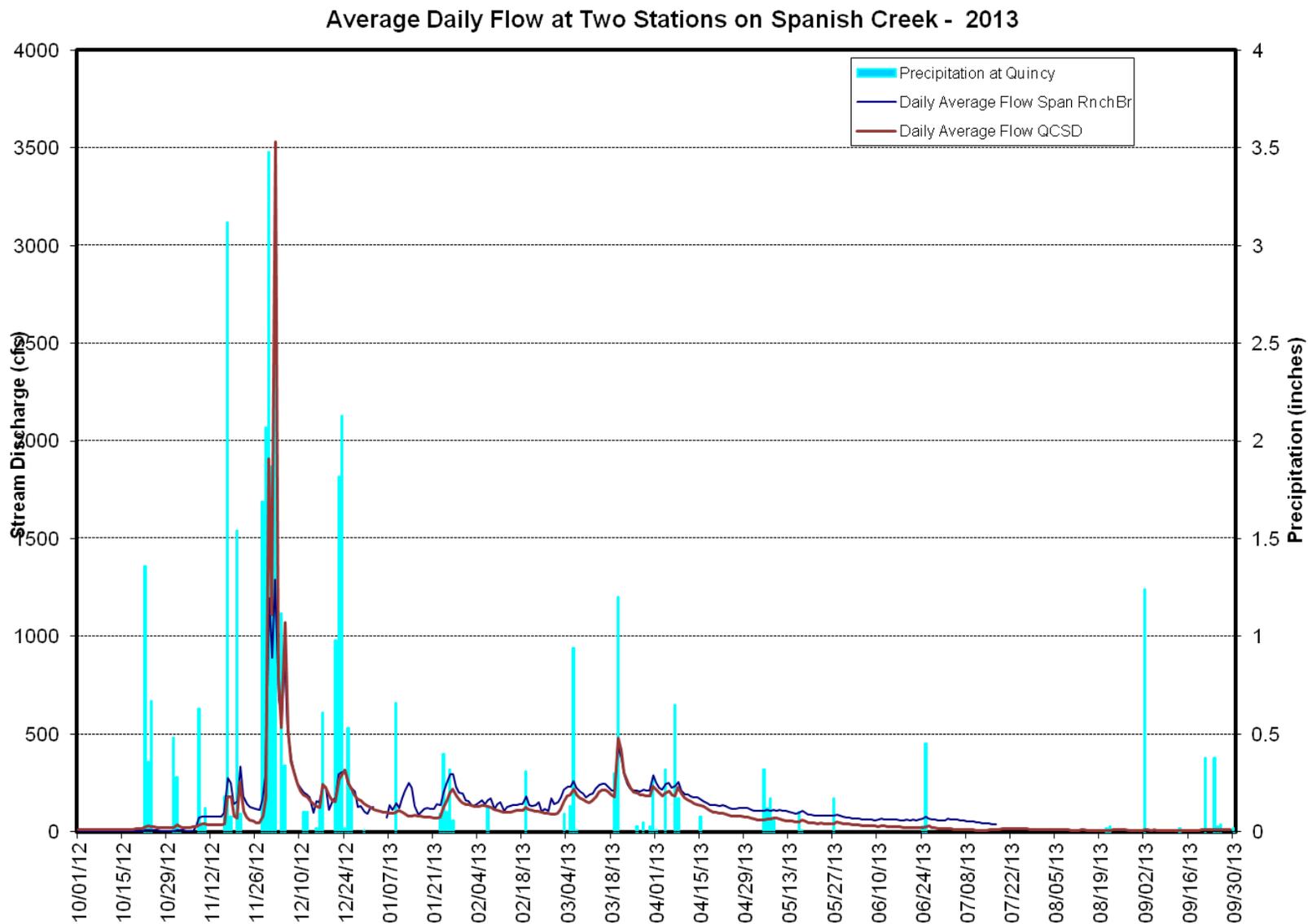


Figure 21: Comparison of Spanish Creek PNF and USGS Quincy gages 2013WY. Data are suspect, since this shows higher flows consistently at the upstream station. More calibration measurements at a variety of stages are needed, particularly at the Spanish Ranch Bridge. High flows not calibrated. The logger at the PNF station was replaced in Nov 2012.

