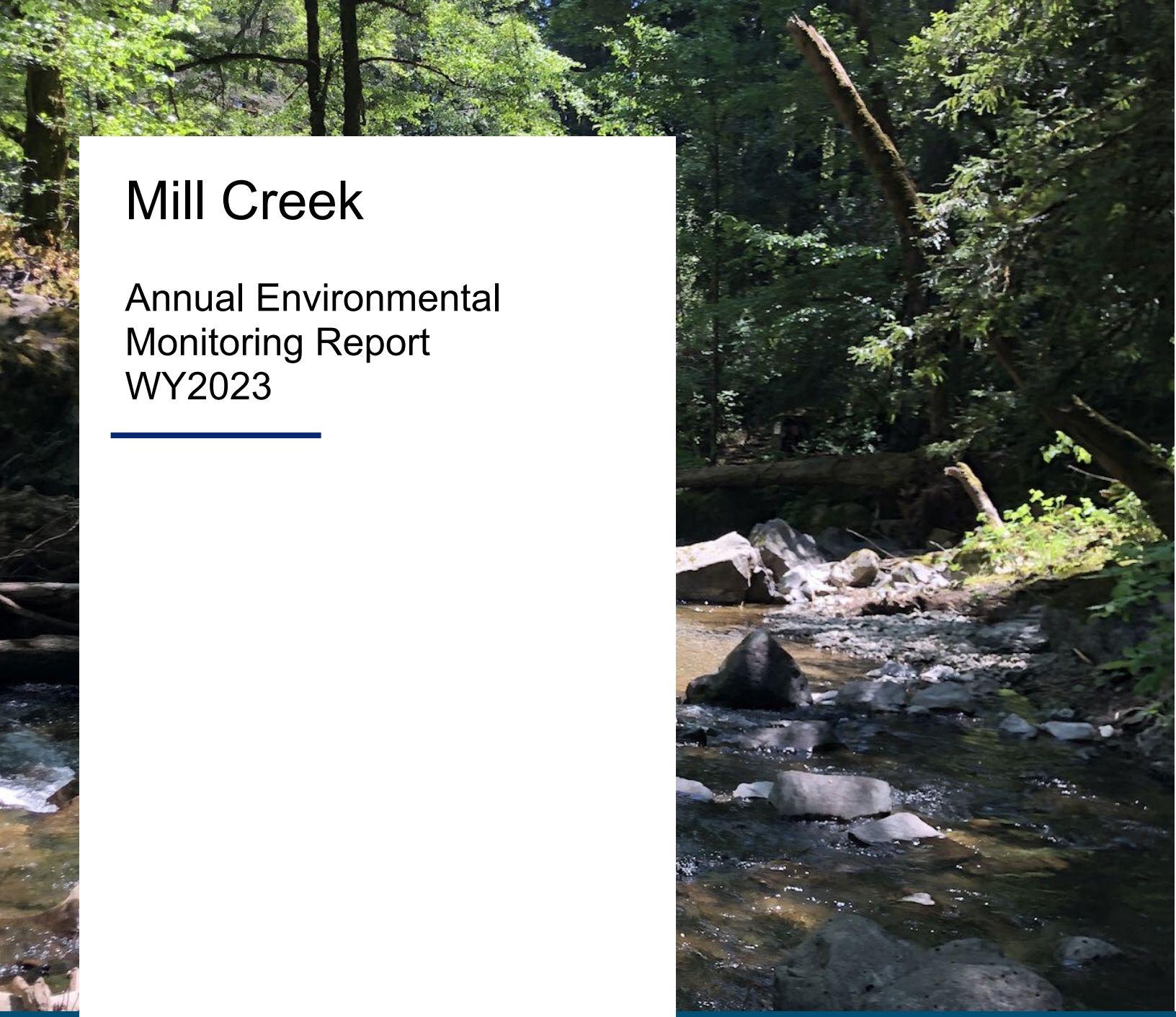

Mill Creek

Annual Environmental Monitoring Report WY2023

MARCH 26, 2024

Prepared for the Wildlife Conservation Board

Prepared by: Trout Unlimited

Contents

1. Introduction

The Russian River Coho Water Resources Partnership (Coho Partnership) identified insufficient summer streamflow as a primary limiting factor in the Mill Creek system and developed a Streamflow Improvement Plan outlining strategies and project types to enhance streamflow conditions in the watershed (RRCWRP 2015). In April 2020, Trout Unlimited (TU), California Sea Grant's Russian River Salmon and Steelhead Monitoring Program (CSG) and Sonoma Resource Conservation District (SRCD) (members of the Coho Partnership) were awarded a Wildlife Conservation Board (WCB) grant to enhance streamflow in the Mill Creek watershed (Russian River, Sonoma County). This Mill Creek Water Storage for Flow Enhancement Project aims to increase summer streamflow in the watershed by developing a series of storage and forbearance projects that will decrease dry-season demand on instream flows.

One aspect of this WCB project is to operate monitoring programs that provide baseline data on streamflow in Mill Creek. The project overview map (Figure 1) shows the streamflow gage locations in the Mill Creek watershed. This report is the third of three annual reports prepared by TU to describe the results of annual streamflow and environmental monitoring activities.

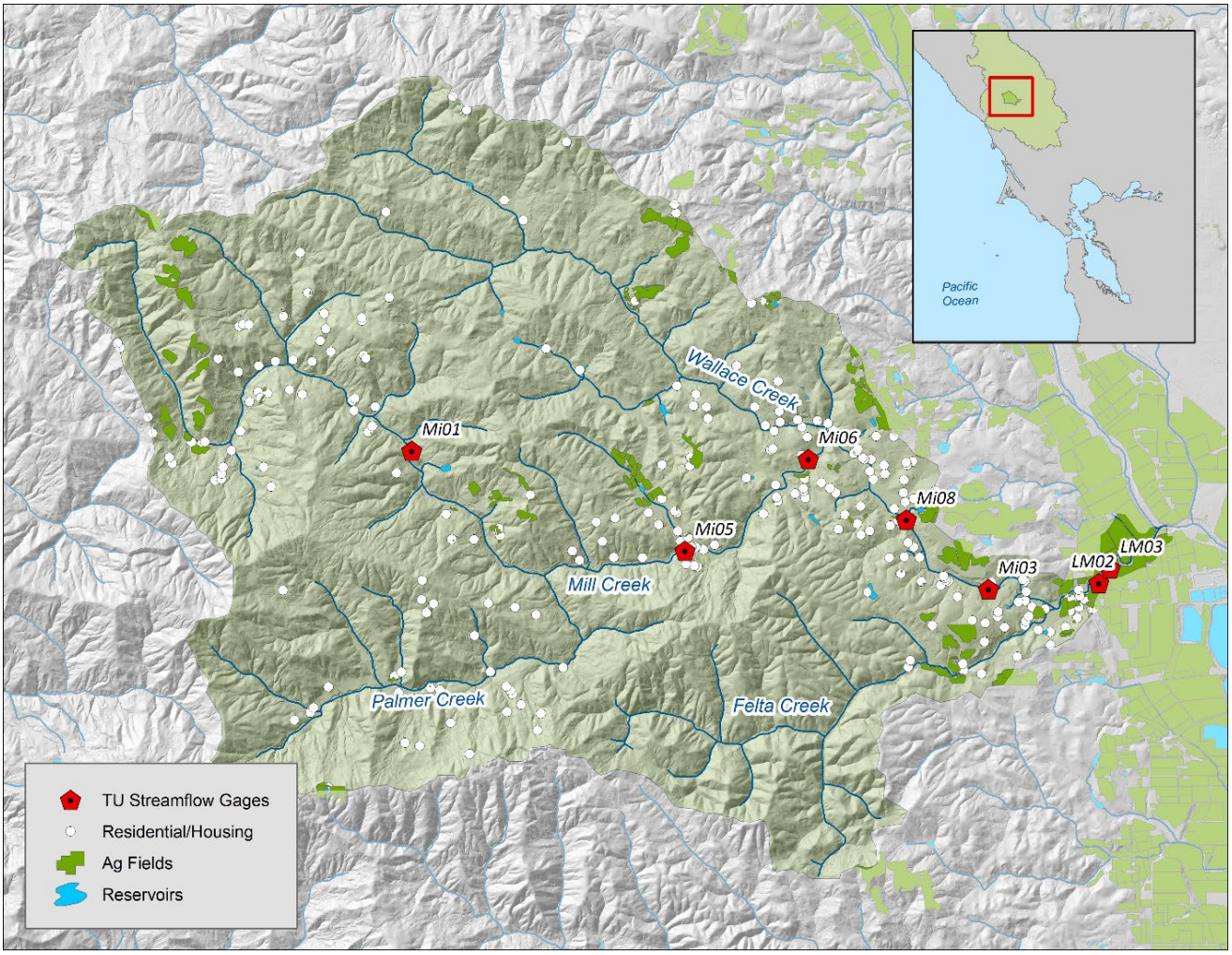

Figure 1. Project overview map, including TU's streamflow gage network and land use – showing potential water use in the watershed.

2. Fire

In summer 2020 the Walbridge fire, part of the LNU Lightning Complex fires, burned the upper portions of the Mill Creek watershed. Between August 17 and October 2, 2020, the fire burned more than 55,000 acres and destroyed more than 150 homes in the rugged hills of northwestern Sonoma County. Sixty-three percent of all accessible salmonid habitat within the Mill Creek watershed was within the Walbridge Fire footprint (https://caseagrant.ucsd.edu/blogs/the-walbridge-fire-and-salmon-habitat). The upper extent of Mill Creek, Felta, Wallace and Palmer creeks experienced extensive burning of the upslope forests as well as the riparian corridor (Figure 2). The burn intensity was greatest in the furthest upstream reaches of Mill Creek, leaving this area exposed to far greater solar radiation and erosion potential than the rest of the watershed. The impact of the fire on streamflow and habitat conditions is largely unknown. This study is the first empirical data collected and evaluated post fire, and this report describes conditions three years after the fire. .

