San Joaquin River Restoration Program
Restoration Administrator's 2021 Report to Settling Parties

Prepared by
Tom Johnson
Restoration Administrator

March 2022

Contents

Appendices:

A. URF Revenue
B. 2021 - 2022 Flow Accounting
C. Unimpaired Runoff History
D. Restoration Allocations
E. 2021 Hydroclimate and Outcomes

1. Introduction

This Restoration Administrator's Report on the status of the San Joaquin River Restoration Program (Program) is prepared in accordance with the Stipulation of Settlement filed September 13, 2006 in the case of *NRDC, et al., v. Kirk Rodgers, et al*. Pursuant to the Stipulation of Settlement (Settlement), the annual report shall include a summary of settlement implementation activities of the previous year, findings of research and data collection, any additional recommended measures to achieve the Restoration Goal, a summary of progress and impediments in meeting targets established pursuant to Settlement Paragraph 11 (Paragraph 11), and a summary of expenditures from the Restoration Administrator (RA) Account.

2. Overview of 2021 Hydrology, Restoration Flow Allocations and Operations

Overall, California had a very dry 2021 water year, the planning for which was made more challenging by the substantial overprediction of runoff from snowpack[1]. The San Joaquin River (SJR) watershed above Friant Dam received less than half of its average precipitation in the 2021 water year (October 2020 through September 2021). The 2021 water year unimpaired runoff inflow to Millerton Lake of 522 thousand acre-feet (TAF) and the April-July unimpaired runoff of 360 TAF, were both the 6th driest in the 121 year record; the August and September unimpaired monthly runoff were the driest on record. The 2021 water year followed the 2020 water year runoff of 886 TAF, making the 2020 and 2021 two-year sequence the 3rd driest in the historical record.

As a result of a dry start to the 2021 water year, the initial Restoration allocation on January 21 was for a Critical Low year-type and a 0 acre-foot allocation at Gravelly Ford. Following a late January storm that deposited over half of the total 2021 snowpack, the Restoration Allocation increased to a Critical High year-type allocation of 70,919 acre-feet on February 5 and a Dry year-type allocation of 170,732 acre-feet on February 19. The subsequent four allocations in the March through June period were all Critical High year-types, reflecting the lack of significant snowpack accumulation following the late January storm.[2] The Critical High 70,919 acre-feet Restoration Flow Allocation was supplemented by an exchange of 10,400 acre-feet of Unreleased Restoration Flows (URF's) from February of 2021 (the last month of Restoration Year 2020) to March of 2021 (Restoration Year 2021). Additionally, a modest volume (< 1,000 acre-feet) of Buffer Flows were utilized.

Reservoir, river and contract scheduling and operations required Reclamation, the Friant Contractors, and the RA to spend considerable time and effort in planning for, then managing through the extended statewide and San Joaquin River drought conditions. In addition, the specter

[1] https://water.ca.gov/-/media/DWR-Website/Web-Pages/Water-Basics/Drought/Files/Publications-And-Reports/091521-Water-Year-2021-broch_v2.pdf

[2] An Allocation History table and forecast tracking graphic are attached in Appendix XX

of a San Joaquin River Exchange Contractor (SJREC) "call on Friant"[3] remained until mid-August, further confounding planning and execution of flow regimes. And for a brief period of time in late August/early September, the State Water Resources Control Board's (SWRCB) curtailment order threatened the release of Restoration Flows.

Initial Restoration Flow Recommendations (through May 12, 2021) were focused on maintaining year-round connectivity through all reaches of the SJR and prescribed even greater use of Buffer Flows and long-term URF exchanges than was ultimately utilized. Even with the maximum possible supplemental flows from exchanges and Buffer Flows, the ability to keep the river connected and flowing would have been very challenging due to anticipated variable seepage losses and challenges with operating at very low flow levels. In addition, the Millerton Lake temperature readings from April and early May showed that it would be highly probable that the reservoir would deplete supplies of cold water prior to the spring run Chinook spawning season in the fall. As a result, the June 1, 2021 Recommendation called for the cessation of Restoration Flows (leaving only Riparian Holding Contract releases in Reach 1) for the balance of the summer and early fall in order to preserve Restoration Flows and cold water. Beginning on June 7th the SJR dried up in Reach 2A, portions of 2B upstream of Mendota Pool, Reach 4A downstream of Sack Dam and the upstream end of Reach 5. This pattern of dry reaches was similar to the dry conditions that existed pre-Restoration Flows and hadn't been experienced by the river since 2016.

In late November, Restoration Flows resumed from Friant Dam, Reach 2A reconnected on December 7th, and the SJR was reconnected over its full length approximately 2 weeks later (although still with very high seepage losses along the length of the previously dry reaches). In-river temperature data at Lost Lake indicates that the daily average river temperature within the first 2 miles of Friant Dam reached 58ºF and occasionally slightly exceeded 58ºF, during the August – October time frame.

Figures 1 and 2 below provide an overview of the Restoration Flow operations. From the standpoint of maintaining river temperatures to support holding, spawning and incubation of Spring Run Chinook in the San Joaquin River, the 2021 flow regime was generally successful as compared to the alternative of using additional limited cold pool[4] resources to keep the river connected. A detailed analysis of this year's river flow recommendations (including the timing of the decrease in reservoir release temps, the overall success/failure of the 2021 strategy, and considerations for potentially using this strategy in the future) will be forthcoming this spring, when all of the flow, temperature and other data is compiled and assessed.

[3] "Call on Friant" is a term normally used to describe the condition under which water is released from Friant Dam to satisfy Reclamation's responsibilities under the "Exchange Contract" (the contract for exchange waters, dated July 27, 1939, between the United States and the San Joaquin and Kings River Canal and Irrigation Company, Incorporated, et al., Contract No. I1r-1144, as amended.