Sulphur Creek at McKenzie Cr - 2013

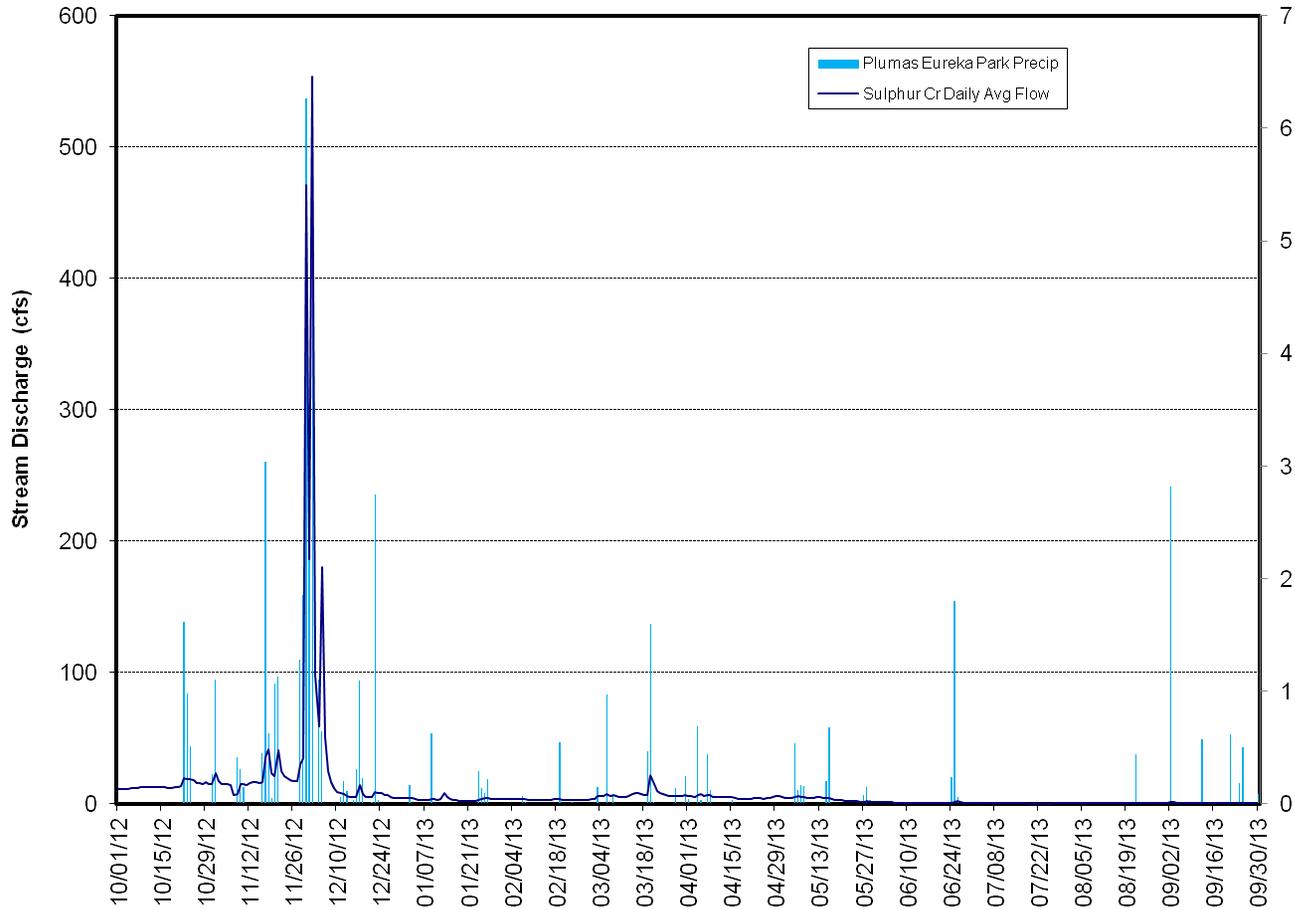


Figure 22: Sulphur Creek below McKenzie Creek Hydrograph 2013WY. The nearest weather station is located near Graeagle at the Plumas Eureka State Park. As in the other graphs, precipitation is on the right Y axis in inches. High flows not calibrated. The logger at this station was replaced in November 2012.