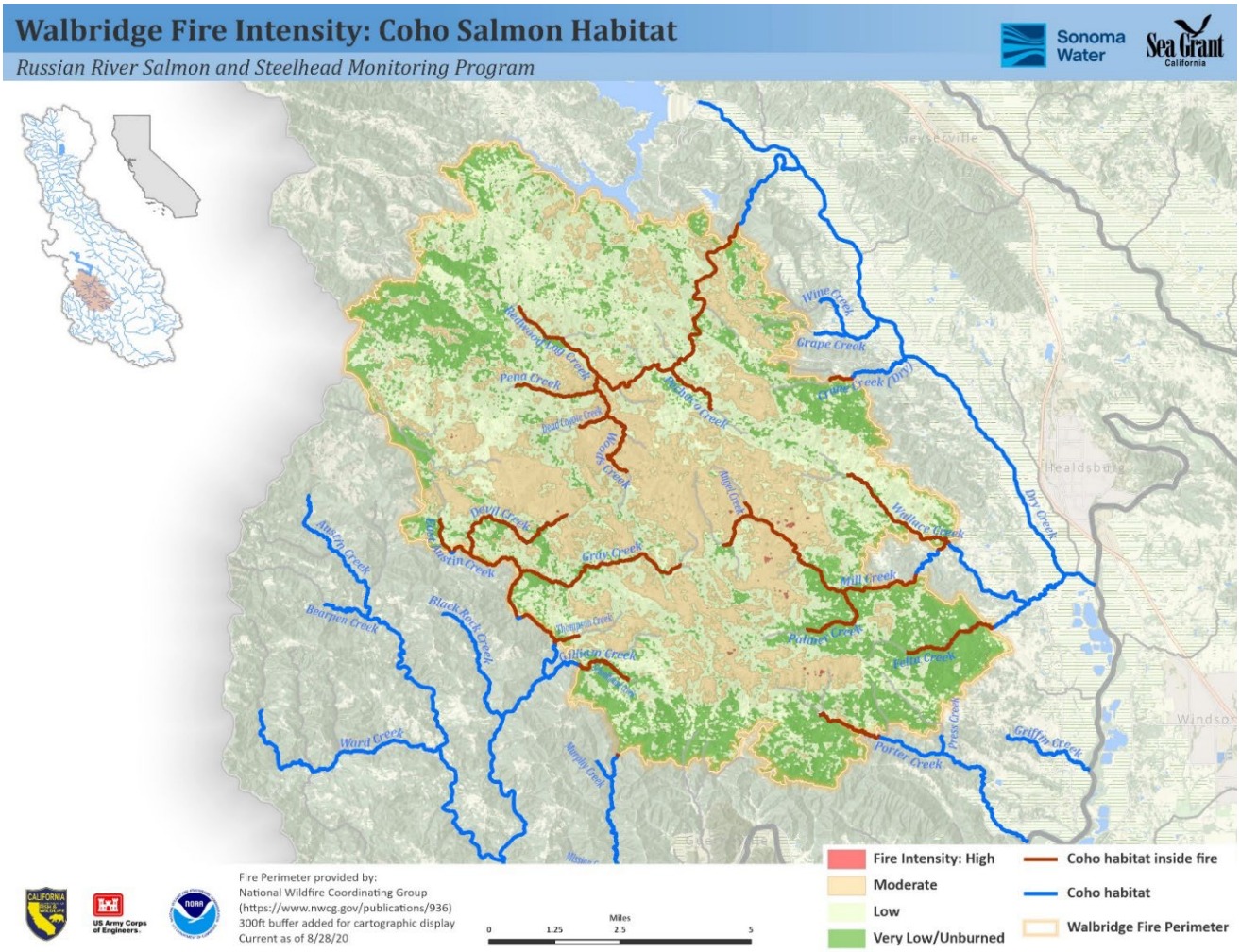

Figure 2. The Walbridge Fire footprint and fire intensity in relation to coho salmon habitat in the lower Russian River basin, including the Mill Creek watershed.

3. Rainfall

Rainfall data were recorded over an 82 water year (WY) period in nearby Healdsburg, CA at National Climatic Data Center (NCDC) Station # 3875 (Healdsburg station, hereafter), median average rainfall at the Healdsburg station is 37.5 inches (Figure 3). Total rainfall in WY2023 was 51.9 inches, 14.4 inches above the long term median, and 20.4 inches higher than the previous year, WY2022 (30.44 inches).

Figure 4 shows total monthly rainfall recorded during in water year 2023, along with the average monthly rainfall for the 82-year period of record. WY2023 was a well-above average water year, with rainfall 14.4 inches higher than the median, and the highest rainfall on record at the Healdsburg station since 2006. After a wet December, WY2023 experienced the highest rainfall over the water year in January (18.7 inches), followed by a somewhat dry February. The second-wettest month of the year was March 2023 (14.1 inches).

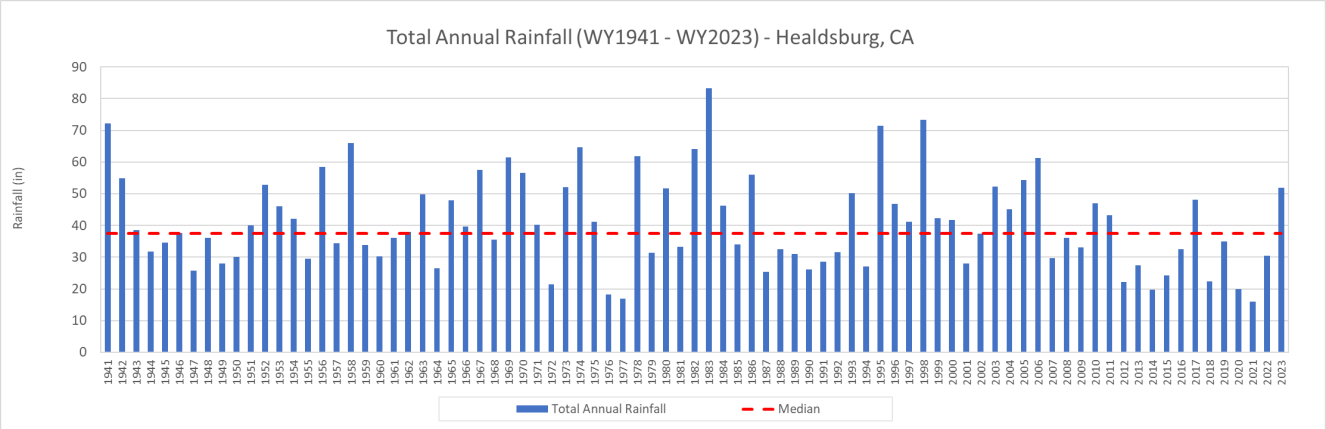

Figure 3. Total and median annual precipitation recorded in Healdsburg, CA (1941-2023) from NCDC station 3875.

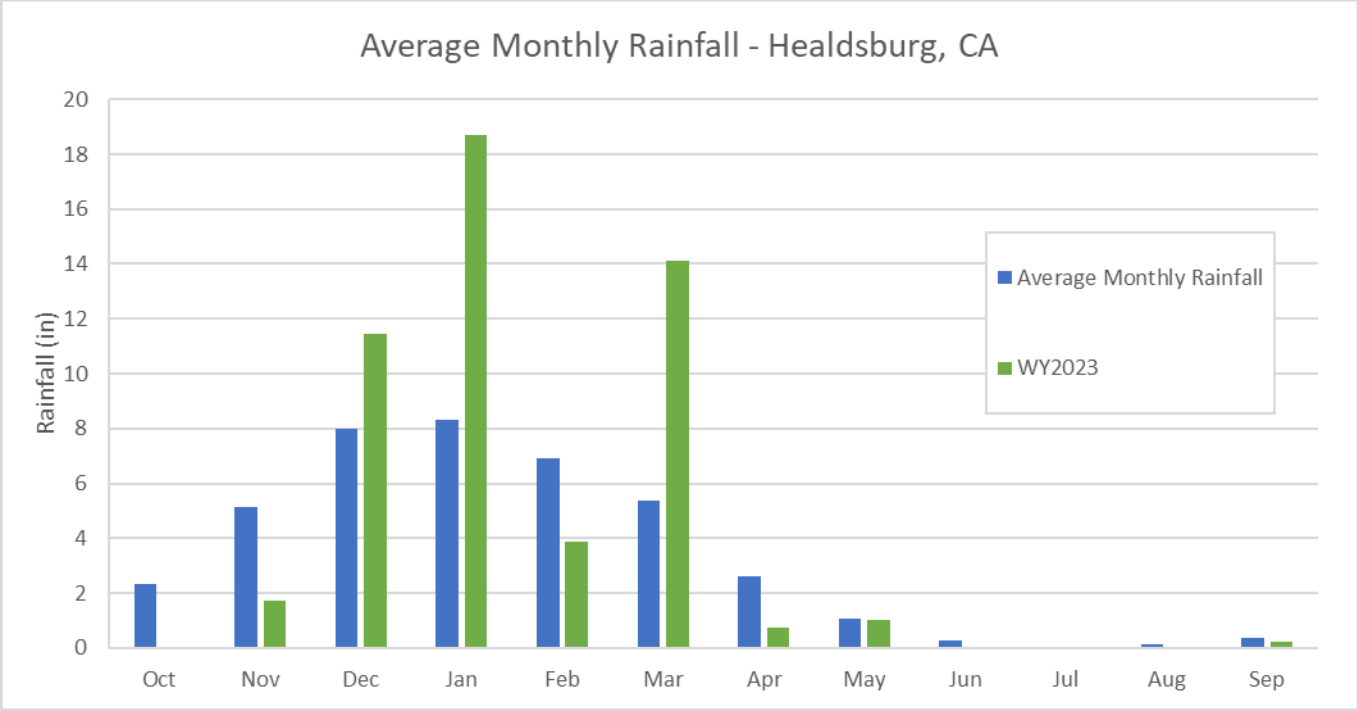

Figure 4. Total monthly precipitation in water year 2023 vs monthly average rainfall recorded in Healdsburg, CA from NCDC station 3875.