[4] Millerton Lake stratifies into temperature bands every year, with temperatures at the elevation of the Madera and Friant Kern Canals and above well above temperatures suitable for Chinook salmonids. "Cold Pool" refers to the approximately 109 TAF of generally colder water located between the Friant Dam river outlet and the elevation of the Madera Canal.

Figure 1. Full Year Flows between Friant Dam and Chowchilla Bifurcation Structure (Reach 1 and 2A)

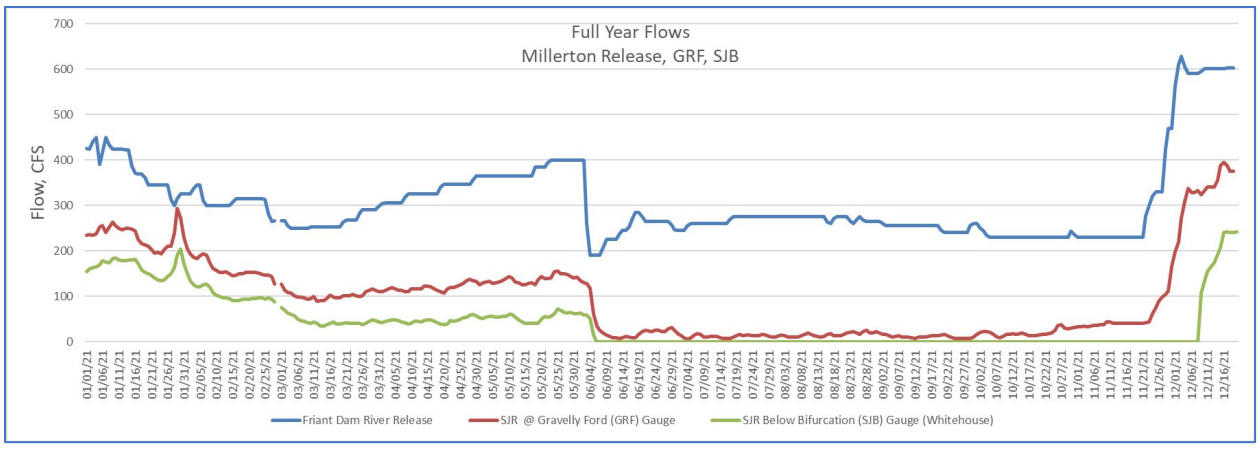

Figure 2. Summer and Fall Water Temperature Profiles in Millerton Reservoir

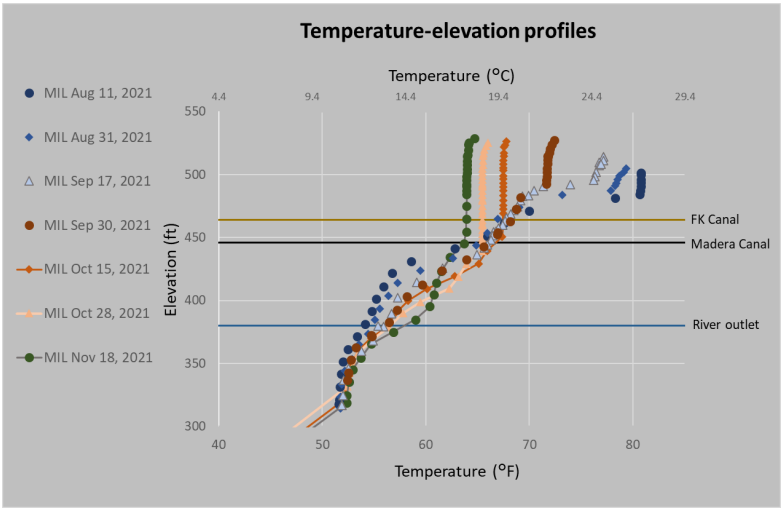

Figure 2 above shows the stratification of Millerton Lake through time, and how the cold pool volume (between the river outlet and Madera Canal) warmed through time. Based on this data and the volume of water not released from the river outlet due to the cessation of Restoration Flows, it is possible that river outlet temperatures would have been 6 to 9 degrees warmer at the end of October than they were, had continuous Restoration Flows been released.

3. Program Milestones and Accomplishments during 2021

This Section provides an overview of specific milestones and accomplishments.

- Between April 5th and June 2nd, a total of 93 spring run Chinook were captured at Hills Ferry or Van Clief in the SJR, of which 74 were successfully tagged and transported to Reach 1 of the SJR Restoration Area. Genetic testing has not yet been completed (due to Covid protocols in place at the testing labs), but it is anticipated that most of these fish will be shown to be returns to the SJR (in 2020, 50 of 57 returning fish were confirmed as releases from the Program that had successfully returned to the Restoration Area). If this proves to be accurate, this will be the fourth year (2017, 2019, 2020, 2021) that it has been documented that spring-run Chinook salmon have completed their life cycle of emigrating out to the Pacific Ocean as juveniles and returning to the SJR as adults.

- Juvenile and adult spring run Chinook salmon from the Interim Salmon Conservation and Research Facility (iSCARF) were released in the Restoration Area in 2021 (see Section 4 for additional details). Many of the juvenile fish successfully migrated out to and through the Sacramento/San Joaquin Delta, as evidenced by capture of some of the released fish at various monitoring locations in the Delta. Many of the adults successfully spawned in the river, as evidenced by viable redds (salmon egg nests) in the river and juvenile salmon production measured by the rotary screw traps (RSTs).

- The 2021 Restoration Allocation was for the Settlement-defined Critical High water year type, with an allocation of 70,919 acre-feet (measured at Gravelly Ford). Additional predictive tools developed by the RA and TAC in consultation with the Program allowed better anticipation of reservoir and in-river temperatures, particularly during the crucial months of August through October when spring-run Chinook are holding and spawning, and eggs are incubating in the SJR. Use of these tools allowed for an aggressive program of disconnecting, and then re-connecting the river in certain reaches to preserve the limited cold-water pool in Millerton Lake.