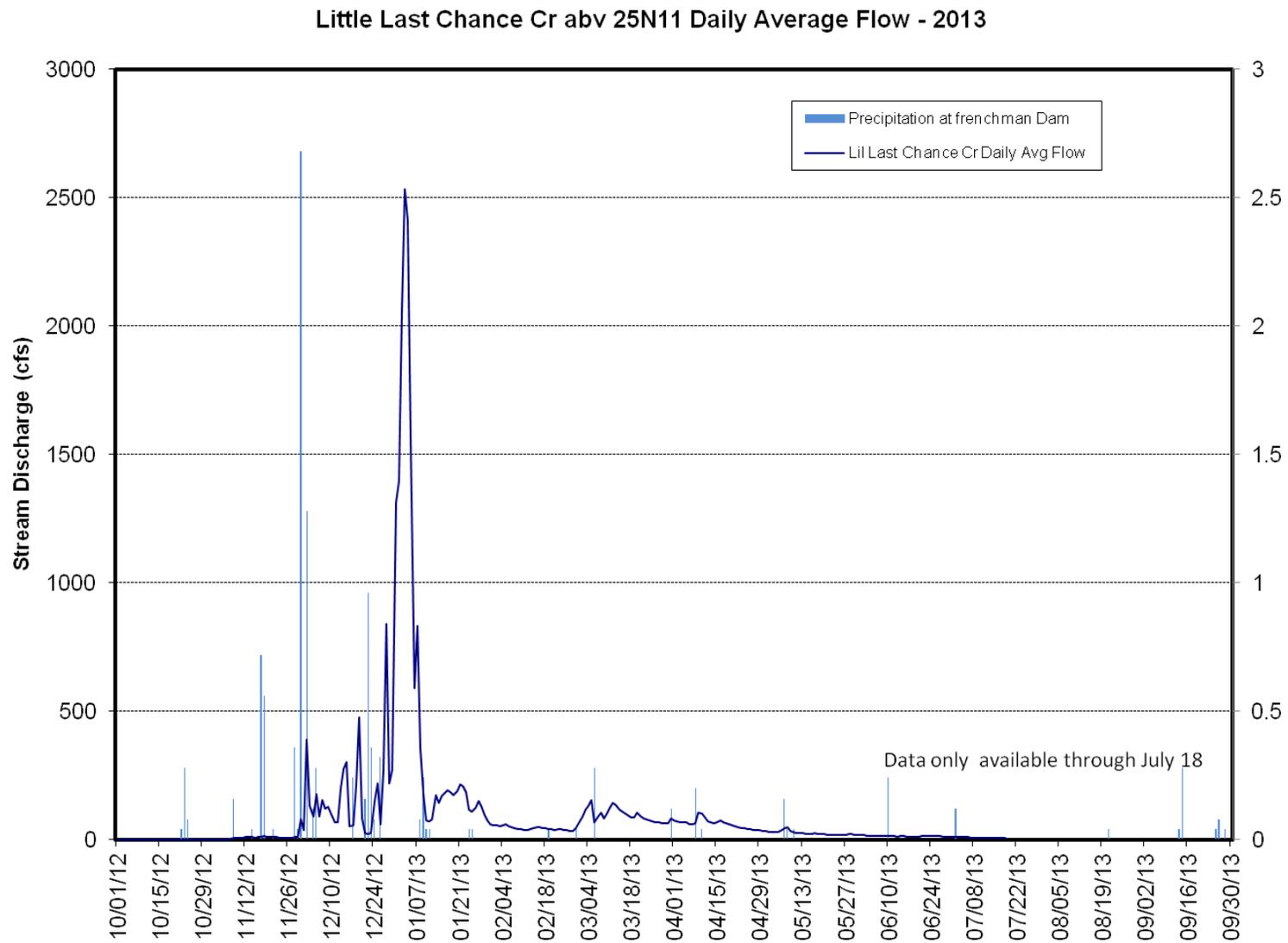


Figure 23: Little Last Chance Creek above 25N11 Hydrograph 2013WY. Precipitation is on the right Y axis in inches. Data after July 18 should be available in the 2014 report. High flows not calibrated.

Conclusion

The 2013 Water Year was characterized by 81% of historic annual precipitation, after a year of below average precipitation in 2012. Maximum water temperature improvements on Red Clover Creek in pre- versus post-project conditions appear to be continuing through 2013, although no conclusion can be drawn on cause and effect, considering temperature improvements on Last Chance in the same year groupings, and some improvement on Indian Creek at the DWR weir.

Due to a paucity of high spring flows and measurements, high flow data cannot be considered accurate. Most low flow data are well calibrated, and can be considered accurate, however, at such low flows, accuracy down to the tenth of a cubic foot per second is suspect. Accuracy is probably closer to 0.25 cfs than 0.1. Additional calibration flow measurements are needed on the relatively new Forest Service stations, especially at the higher flows.