4. Streamflow

Streamflow was monitored at five sites in the upper Mill Creek watershed and one site in the lower Mill Creek watershed (to evaluate surface and groundwater dynamics) (Figure 1). Adjusted stage data and discrete discharge measurements were used to develop hydrographs for each of the monitored sites for the study period. This section describes stage in WY2023 for all gage sites in the upper watershed, in order from upstream (Mi01) to the farthest downstream (Mi03).

(Mi01) Mill Creek at Bear Flat

At site (Mi01) Mill Creek at Bear Flat, stage began to rise in response to the first storms of the year in late December 2022 (Figure 5). Stage rose notably in mid-January in response to the first of the large storm cycles of the winter. At its highest level, stage rose above 5 feet. The gage was dislodged from the bank during the large storms of mid-January, then repaired in the spring; data from between the damage and repair has been omitted. Stage began to recede in early April, then then fell through September.

Figure 6 shows dry season streamflow conditions at Mill Creek at Bear Flat in WY2023. Streamflow in early May 2023 was recorded at approximately 4.2 ft^3/sec. Flow slowly receded through May, June and August, before reaching a baseflow of about 0.5 ft^3/sec in late August.

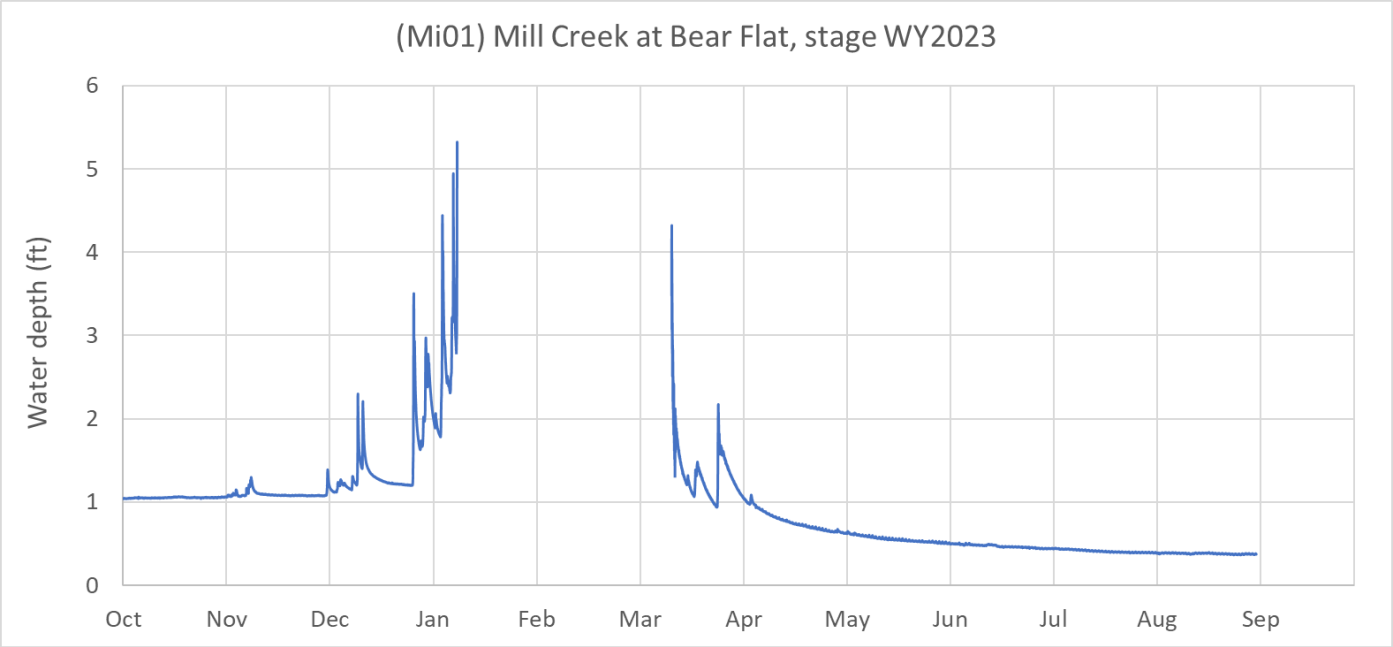

Figure 5. Stage at Mill Creek at Bear Flat, WY2023.

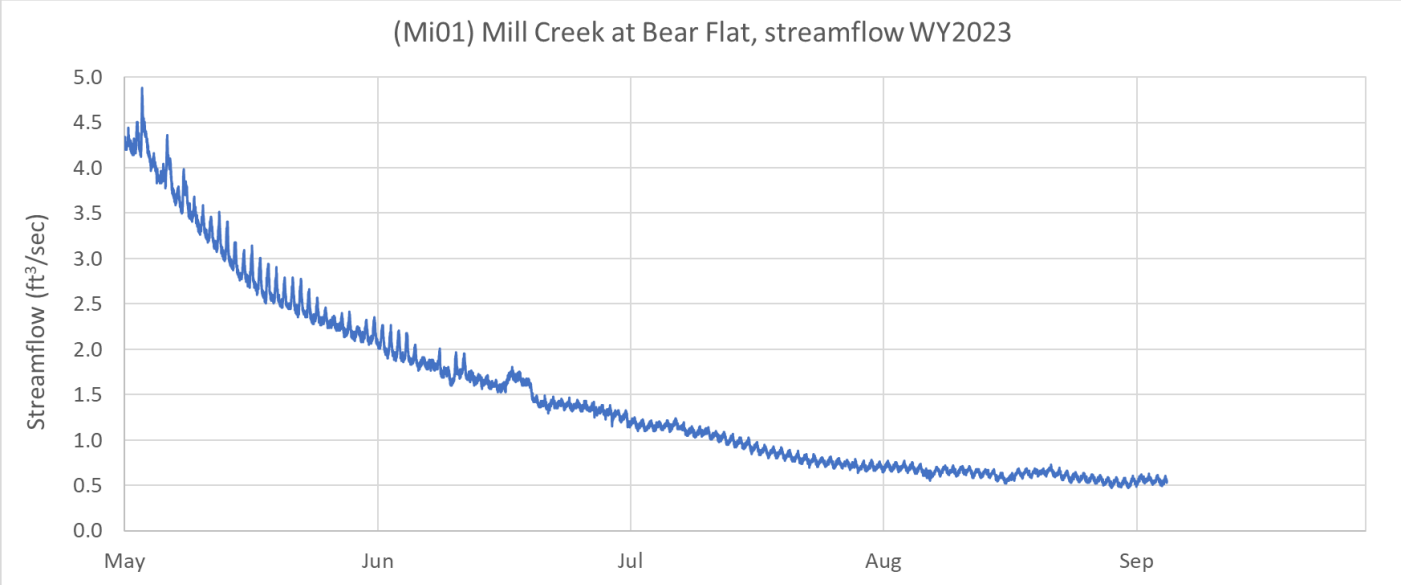

Figure 6. Streamflow at Mill Creek at Bear Flat, WY2022.

(Mi05) Mill Creek below Puccioni Road

At site (Mi05) Mill Creek below Puccioni Road, stage began to rise in response to the first storms of the year in late December 2022 (Figure 7). The two largest stormy periods of the year occurred in January and March, with stage staying elevated for much of these months. At its highest level in early March, stage rose above 9 feet. Stage began to recede in early April, then then fell through September.

Figure 8 shows dry season streamflow conditions at Mill Creek below Puccioni Road in WY2023. Streamflow in early May 2023 was recorded at approximately 10.5 ft^3/sec. Flow slowly receded through May, June, August and early September. Several drops in flow are detected throughout the summer, Figure 9 shows streamflow conditions zoomed to highlight some of the diversion signals. The gage data shows multiple different diversion

signals on a daily basis (ranging from 0.05-0.08 ft^3/sec). These diversion signals are not recorded at the upstream gage (Figure 6), indicating that the diversions are occurring between the two gage sites.

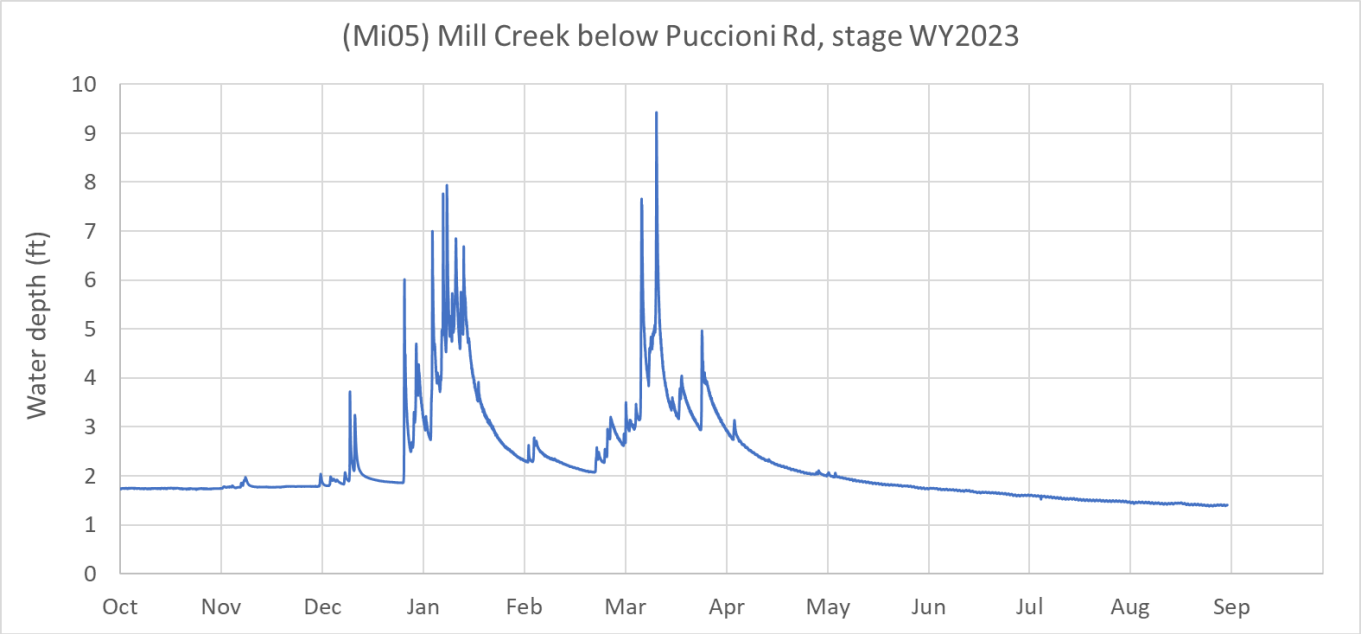

Figure 7. Stage at Mill Creek below Puccioni Road, WY2023.