- Precise and accurate operations of the San Joaquin River downstream of Millerton Lake are complex, due to relatively small watershed storage capacity, the length of the Restoration Area, substantial uncontrolled seepage losses, and multi-party operations. 2021 was further challenged by the potential for a "call" on Friant and SWRCB emergency curtailment rules (which impacted upstream reservoirs owned by Southern California Edison and Pacific Gas & Electric but not Millerton Lake). Despite all these challenges, the Program, in consultation with the RA, provided the best possible habitat for the nascent population of spring-run Chinook downstream of Friant Dam.

- Program activities and progress continued to be constrained in 2021 due to the COVID-19 pandemic, workplace rules, prohibitions against some in-person events or meetings, etc. Reclamation, the Program, and the Implementing Agencies all implemented numerous

measures to ensure employee safety while attempting to maintain progress on various Program objectives. However, some activities (for example, fisheries field work) that requires the in-person participation of several staff had to be rescheduled or cancelled for safety reasons. Overall, it seemed that the challenges and impacts of Covid were less than in 2020, but still noticeable and substantial. Adhering to testing and masking protocols, on October 21, the Restoration Flow Guidelines Small Work Group held its first in-person meeting in nearly two years at the San Joaquin River Parkway River Center. That day included a field tour of Friant Dam facilities and Spring run spawning sites. On October 27 and 28, the RA led a group of Settling Party, CADWR, SWRCB technical representatives on field tour of San Joaquin River flow gaging sites and infrastructure from Friant Dam to the confluence of the Merced River.

- Despite COVID-related challenges, the Program continued work on the major Paragraph 11(a) projects, including advancing design and analysis of the Compact Bypass and Arroyo Canal screen/Sack Dam bypass projects. Progress included realty actions, collection of geotechnical data from multiple sites, and layout and design work tasks.

- The Program has continued to work through operational coordination, and operational and accounting rules development. The Program, assisted by input from the Friant Division water contractors' (Friant Contractors) work group and TAC members, led to further refinements in the Restoration Flow Guidelines (RFG's), the rules for allocation, release, operations, and accounting for Restoration Flows.

- Reclamation's Joint Forecasting Team (RJFT) provided periodic runoff forecasts throughout the winter and spring, integrating disparate indicators of snowpack, runoff efficiency, and forecasted runoff. This information was used to inform Allocations through the winter, spring and early summer. The RFJT provided monthly technical briefings through the monthly Millerton Forecast Advisory Committee (now renamed as the Upper San Joaquin Watershed Forecasting Discussion).

- The National Marine Fisheries Service (NMFS) completed and released the 2022 Technical Memorandum[5] that outlined the spring-run Chinook salmon release and monitoring plans for 2022, plus methods for identification of spring-run Chinook salmon outside of the San Joaquin River. Appendix A of the NMFS Technical Memo provides an overview of fish releases, RST monitoring, telemetry monitoring, and adult broodstock releases in the SJR from late fall 2020 through fall 2021.

- A 2022 Channel Capacity Report (CCR) was published by the Channel Capacity Advisory Group (CCAG) to determine and update estimates of then-existing channel capacities in the Restoration Area, to ensure Restoration Flows would be kept below levels that would increase seepage or flood risk[6]. The 2022 CCR recommends the then-existing channel capacity (limits for the current year) will be generally the same as the 2021 CCR, except

[5] https://media.fisheries.noaa.gov/2022-01/2022-sr-tech-memo-v2.pdf
[6] https://www.restoresjr.net/wp-content/uploads/2020/02/Channel-Capacity-Report_2020_508.pdf

with an increase in capacity in the Middle Eastside Bypass (MESB) based on additional studies completed and analyzed in 2021.

- Work on the Salmon Conservation and Research Facility (SCARF) was not resumed in 2021; however, the State has secured sufficient funding to complete the construction and has completed required re-design of the project. The State is waiting on necessary approvals and is bidding the project in early 2022 with a scheduled completion date of March 2023. Until the SCARF is commissioned, the iSCARF continues to produce the required numbers of fish to support Program objectives and research.
- In fall 2021, 32 redds were identified in the SJR from translocated and released spring-run Chinook salmon trapped at the downstream end of the Restoration Reach. Fish surveys were partially limited due to Covid restrictions, so actual redd construction may have been greater than what was observed.
- The Program produced a Draft Sediment Management Plan in December to serve as a guidance document for sediment management activities that will benefit Chinook Salmon spawning and incubation in the San Joaquin River. Program Managers are currently reviewing the draft document, which will be finalized in 2022.
- The Program has issued a draft Fishery Long Term Monitoring Plan, which summarizes the monitoring data needed to measure success toward the Restoration Goal.

4. Progress toward Achieving Paragraph 11, 13, and 14 Requirements during 2021

This Section provides an overview of progress towards meeting Paragraph 11, 13, and 14 requirements of the Settlement.

- In March, the Program issued a 10% Design Report for the Arroyo Canal Fish Screen and Sack Dam Fish Passage project, along with concept design drawings for several different alternatives and configurations for a fish screen and bypass structure. The 30% design package is due in early 2022. In addition, the Program undertook geotechnical drilling and other investigations for the construction site footprint.
- In mid-2021, the Program completed construction of the Mowry Bridge, which will be a key Reclamation construction haul route and provide long-term access to Mendota Pool Bypass and Reach 2B infrastructure. The bridge also supports various utilities, including the pipeline that conveys the high-quality water supply for the City of Mendota.
- Reclamation's Technical Service Center constructed a physical model of the combined civil structures for the Compact Bypass, including the Compact Bypass Control Structure, Mendota Pool Fish Screen, and Reverse Flow Facility. Testing using the physical model was conducted over the second half of 2021. In addition, the Program continues to

undertake geotechnical drilling and other investigations for the construction of the Compact Bypass and associated levees.