Statistical analysis has not yet shown any significant difference in flows due to restoration, except on Cottonwood Creek above and below Big Flat. The 2011, 12 and 13 water years were not analyzed for significance in Ken Cawley's 2011 report. It is hoped that funding will soon be available to extend the analysis into recent years.

This year, an analysis of the difference between daily max and min flows during storm peaks was conducted on the Red Clover Creek flow data at Notson Bridge to see if there was a difference in pre-project (before 2006) versus post-project (after 2006) conditions. The first storm of the season, and the highest storm peak of the season were compared. There was no discernible difference between pre- and post-project conditions in either storm set. The last peak of the season was not analyzed, but may be a fruitful analysis. Confounding factors in the analysis were the limited data set, rule-making on exactly what constituted a storm peak, using the calendar day 24 hour cycle (instead of a cycle based on each event), the variability in storm precipitation intensity and timing, and multi-year climatic conditions. Time and budgetary constraints prohibited further data analysis of the watershed monitoring data, however, for next year's report, including daily max and min flows instead of, or in addition to, daily average flows may be useful.

The Lights Creek station and the Million Dollar Bridge station on Last Chance Creek both malfunctioned in 2013, and will not be continued into the future.

Meaningful display and analysis of the remaining and ever-increasing data set used in this report continues to be a challenge.

Appendix A

Comparison of five Eastside Feather River Rain Tube station annual precipitation to Feather River Basin ten-station averages.
All data from California Department of Water Resources

<u>10-station Feather River Basin to Eastside sub-basin Precipitation Comparison 1998-2013</u>												
<u>Water Year</u>	Feather River Basin	Red Clover (Clover Valley) (installed 1965)		Last Chance (Granite Springs) (installed 1969)		Clarks Peak (installed 1959)		Upper Indian (Boulder Cr) (installed 1969)		Little Last Chance (installed 1960)		Deviation of Eastside basins from FR Basin Percent
		% normal	inches	% normal	inches	% normal	inches	% normal	inches	% normal	inches	
		45" is normal precip										
1998	144%	122%	25.87	123%	22.85	119%	27.33	124%	32.30	133%	24.33	-20%
1999	99%	120%	25.70	114%	21.25	104%	23.90	102%	26.45	106%	19.30	10%
2000	101%	91%	19.40	75%	13.80	85%	19.50	87%	22.50	81%	14.80	-17%
2001	56%	42%	8.80	41%	7.45	45%	10.25	42%	10.75	37%	6.60	-15%
2002	77%	60%	12.50	83%	15.00	78%	17.65	78%	19.75	66%	11.65	-4%
2003	111%	75%	15.50	75%	13.40	89%	20.10	83%	20.8	74%	13.00	-32%
2004	83%	75%	15.25	76%	13.50	77%	17.20	82%	20.5	74%	12.90	-6%
2005	109%	34%	6.90	92%	16.35	99%	22.10	87%	21.75	86%	15.05	-29%
2006	154%	150%	30.45	38%	6.55	143%	32.30	147%	37.2	149%	26.35	-29%
2007	60%	68%	13.76	67%	11.51	53%	11.81	66%	16.45	56%	9.77	2%
2008	68%	73%	14.72	73%	12.58	79%	17.57	52%	12.81	63%	10.88	0%
2009	84%	112%	22.45	112%	19.35	91%	20.15	86%	21.05	82%	14.15	13%
2010	101%	99%	20.01	87%	14.90	74%	16.28	72%	17.61	82%	14.11	-18%
2011	142%	148%	30.09	140%	24.30	137%	30.51	126%	30.92	152%	26.46	-1%
2012	79%	72%	14.51	60%	10.28	62%	13.62	62%	15.15	66%	11.44	-15%
2013	81%	111%	22.42	94%	16.19	86%	18.98	94%	22.95	82%	14.19	12%
running avg in 1998		21.22		18.53		22.94		25.98		18.23		
running avg in 2013		20.27		17.17		22.07		24.32		17.25		
decrease in running avg		0.95		1.36		0.87		1.66		0.98		

if yellow outliers were removed, these would be -7% rather than -29%

The period-of-record running averages result in minor fluctuations in annual average year-to-year.

The percent normal figures in the column use the period of record to calculate the running average for each station.

The current dry decade has caused all station averages to drop noticeably since 1998.

The Feather River Basin average is a 30-year running average calculated by DWR.

% normal precip calculated by Plumas Corp by averaging % normals from each of the reporting stations for each year.