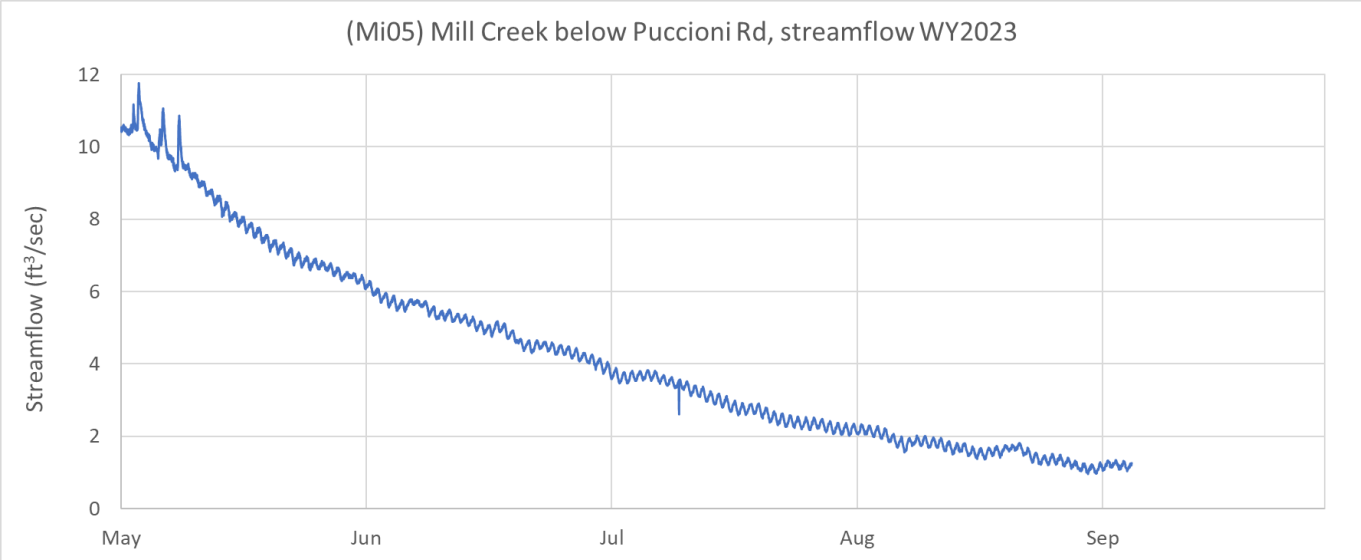

Figure 8. Streamflow at Mill Creek below Puccioni Road, WY2023.

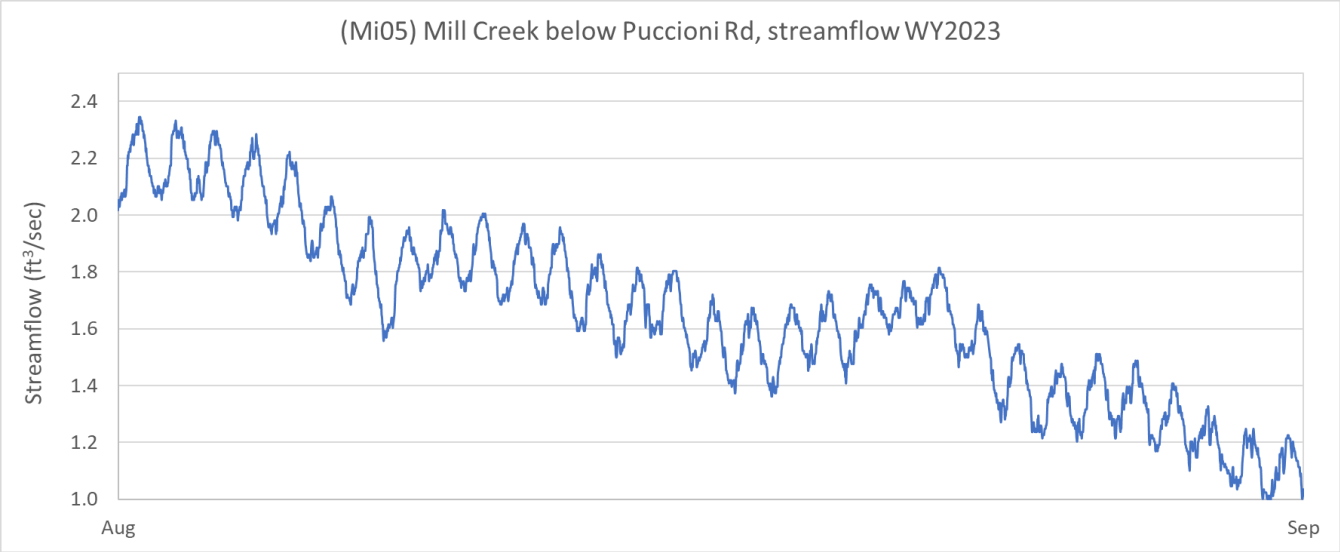

Figure 9. Streamflow at Mill Creek below Puccioni Road, WY2023, showing drops in streamflow caused by surface water diversions.

(Mi06) Mill Creek above Wallace Creek

Similarly to upstream sites, at site (Mi06) Mill Creek above Wallace stage began to rise in response to the first storms of the year in late December 2022 (Figure 10). Stage rose notably in response to the large storm cycles of January and March, with stage staying elevated for much of these months. At its highest level in early March, stage rose to nearly 8 feet. Stage began to recede in early April, then then fell through September.

Figure 11 shows dry season streamflow conditions at Mill Creek above Wallace in WY2023. Streamflow in early May 2023 was measured at approximately 12 ft^3/sec. Flow slowly receded through May, June, August and early September to a baseflow of approximately 1 ft^3/sec. Several drops in flow are detected throughout the summer, Figure 12 shows streamflow conditions zoomed to highlight the diversion signals. However, the diversion signals recorded at Mi06 do not match those recorded at the upstream gage site (Figure 9), this is likely due to the influence of the tributary between the two gage sites. The gage data from (Mi06) Mill Creek above Wallace shows 2-3 different diversion signals on a daily basis (approximate volume is 0.1 ft^3/sec).

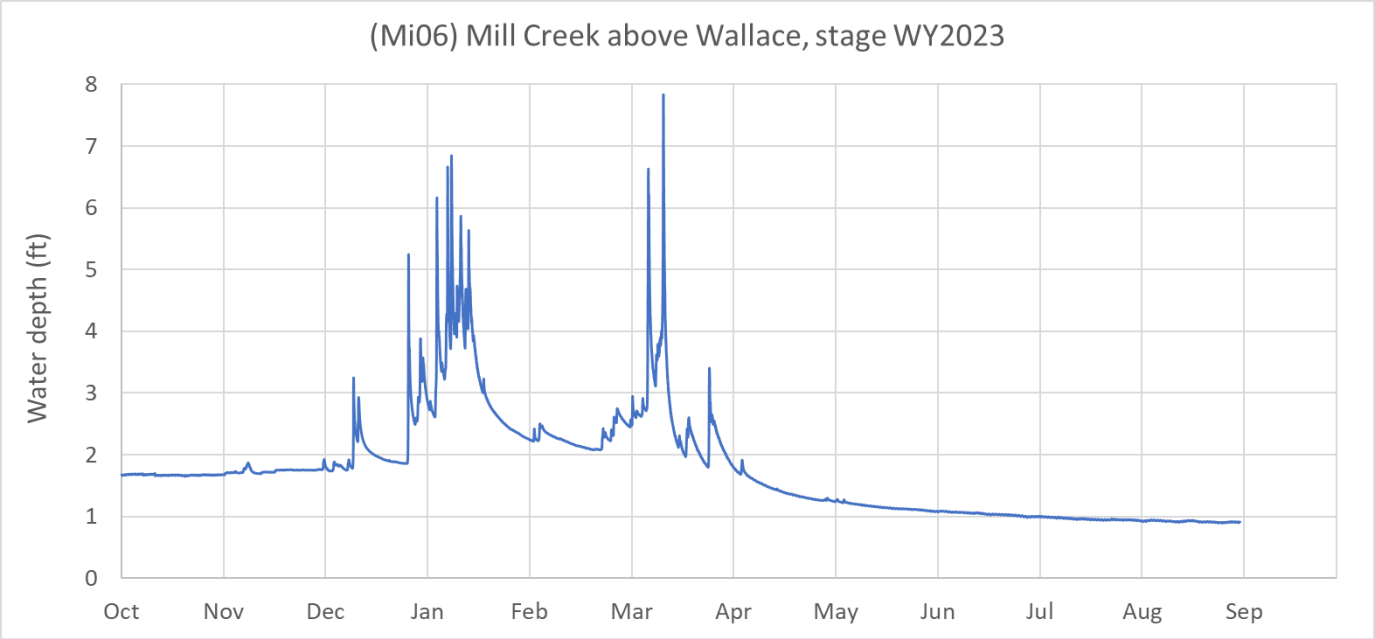

Figure 10. Stage at Mill Creek above Wallace, WY2023.