- The Program completed the removal of a second (upper) weir on the Merced National Wildlife Refuge, removing that barrier to fish passage.
- The Program successfully acquired approximately 8 acres on the east side of Sack Dam, which will provide the footprint for construction of a river bypass around Sack Dam for river flows.
- Reclamation has added additional design staff, and now has separate design teams working on the Arroyo Canal/Sack Dam complex and the Reach 2B complex. In addition, Reclamation is in advanced discussions with the California Department of Water Resources (DWR) to have DWR undertake certain levee design elements for the Reach 2B/Compact Bypass project.

Pending completion of the Paragraph 11 modifications, the Program is undertaking interim measures to continue the process of reintroduction, build fish stocks, and to continue to glean valuable monitoring data to further inform future adaptive management actions. Specifically, in 2021:

- The Program continued to develop spring-run Chinook salmon brood stock at the iSCARF, utilizing the selected foundation stock from the Feather River Fish Hatchery.
- The Program completed several Young-of-Year and Yearling Juvenile Spring-run Chinook releases, as well as the release of mature fish. The details of those releases are best documented in the *NMFS "2022 Technical Memorandum Regarding the Accounting of San Joaquin River Spring-run Chinook Salmon at the Central Valley Project and State Water Project Sacramento-San Joaquin Delta Fish Collection Facilities"*[7].
- Adult Releases - A total of 150 adult spring-run Chinook salmon broodstock cultivated at the iSCARF were released by the California Department of Fish and Wildlife (CDFW) into Reach 1A of the San Joaquin River in 2021 (https://www.restoresjr.net/why-releasing-adult-spring-run-chinook-is-part-of-the-plan/). All fish received external color-coded Floy tags with individual identification numbers, and all females and a subset of male fish were fitted with acoustic tags to track fine-scale movement. Genetic tissue samples of all broodstock adults were taken at the iSCARF for use in later parentage analysis.
- Juvenile Releases - From January – May 2021, several groups of yearling and juvenile fish were released to the SJR. Groups were released in Reach 1 or 2 (generally to test the efficacy of rotary screw traps), or into Reach 5 (for movement out to the ocean). A total of 6,956 yearlings and 201,031 juveniles were released. All these juveniles had coded wire tags.

[7] https://media.fisheries.noaa.gov/2022-01/2022-sr-tech-memo-v2.pdf

- Adult Chinook Salmon Returns - A total of 93 adult spring-run Chinook salmon were captured in the lower reaches of the Restoration Area; of those, 74 were transported to Reach 1 (the balance died prior to release). Genetic testing of those fish has not yet been completed (lab work was interrupted due to Covid protocols).
- Trap and haul of adult fall-run Chinook salmon did not occur in 2021. Incidence of adult fall-run in the Restoration Area were not well documented. Unlike previous years, incidental observation of adult fall-run in the Restoration Area was limited due to reduced field work levels as a result of Covid restrictions.

5. Challenges and Recommendations 2021

5.1 General Challenges

The Restoration Program faces several general challenges, many either out of th3e Program's control (e.g. COVID-19, Hydrology), or particular to the Restoration Area but not the fault of the Program. Still, all of these challenges require management and demand resources from the Program.

1. COVID-19

The COVID-19 pandemic continued to be a major challenge to progress. Although Reclamation, the Program office and the Implementing Agencies adapted as well as possible and were able to maintain forward momentum on key projects, there were still numerous constraints and impediments. For example:

- Program staff and many Implementing Agency staff worked from home for most of 2021. As of the end of 2021, it is not clear when office buildings will re-open for normal operations.
- Program and Implementing Agency staff typically interact with many stakeholders every month, often via in-person meetings. Inability to meet in-person slowed land negotiations, design, permitting, land acquisition, and field reconnaissance activities.
- Much of the field work conducted by the Program or Implementing Agencies requires the participation of multiple staff (fish tagging and release, monitoring activities, etc.). While some field activities were able to be continued, many tasks were slowed substantially by safety protocols and other tasks had to be deferred or cancelled.

2. Drought Hydroclimate and Challenges to Forecasting, Restoration Allocation and Management

The 2021 hydrologic year was categorized as Critical High, with a forecast of only 529 TAF (June 25, 2021, Final Allocation) Reclamation, the Friant Contractors, and the RA spent considerable time and effort in planning for, then managing through, extended drought conditions. In addition, the specter of an Exchange Contractor "call" on Friant remained until almost August, further confounding planning and execution of flow regimes. For example, the decision to cease Restoration Flows between the end of May and late November in order to preserve cold water in the reservoir was very complex, and involved not only extensive modeling but also numerous discussions among and between implementing agencies, biologists and river operators.

Extremely wet or flood conditions (e.g., 2017), or extremely dry or drought conditions (e.g. 2014, 2015, 2021) are particularly difficult to manage effectively, and draw considerable resources from other projects for Reclamation, the Friant Contractors, and the RA.

3. Stakeholder Challenges

As described in previous Annual Reports, there are many, many stakeholders (landowners, operators who utilize the river for water conveyance, nearby entities or facilities potentially impacted by Restoration Program operations) with an interest in or potentially impacted by the Program. During 2021, as in most previous years, numerous stakeholders expressed reservations, concerns, or protests about SJRRP activities. The SJRRP or Reclamation management are drawn in to resolving the issue at hand, which results in a drain on resources that could otherwise be used for Program implementation. While it is anticipated that stakeholders will continue to express reservations, concerns, or protests for the duration of the SJRRP implementation period, at least in 2021 it seemed as if there were fewer and/or less strident issues raised than in past years (perhaps an unexpected result of Covid restrictions and dry river reaches).

4. Groundwater Pumping

Heightened focus on groundwater, and potential effects of high groundwater pumping rates, have been highlighted by the 14 Groundwater Sustainability Plans (GSP's) filed 40 Groundwater Sustainability Agencies (GSA's) proximate to the SJR. Initial review of the GSP's by the SWRCB, DWR and others have raised many questions about the nexus and impacts of groundwater pumping on river flows. On January 21 and January 28, 2022, DWR officially issued "incomplete" designations for the Merced, Chowchilla, Kings and Delta-Mendota sub-Basins. The aforementioned represent 10 of the 14 GSPs that the Settling Parties GSP work group reviewed. The other 4 GSPs are in the Madera sub-basin and are still undergoing review since they were submitted about 6 months after the others. The identified deficiencies are consistent with the comments submitted by the Program related to interconnected surface and groundwater, subsidence, thresholds, coordination, etc. The deficiencies must be addressed in 180 days (by July 20 or July 27, 2022) or they risk being declared "inadequate" and triggering State Board intervention.

5. Biological Challenges

There continue to be numerous biological and fisheries challenges with the implementation of the Restoration Goal, some of which were known or suspected during the crafting of the Settlement and others that have come to light during these early phases of reintroduction and restoration. The Program, Implementing Agencies and TAC continue to work to better understand and remediate various challenges.

Flow challenges (mostly related to conveyance capacity status, see below, and high seepage losses everywhere in the river) and in-river temperature challenges (due to the physical limitations of Millerton Lake's small reserve of cold water) have been known for some time, and quantification of those challenges under different operations scenarios continues. Biological challenges, such as what appears to be relatively low emergence success (salmonid egg-to-emergence ratio), and what appear to be relatively high predation levels, were only suspected when the Settlement was crafted and are currently receiving considerable study. The biological study program that the Program and Implementing Agencies are pursuing in the river are robust, cover all of the in-river life stages

as well as many habitat types and areas, and will yield results and conclusions that will ultimately allow the Restoration Goal to be successful.

6. General Operations Challenges

As discussed in the 2020 Annual Report, key operational issues or concerns were identified and discussed within the Program and Reclamation's South-Central California Area Office (SCCAO), and with stakeholders including DWR, U.S. Geologic Survey (USGS), Central California Irrigation District (CCID) and Henry Miller Reclamation District No. 2131 (HMRD). As of 2021, high priority operations issues include:

- Excess losses continue (much greater than anticipated in Exhibit B of the Settlement) in several reaches of the river, most notably Reach 1 and Reach 4 (Exhibit B assumed the use of the natural river channel in Reach 4B, not the use of the East Side Bypass (ESB), thus the high loss rates in the ESB were not anticipated).
- Flow changes by non-Program operations or diverters to meet demands or targets that cause substantial fluctuations in Restoration Flows, notably observed at Gravelly Ford and Sack Dam.
- Substantial unexplained swings in river flows, potentially from changes in seepage rates or from unauthorized or unreported injections, withdrawals, or transfers.

The Program has made and continues to make progress on addressing operational issues such as flow changes, particularly for the GRF and SDP[8] compliance points. However, resolving losses and monitoring issues will continue to be challenging, as most are not directly under the control of Reclamation and will involve working with landowners, diverters, and other river operators to solve.

One issue that has arisen in importance during the past few years (in conjunction with the release or return of spring-run Chinook salmon into the upper portions of Reach 1) is increased focus on management of the minimal cold pool resources of Millerton Lake to ensure that appropriate water temperature is maintained in the river for the various spring-run life stages.

As described elsewhere in this Annual Report, the TAC, in conjunction with Program and SCCAO staff, worked to better characterize and understand these operational issues (TAC contributions to synoptic measurement, water rules initiatives, and comments on GSP's are prime examples, as well as TAC efforts to better model cold pool persistence and releases).

Recommendation: The RA and TAC will continue to assist the Program Office and SCCAO, to focus on improving monitoring and protection of Restoration Flows down the river and resolution of operational issues during 2022 and beyond (see RA and TAC Priorities and work with the Water Rules Group later in this Report).

[8] GRF and SDP are abbreviations used for the flow measurement points at Gravelly Ford (GRF) and downstream of Sack Dam (SDP)

5.2 Flow-Related Challenges

a. Flood Flows – Restoration Flows

One flow management issue that arose in 2019 is the protection of Restoration Flows during flood control releases to the river. Flood control releases are required to manage Millerton Lake elevation and storage in periods of high precipitation and runoff to avoid uncontrolled spills from the reservoir. Flood control releases with appropriate timing and volume can also meet the needs of Restoration Flow releases, while minimizing impacts to Friant Contractor water supply. As such, the Settlement recognizes in Paragraph 13j (vi) the necessity of "determining the extent to which flood releases meet the Restoration flow hydrographs…." and will be addressed in future versions of the RFG. For that dual purpose of the flows to occur, however, they must continue down the river through the Restoration Area. These flows, likely a portion of flood control release flows designated as Restoration Flows, are protected under the existing SWRCB Order dated October 21, 2013, dedicating Restoration Flows "for instream purposes pursuant to Water Code sections 1707 and 1700" and therefore cannot be legally diverted from the SJR or its flood bypass system. Only flows superfluous to the approved Restoration Flow Recommendation are available for diversion. However, on more than one occasion in previous years of flood control releases (2011, 2017, and 2019), approved Restoration Flows did *not* remain in the river and were instead diverted. In addition, third parties demanded the diversions based on claims of "impacts" from the Restoration Program.