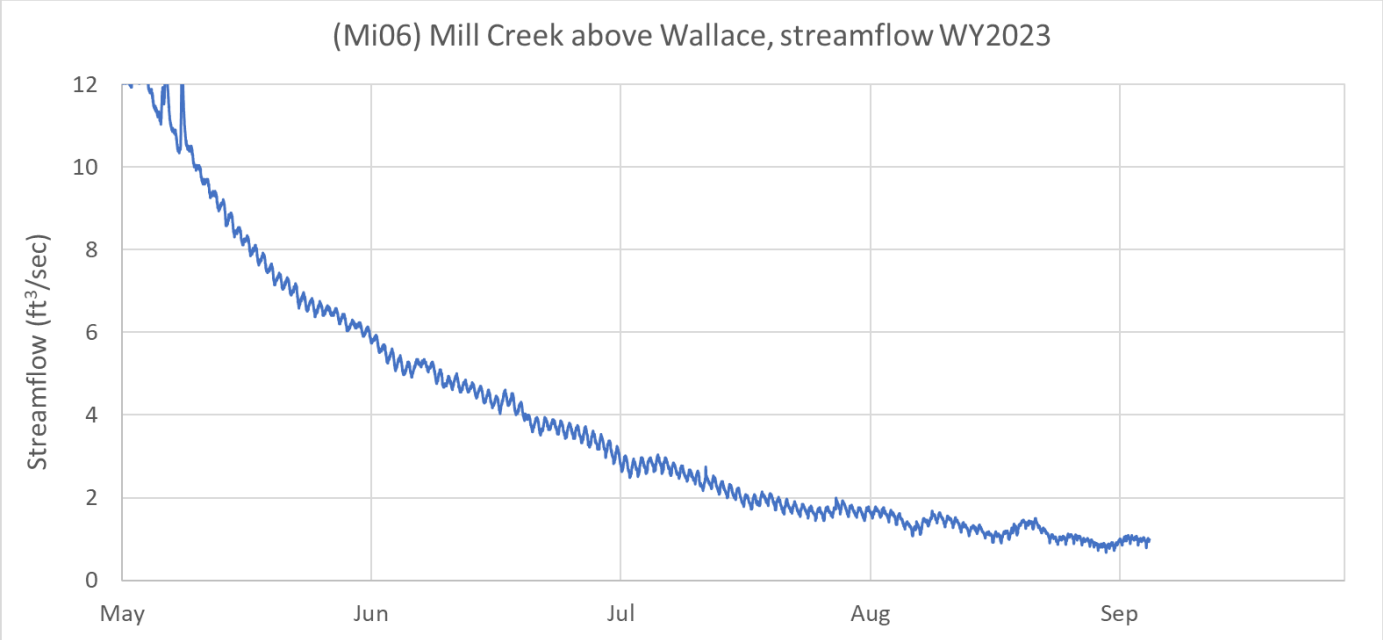

Figure 11. Streamflow at Mill Creek above Wallace, WY2023.

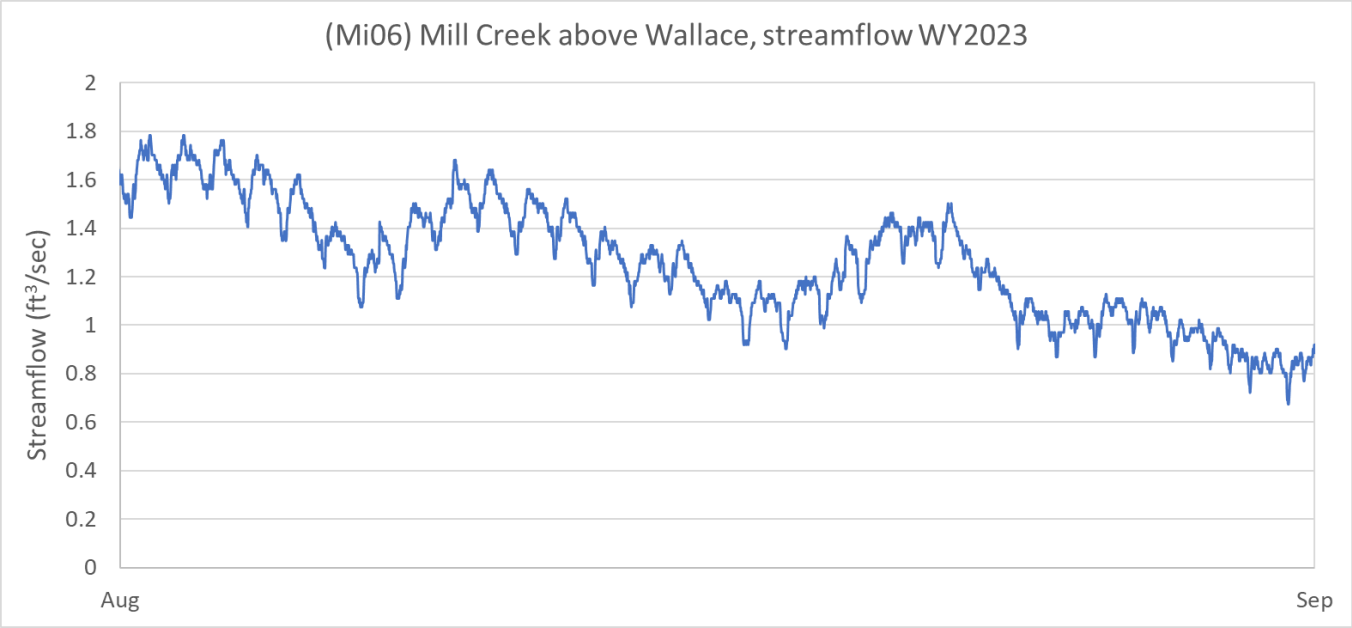

Figure 12. Streamflow at Mill Creek above Wallace, WY2023, showing drops in streamflow caused by surface water diversions.

(Mi08) Mill Creek at Mill Creek Lane

Similarly to upstream sites, at site (Mi08) Mill Creek at Mill Creek Lane stage began to rise in response to the first storms of the year in late December 2022 (Figure 13). Stage rose notably in response to the large storm cycles of January and March, with stage staying elevated for much of these months. At its highest level in early March, stage rose above 11 feet. Stage began to recede in early April, then then fell through September.

Figure 14 shows streamflow conditions at Mill Creek at Mill Creek Lane in WY2022. Streamflow in early May 2023 was measured at approximately 12.5 ft^3/sec. Flow slowly receded through May, June, August and early September to a baseflow of approximately 0.5 ft^3/sec. Several drops in flow are detected throughout the summer (Figure 12); however, the diversion signals recorded at Mill Creek at Mill Creek Lane do not match those recorded at the upstream gage site (Figure 12), this is likely due to the influence of the Wallace Creek tributary between the two gage sites. The large drops in flow recorded in August, for example, are on the order 0.2 ft^3/sec. Smaller drops in flow are recorded at sporadic intervals through the summer, with an increase in late August and September.

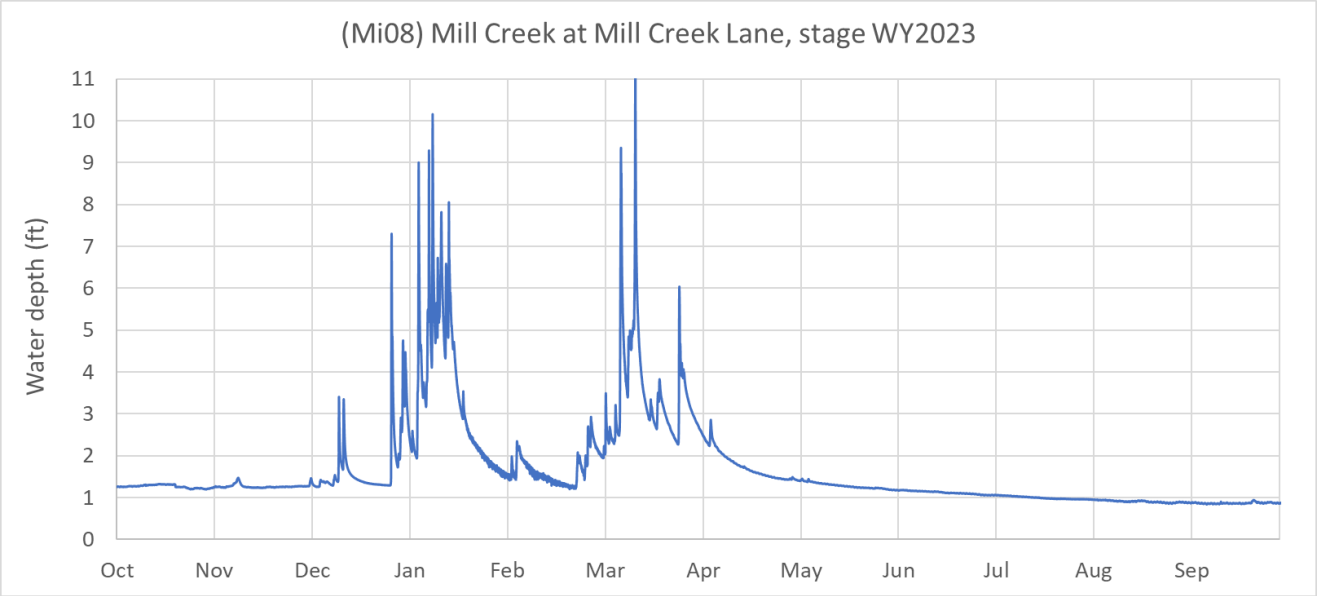

Figure 13. Stage at Mill Creek at Mill Creek Lane, WY2023.

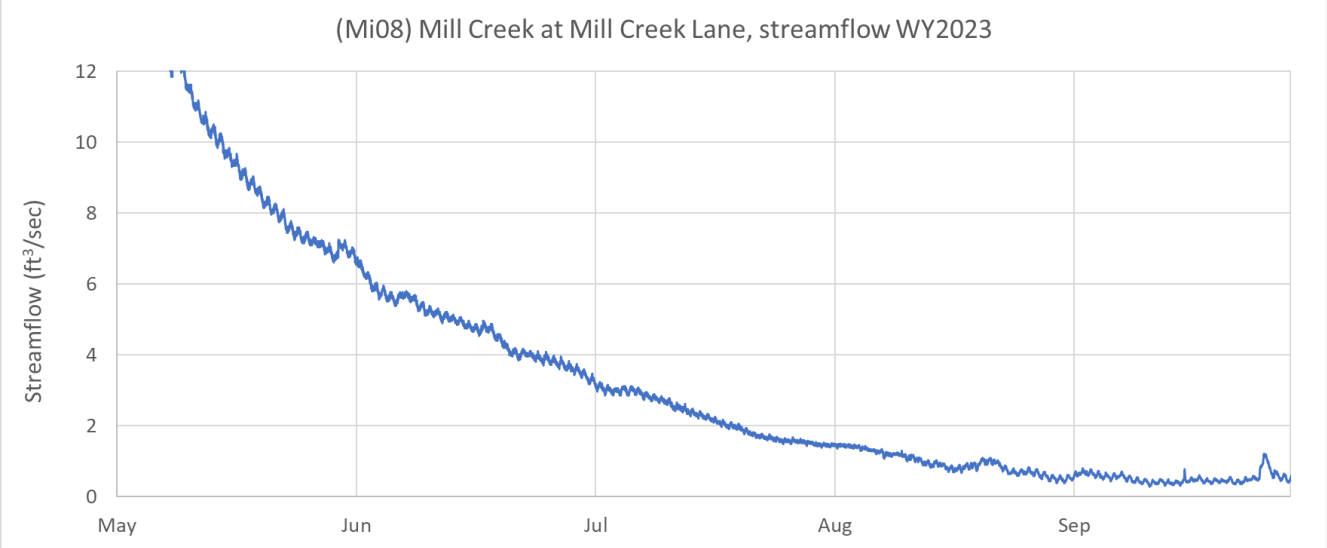

Figure 14. Streamflow at Mill Creek at Mill Creek Lane, WY2023.

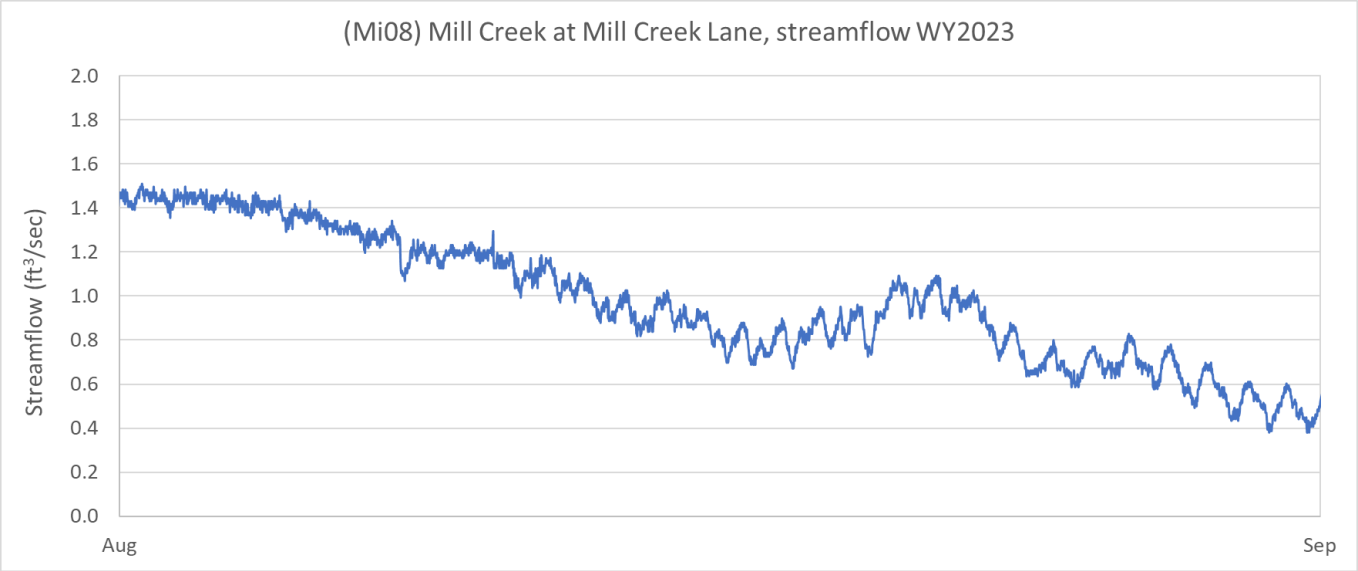

Figure 15. Streamflow at Mill Creek at Mill Creek Lane, WY2023, showing drops in streamflow caused by surface water diversions.

(Mi03) Mill Creek above the falls

As seen at the other gage sites, at site (Mi03) Mill Creek Above the Falls stage began to rise in response to the first storms of the year in late December 2022 (Figure 16). Stage rose notably in response to the large storm cycles of January and March, with stage staying elevated for much of these months. At its highest level in early March, stage rose above 8 feet.

Figure 16 shows dry season streamflow conditions at Mill Creek Above the Falls in WY2023. Streamflow in early May 2023 was measured at approximately 14 ft^3/sec. Flow slowly receded through May, June, August and early September to a baseflow of approximately 0.8 ft^3/sec. Several drops in flow caused by surface water diversions are detected throughout the summer (Figure 15); however, the diversion signals recorded at Mill Creek at Mill Creek Lane do not match those recorded at the upstream gage site (Figure 12), this is likely due to alluvial deposits between the two gage sites. Small drops in flow, likely caused by surface water diversions, are recorded at sporadic intervals through the summer at a pumping rate of 0.17 – 0.2 ft^3/sec.

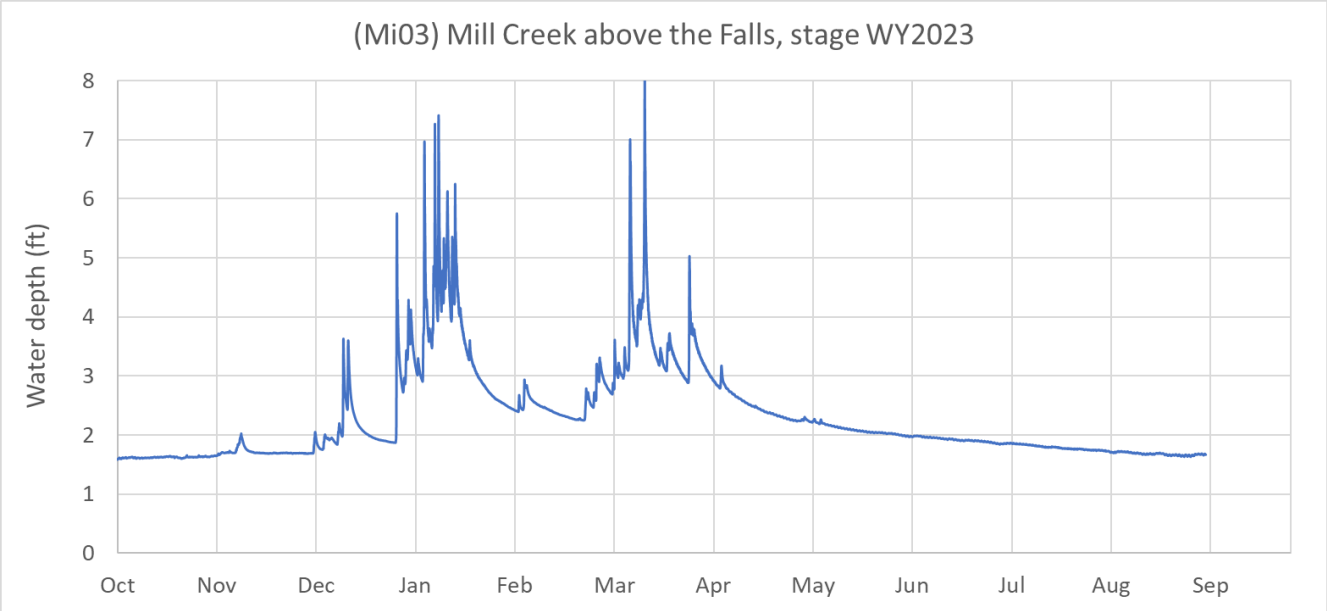

Figure 15. Stage at Mill Creek above the falls, WY2023.