Reclamation began working towards resolution of this issue in 2020 and continued intermittently through 2021. However, it appears that Covid and other priorities have prevented this issue from being resolved. Per the Program, there is potential for additional progress on this issue in the first half of 2022.

Recommendation (remains in place from 2020): Reclamation should resolve the "flood flows vs Restoration Flows" issue as soon as feasible, but certainly prior to the 2022-2023 winter season in case it is a wet year with flood control releases.

b. Transition Between Years with Restoration Flows

The Settlement's Exhibit B has Spring Flexible Flow provisions, which allow water to be "pulled forward" to the current Restoration Year from the following Restoration Year. Specifically, the Restoration Year commences on March 1 each year; however, water from the Restoration Year that commences on March 1 can be utilized as early as February 1 (during the previous Restoration Year), either in place of the prior Restoration Year flows or as a supplement. This is particularly useful when a wetter Restoration year follows a drier year; a portion of any shortfalls from the earlier drier year may be alleviated by the ability to transfer flows across year types.

No equivalent provision allows water to be shifted from the current Restoration Year to the following Restoration Year; thus, if the current year is wetter and is followed by drier conditions, no excess winter water may be used to ease shortages after March 1. It is possible, therefore, for Restoration Flows to drop precipitously from the end of February to March 1 without the ability to smooth the transition.

The foremost example of this phenomenon occurred early 2020. 2019 was classified as a "Wet" Restoration Year type, and Restoration Flows of 235 cfs past GRF were scheduled through February. 2020 started out with a "Dry" classification, which fell to "Critical High" by the February Allocation. Although subsequent Allocations returned to only "Dry" conditions, the prospect of falling from 235 cfs to 100 cfs or less at GRF overnight was real. 2020 remained "Dry", but 2021 was initially classified as "Critical Low" before settling at "Critical High" for the year.

A transfer of some 10,400 acre-feet from February to March 2021 was eventually secured through a work-around involving several Friant Contractors and a URF exchange. However, the level of effort required to affect the exchange amounted to literally hundreds of hours by Program and Reclamation Contracts staff, Friant Contractors and the RA.

To date, exchanges have been utilized on two or three occasions to move water forward between Restoration Years; however, the exchanges have been a far from efficient tool to move a modest amount of water. A more streamlined process, or a simple and modest carry forward allowance (e.g., 5 to 10 TAF), with specific rules for use (e.g., any carry-forward Restoration Flows must be used in March) would help to bridge future wet year-to-dry year transitions. Early season (January and February) forecasts and allocations are often relatively imprecise and are substantially revised in March and later forecasts and allocations. For context, "connectivity flows" to keep the SJR connected downstream of GRF at a minimal level require about 165 cfs at GRF, depending on season and weather conditions. A 165 cfs flow at GRF for the month of March would equal approximately 10 TAF.

Recommendation: Reclamation should work with the other Settling Parties to find a way to ensure modest February-to-March flexibility for Restoration Flow shifts, to allow better management of wet year-to-dry year transitions.

c. Conveyance Capacity status

Conveyance capacity for Restoration Flows remains largely constrained by groundwater levels and the need to avoid impacts to adjacent landowners due to real or perceived seepage associated with Restoration Flows. Although the Program has undertaken extensive efforts to model and monitor groundwater levels to assess seepage impacts, the shallow (within 20 feet of surface) groundwater interactions are complex and influenced by multiple factors. Low quality or inconsistent data from monitoring wells, variation in well response to river flow changes versus other influences, and different irrigation or other operating conditions are all challenges in assessing river-derived versus other factor groundwater impacts.

As of early 2022, the most limiting reaches for Restoration Flows are Reaches 3 and 4A. Channel capacities in Reach 3 are limited to about 800 cfs (subject to flow bench evaluation), inclusive of both Restoration Flows and deliveries to Arroyo Canal, although this reach has a flow capacity of 4,000 cfs of flood flows. Channel capacities in Reach 4A are limited to about 300 cfs of Restoration Flows, although this reach also has a capacity of 4,000 of flood flows.

Resolution of any of these immediate constraints is not anticipated prior at least the 2024 Restoration year. Resolution of all seepage limitations to allow release of Restoration Flows up to the full Settlement amounts remains years in the future.

Channel capacity constraints prevent the Program from releasing the full Restoration Flows and limit the progress and effectiveness of the Restoration effort. These constraints will remain until Reclamation is successful in resolving key seepage limitations in the Restoration Area.

5.3 Schedule and Budget Concerns & Recommendations

As of the end of 2021, there were no 30% designs in hand for any major facility (Arroyo Canal/Sack Dam complex, Compact Bypass or Compact Bypass civil structures). Additionally, there were no 10% designs in hand for the remaining canal and levee projects (South Canal, North and South levees). At this juncture, it doesn't seem likely that construction could commence on any of the major structures prior to mid-2024 at the earliest, and construction on some structures or levees may not commence until 2026 or later.

Separate from the construction timeline, current well-reported inflation and supply chain issues will certainly have an impact on the cost of the projects.

The Settlement does not commit the Parties to completion of Paragraph 11 facilities by any date certain; however, 2025 will be 20 years after the execution of the Settlement and 17 years after the passage of the Settlement Act (Title X, Subtitle A of Public Law 111-11).

The Record of Decision for the San Joaquin River Restoration Program requires an Annual Work Plan be developed outlining expected annual Program activities for the next twelve-month period and is to include projected activities for the subsequent two years and a reporting on the activities accomplished in the prior year. Development of the Annual Work Plan is also a requirement under the SWRCB order approving the change in Reclamation's water rights for the purposes of preserving or enhancing wetlands habitat, fish and wildlife resources, or recreation in, or on, the water. To date, no 2020, 2021 or 2022 Annual Work Plan has been prepared.