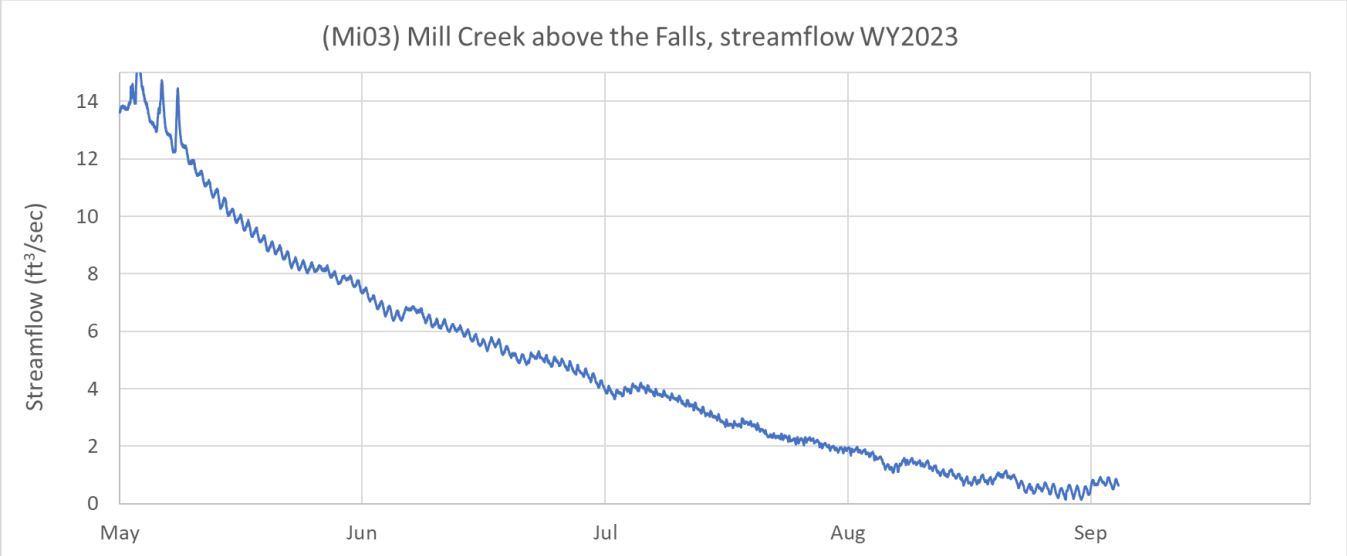

Figure 16. Streamflow at Mill Creek above the falls, WY2023.

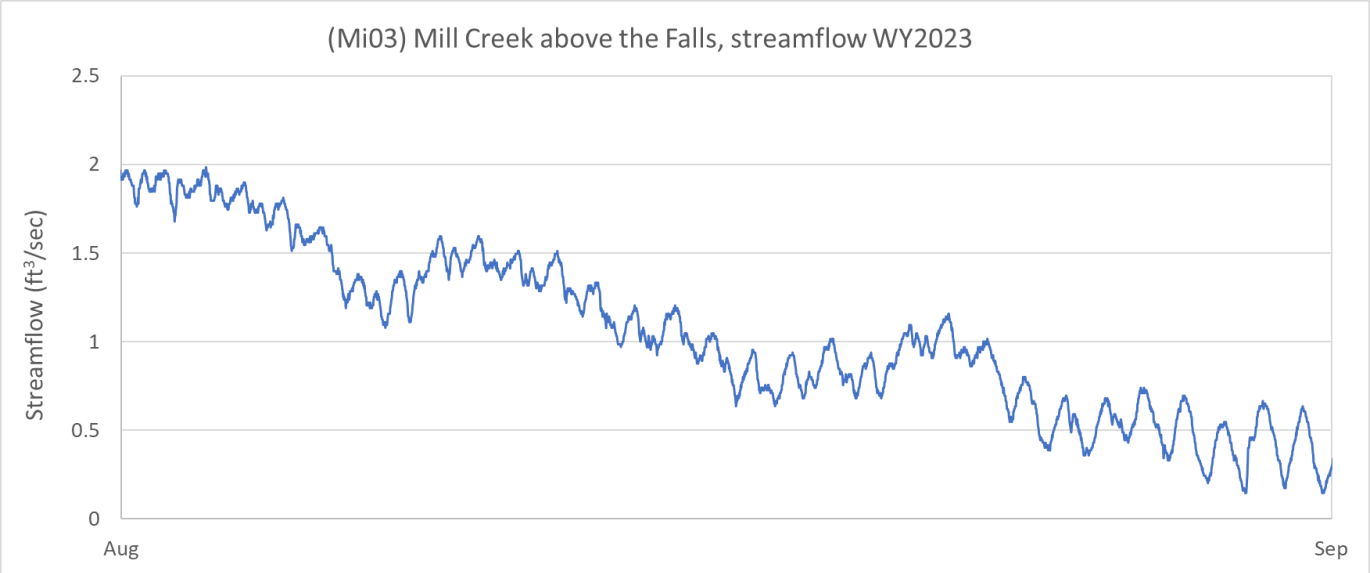

Figure 17. Streamflow at Mill Creek above the falls, WY2023, showing drops in streamflow caused by surface water diversions circled in red.

Mill Creek all gage sites

Figure 18 shows streamflow from May through September in WY2023 at all sites in the upper Mill Creek watershed. In the beginning of May streamflow increased from the most upstream gage site to the farthest downstream site (as you would expect with the increase in drainage area). This pattern began to shift in June, and by the time the system settled into baseflow in early September, the most downstream site (Mi03 had the lowest flow. Mi01 and Mi08 also had similarly low flows (~0.6 ft^3/sec) while the further upstream sites (Mi06 and Mi05) had higher flows of about 1.0 and 1.3 ft^3/sec, respectively. In this wetter year, all sites remained connected through early to mid-September.

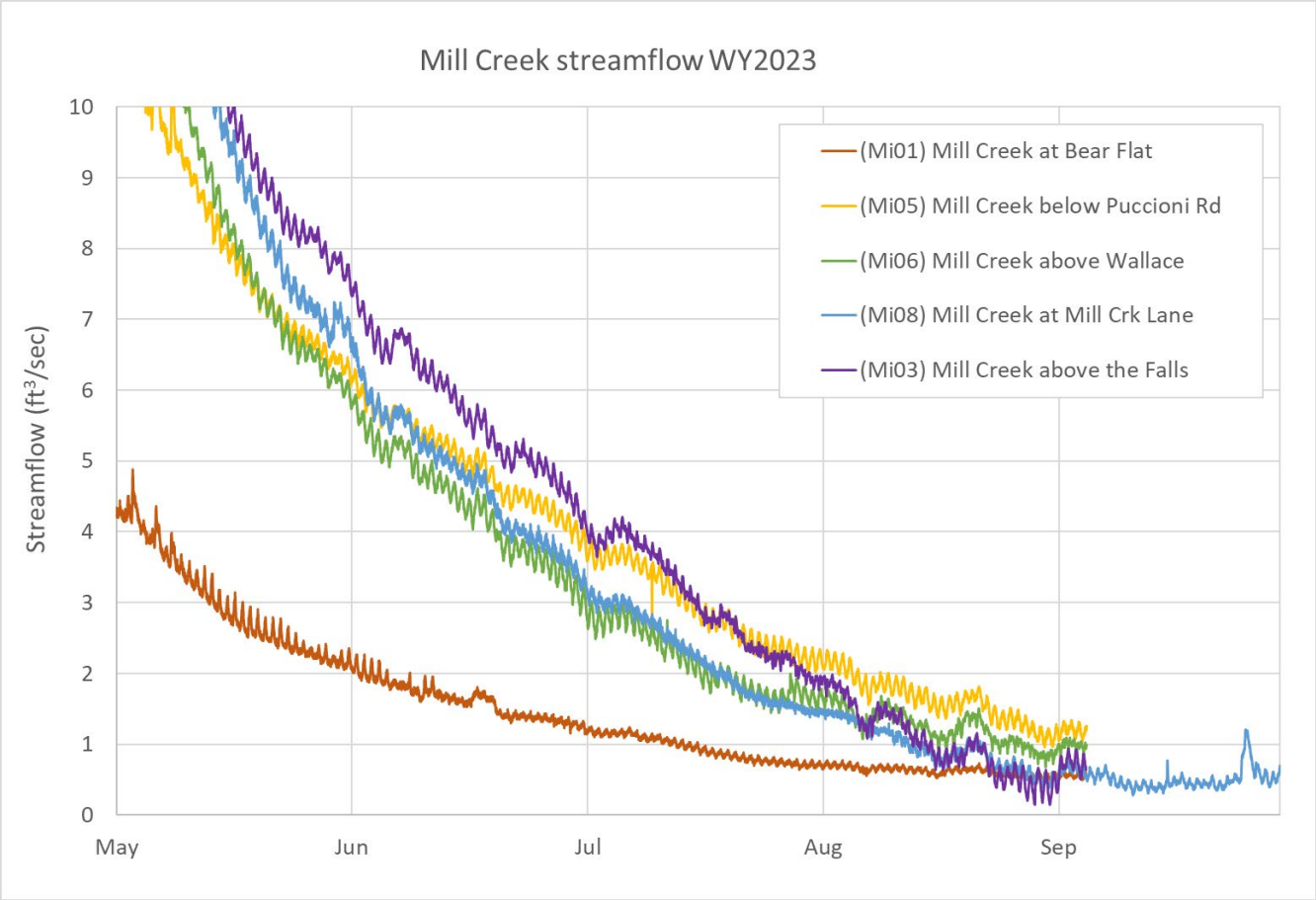

Figure 18. Streamflow at all Mill Creek sites, WY2023.

Streamflow and groundwater conditions – Lower Mill Creek

In WY2023 TU monitored one surface water gage (LM03) and one continuous groundwater well gage (LM01) in the lower alluvial portion of Mill Creek (Figure 1). Another gage in the reach, LM02, was damaged during the storms of WY2023 and not monitored during the dry season. The lower portion of Mill Creek flows out of a confined bedrock canyon into a broad alluvial valley before joining Dry Creek, which then flows into the Russian River. The reach is highly incised and disconnected from its floodplain. The surrounding floodplain is primarily used for vineyards and small-scale agriculture. Due to the permeable nature of the underlying alluvial sediments in this reach, surface flows can be absorbed into the channel bed and underlying aquifers, causing the lower reaches of the channel to dry out in the summer months.

Figure 19 shows streamflow from May through October at LM03 for WY2023. Flow at this site was about 30 ft^3/sec in May 2023, and due to the flashy nature of the reach, diminished quickly from June through August. Flows reaches a low baseflow below 0.1 ft^3/sec in September and October, remaining connected through the season.

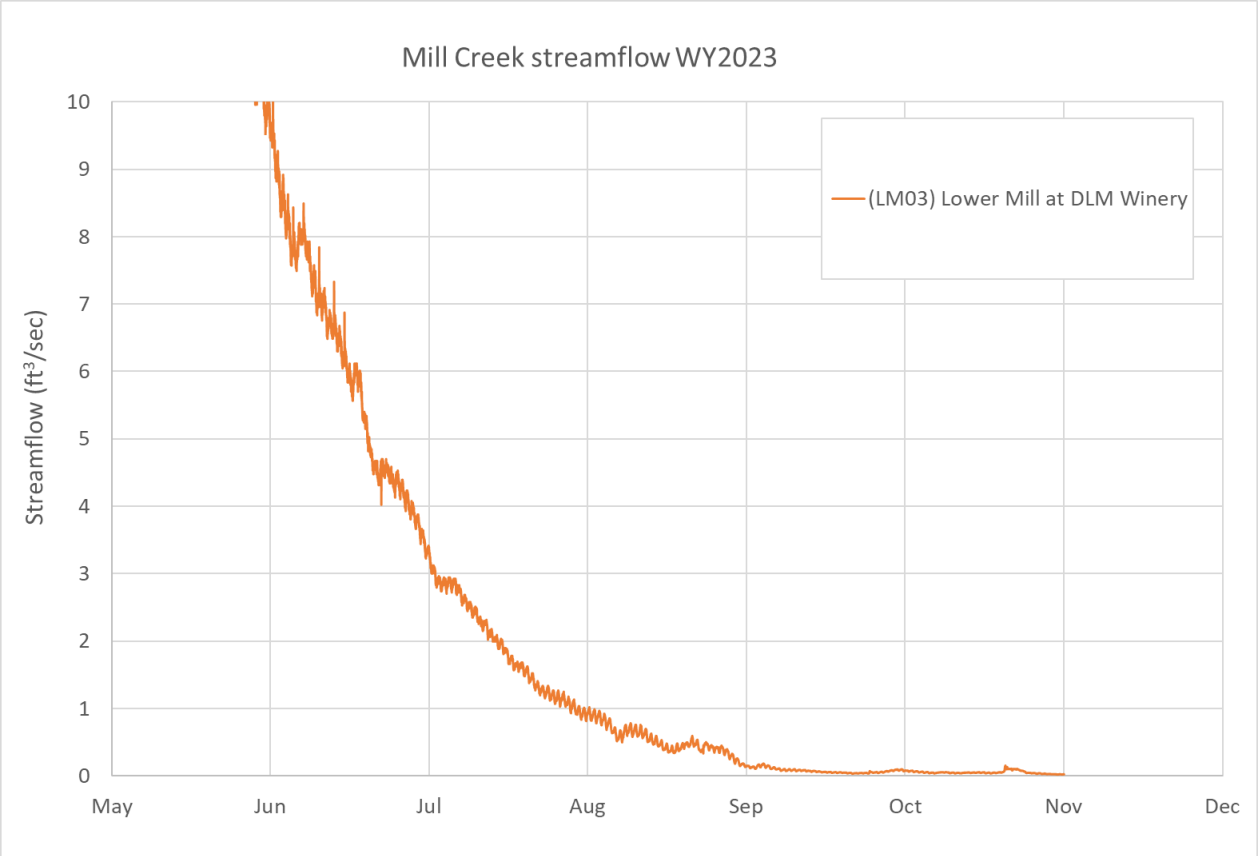

Figure 19. Streamflow at lower Mill Creek sites, WY2023.

Figure 21 shows continuous groundwater elevation in feet above mean sea level (MSL) at well LM01 (Unused Well 1) through WY2023, as well as the elevation of surface water LM03. LM01 is a well is adjacent to the channel about 0.5 miles upstream of surface water gage LM02. A datalogger in this well reads 15-minute elevation data year-round. Note that elevations at LM03 are about 7 feet lower than LM01 because LM03 is further downstream.

Early in WY2023 (October 2022), groundwater levels at LM01 were at a low of about 79 feet above MSL. Water levels rose in mid-October 2022 in response the season's first small rain events. From late November through March, groundwater was reconnected with the surface water, and water levels at both sites rose and fell in response to winter storms. From April to through September, ground and surface water levels declined slowly, and did not drop as swiftly as seen in previous years. Groundwater reached a low point of 78.5 feet.

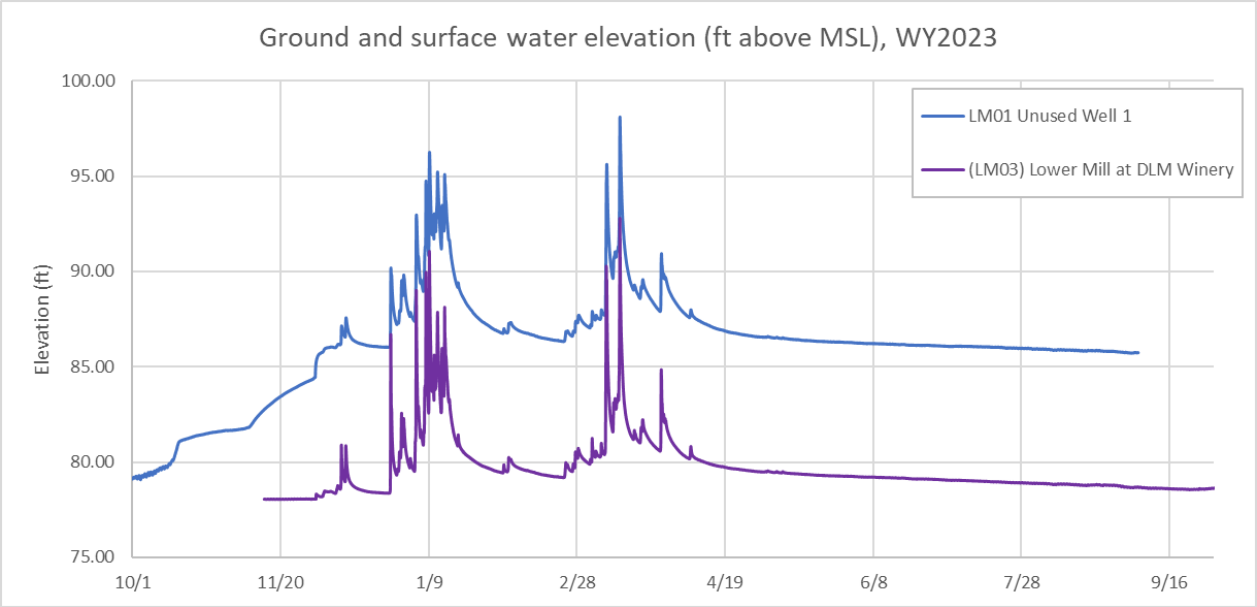

Figure 20. Continuous groundwater and surface water elevation, lower Mill Creek sites, WY2023.

5. Discussion

The 2022 water year in the Russian River watershed and the surrounding region was characterized by *severe drought* conditions and was wetter than during the *exceptional drought* of 2021 (https://droughtmonitor.unl.edu/Maps/MapArchive.aspx). Of the 194 km of channel in the 42 streams where wetted habitat surveys occurred in the lower Russian River watershed, 66% remained wet and connected through the summer of 2022 (California Sea Grant 2022b). Comparison of the 39 streams that were surveyed in both 2021 and 2022 revealed that there was 18% more wet and connected habitat at the end of the 2022 dry season (68% of total stream length) than in 2021 (50% of total stream length).

The gage data shows the watershed was gaining flow from upstream to downstream at the beginning of the dry season and began losing late in the season, in September this year as compared to June in 2022. At the beginning of May 2023, streamflow increased from the most upstream gage site to the farthest downstream site (as you would expect with the increase in drainage area), and this pattern began to shift in June, and by the time the system settled into baseflow in early September, the most downstream site (Mi03 had the lowest flow. Mi01 and Mi08 also had similarly low flows (~0.6 ft^3/sec) while the further upstream sites (Mi06 and Mi05) had higher flows of about 1.0 and 1.3 ft^3/sec, respectively. This pattern, of the upper gages maintaining higher flows than the lower gages, is consistent with TU's previous years of data collection. This year, all sites stayed connected through the monitoring period.

Many surface water diversion signals were detected through the upper Mill Creek gage network. The upper gage, (Mi01) Mill Creek at Bear Flat, shows relatively unimpaired flow. The gage at (Mi05) Mill Creek below Puccioni Rd showed the largest amount of instream diversions, with multiple pumping signals occurring daily. Streamflow enhancement projects in the reach between Mill Creek at Bear Flat and Mill Creek below Puccioni

Rd would improve streamflow and habitat for fish, given the high frequency of pumping.. The decrease in streamflow between Mill Creek above Wallace and Mill Creek at Mill Creek Lane indicates that groundwater pumping may be reducing surface flow. Water storage and forbearance projects that target groundwater pumping in this reach could potentially improve streamflow conditions.

Groundwater and surface water interactions in the lower portion of the Mill Creek watershed remained more elevated in this wet year than in previous extremely dry years, and ground and surface water remained connected for a greater duration of the season. were less heavily impacted by the year's rainfall patterns and particularly dry winter. Early in WY2022 (October 2021), groundwater levels were very low due to the previous summer and fall (WY2021) being extremely dry, and the channel in lower Mill Creek was dry, suspended above the water table. This year, groundwater levels rose from their low point in October 2022 and rose and fell with the numerous storms of the season, then never dropping to the lows seen in previous dry seasons. The channel remained flowing, albeit at a very low baseflow, throughout the dry season.

Moving into the fourth sample year of the project, we plan to continue monitoring streamflow at all six Mill Creek gage sites. This will allow us to evaluate conditions in what is on track to be an average water year, build on our growing understanding of watershed conditions post-fire, help inform evolving project opportunities and document changes after streamflow project implementation.

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