In several other annual reports (most recently in 2019), I expressed concerns about the schedule and budget for Program implementation and urged a relentless focus on cost reduction and schedule urgency. At this juncture, implementation of the Paragraph 11 projects will likely not be completed until well past 2025 and will ultimately cost considerably more than currently projected. I have shared these concerns with the non-Federal Settling Parties, with senior Program staff, and with Reclamation regional management.

I have also recommended that the Program develop an Implementation Plan that could help guide overall budget and schedule and highlight areas where additional Reclamation resources would be needed to improve implementation prospects. I continue to believe that an Implementation Plan would be helpful to the Program. For example:

- The Program continues to utilize the same organizational chart as it has for several years, despite the changing focus from planning to design, construction and commissioning.
- The Program has been operating without an in-house Program Engineer for nearly four years.

- The Program has been operating without Deputy Program Managers for several months (although a recruitment effort is underway).
- COVID-19 has impacted Program implementation, certainly at no fault of Reclamation or Implementing Agencies. However, it is unclear what Reclamation may be able to do to regain time lost resulting from Covid restrictions.

These and other issues could be addressed or considered in an Implementation Plan.

Recommendation (remains in place from 2020): The Program should produce a comprehensive Implementation Plan for construction of the Paragraph 11(a) projects that are included in Stage 1 of the Funding Constrained Framework by no later than the end of 2022. This Implementation Plan should include a detailed schedule for design and construction, and a list of current and required resources necessary to implement the schedule, and an updated budget for construction work.

Recommendation: The Program should re-start the process of developing an Annual Work Plan as committed to in the Record of Decision and as required in the SWRCB Order dated October 21, 2013, dedicating Restoration Flows for instream purposes pursuant to Water Code sections 1707 and 1700.

6. Specific RA and TAC Activities Completed During 2021

The RA and TAC completed a variety of tasks during 2021 to support and contribute to Program implementation efforts as required by the Settlement. In addition to specific tasks assigned by the Settlement, the RA and TAC have broad latitude pursuant to the Settlement to consult with State and Federal representatives "on matters including, but not limited to, pre-permitting and pre-ESA consultation activities, sharing of information, and technical assistance during initial project development, planning, design, and implementation phases, and monitoring."[9]

Section 7 describes focused TAC priorities for 2022, (particularly those that were not specifically assigned or foreseen in Settlement), and Section 8 describes TAC expenditures for 2021.

- The RA provided Restoration Flow Recommendations throughout 2021, responding to changing conditions and updated Restoration Flow Allocations.
- The RA and the TAC were involved in numerous meetings and discussions regarding various Program initiatives, including:
    - Arroyo Canal/Sack Dam improvements process, including review and comment on various iterations of the Arroyo Canal Fish Screen and Sack Dam improvement facilities;
    - Monitoring seepage well status with regards to permissible Restoration Flows;
    - Input on fisheries monitoring activities in response to flow release operations;
    - RFG meetings and RFG section drafting;
    - Weekly flow management conference calls;
    - Contributions to the Fishery Long Term Monitoring Plan;
    - Development of improved flow and temperature tracking web applications (see https://flowwest.shinyapps.io/SJRRPMonitoring/);
    - Spawning and Incubation Small Interdisciplinary Group (SIG) and Draft Sediment Management Plan development.
    - Millerton Forecasting Advisory Committee (MilFac) now entitled the "Upper San Joaquin Watershed Forecasting Discussion"
- The RA and individual members of the TAC organized and led the following initiatives working with the Program , non-Federal Settling Parties, and implementing Agencies:
    - Synoptic flow gaging in Reach 1, Reach 2b, and the East Side Bypass
    - Water Quality Paper– The TAC produced a draft report summarizing the status of water quality and water quality monitoring in the Restoration Area. It identifies data gaps and contains recommendations for improvements in monitoring programs and will be finalized in 2022.

[9] Stipulation of Settlement, Exhibit D Paragraph C.9

- Refinement of Excel-based water temperature gaming tools
- Initiation of CE-QUAL water temperature model refinement for Millerton Reservoir
- Field trips on San Joaquin River on October

Bi-Monthly TAC meetings Convened by the RA: Bi-Monthly coordination calls involving TAC members were convened to address restoration issues, updates on meetings recently attended by TAC members, and general program updates. These meetings (conference calls) were useful in improving coordination among TAC members, and usually occurred twice per month throughout 2021.There were no in-person TAC meetings due to Covid.

RA Weekly Telephone Conferences with the Program Manager and Key Staff: The RA met via telephone on Monday mornings for an hour or more with the Program Manager and key senior Program and Implementing Agency staff throughout 2021 to discuss upcoming events, program schedule, emerging issues, coordination of efforts and other matters.

RA and TAC Member Participation in Regular Water Quality, Monitoring and Flow Scheduling Conference Calls: The Program holds weekly conference calls involving the Implementing Agencies, Settling Parties and RA/TAC to address water quality, flow monitoring and flow scheduling issues. These meetings contributed to improving communication between the various Program participants on a range of flow scheduling and monitoring needs and activities.

Participation in other Program Technical and Stakeholder Meetings

In 2021 the RA and/or members of the TAC participated in numerous technical work group and technical feedback meetings:

- The RA participated as available in Fisheries Management Workgroup monthly meetings
- The RA and TAC participated in Restoration Flow Guidelines revision meetings and workshops.
- The RA and TAC participated regularly in the Long-Term Management Plan meetings
- The RA and TAC participated in Spawning and Incubation Group bi-monthly meetings
- The RA and TAC participated in ad-hoc group meetings to discuss water temperature data, analysis, management and models
- The RA and TAC participated in the Millerton Forecasting Advisory Committee (MilFac) now entitled the "Upper San Joaquin Watershed Forecasting Discussion"

Contribution to Technical Products of the Program and Implementing Agencies: The RA and TAC contributed (drafting, editing or proofreading) several technical work products produced by the Program and/or individual Implementing Agencies, including:

- Work products from the Spawning and Incubation SIG, including the Draft Sediment Management Plan and the Phase 1 Spawning Habitat Improvement Plan
- Migration of the CE-QUAL Reservoir Temperature model to the current version of the software, planning and data collection for updating the model to current conditions
- Continued refinement of the empirical reservoir and river temperature forecast models jointly operated by the Program and the TAC
- Drafting, edits and comments on the Long-Term Monitoring Plan
- Completed hydraulic and temperature analyses in support of sturgeon conditions evaluation to inform fish passage facilities planning and design, and future operations. Preliminary results captured in interactive web application https://flowwest.shinyapps.io/sjrrpSturgeon/ reviewed by Fisheries Forum and used to facilitate sturgeon discussions in fisheries forum meetings.
- Coordination with Reclamation SJRRP staff (Portz, Burgess, and Story) and CVPIA staff (Wittler) to identify where CVPIA data management resources could be used to make key SJRRP data more accessible and easier to use in SJRRP evaluations.
- Initiated discussions with River Partners and the San Joaquin River Conservancy regarding the Ball Ranch (SJRRP Reach 1) Flood Managed Aquifer Recharge (MAR) feasibility evaluation to identify potential benefits and/or impacts of a Ball Ranch MAR project on SJRRP goals.
- Provided design and planning feedback on Arroyo Canal Fish Screen
- Provided feedback on the North Fork Road Bridge replacement project
- Development of a table of flow gauges included in the draft Flow Monitoring and Management Plan, as well as substantial edits to the Plan.

7. Priority RA/TAC Tasks for 2022

The following list includes proposed 2022 TAC priority tasks (including both tasks as required by the Settlement and focus areas that the RA and TAC feel are important for contribution):

Science and Analysis

1. Undertake a detailed analysis of the 2021 Restoration Flow recommendation that included cessation of Restoration Flows from June 1 through November 28th, 2021, including a detailed analysis of reservoir and river temperatures as they occurred, plus an estimate of

what temperatures may have been with continued Restoration flows. This analysis has been pending access to all of the confirmed flow, temperature and fisheries data.

2. Expand data management tools. The TAC completed both groundwater data analysis and sturgeon habitat/flow analysis tools in coordination with Reclamation's Central Valley Project Improvement Act (CVPIA) Structured Decision Making (SDM) program. Reclamation will consult with the TAC and Program with regards to the next priority data sets for improved data management of use to the Program and CVPIA. Data sets that would benefit from improved management and analysis tools would include spawning, redd, emigration or rotary screw trap data sets, Millerton Lake water temperatures, and/or SJR temperature data from CDFW loggers.
3. Fisheries Framework analysis:
    a) Reach 1 Productivity, data synthesis and analysis, including use of redd and emergence data: re-engage on this discussion in 2022.
    b) Coordination with the San Joaquin River Conservancy on floodplain restoration opportunities and design.
4. Water Temperature Analyses and Modeling: Work with Program staff to update the CE-QUAL temperature model for Millerton Reservoir with additional data (through 2020 or 2021, and develop the model into an operational tool for better managing Restoration Flow releases to preserve cold-water pool to improve fall spawning/incubation water temperatures.
5. Sediment Management Plan: Participate in the Spawning and Incubation SIG to help finalize the Sediment Management Plan for Reach 1A of the SJR.
6. Work with DWR through the Spawning and Incubation SIG to continue developing a pilot gravel augmentation project in Reach 1
7. Work with San Francisco State University to conduct sediment transport sampling in Reach 1A during 2022 high flow events
8. Revisit the Draft Water Quality Overview technical memorandum, consider finalizing and next steps with the Program and SJRRP

<u>Paragraph 11 Projects</u>

1. Review of forthcoming 30% designs for Arroyo Canal/Sack Dam complex and Compact Bypass facilities, provide feedback and comments to the Program.
2. Continue to suggest that the Program develop operational principles for operations of the 2B and Arroyo/Sack Dam complexes. This will at a minimum be a high-level document outlining how the facilities will operate, who makes key decisions, and approaches to ensure adherence to operational requirements.

3. Continue to work with the Program and DWR to attempt to develop a pathway to improve or assure passage for fish in the flood bypass system (Chowchilla Bypass). The Chowchilla Bypass is and will continue to be a critical bi-directional pathway for adult and juvenile movement in all years with flood control releases in the Bypass; thus, improvement of this pathway will greatly benefit the success of the Restoration Goal. The Settlement and the Settlement Act do not specifically authorize any work in the Chowchilla Bypass; however, any progress on this task outside of the work of the SJRRP would be highly beneficial for the success of the SJRRP Restoration Goal.

Water Accounting & Water Rules

Note: Reclamation is responsible for accounting and reporting of use of water that flows into and out of Millerton Lake – the RA and TAC provide input and support to Reclamation's accounting roles.

1. Water Measurement and Operational Consistency – work towards the goal of steady and accurate flows down the river.
    a. The Program and TAC members developed a draft Tech Memo regarding needed improvements in gauging and flow measurement. The TAC will continue to work towards finalization, funding and implementation of a gauging update program.
2. Undertake better estimates or enumeration of losses (or reduction of accretions) in Reaches 1, 2, 3, 4, and 5.
    a. Continue analysis of historical gauge and loss data to anticipate seepage loss rates for various reaches of the Restoration Area.
    b. Undertake additional real time or synoptic measurements, and/or tracking as opportunities arise.
    c. Undertake better identification of the sources, locations and types of losses. Per Settlement paragraph 13(f) differentiating losses from surface diversions and sub-surface diversions including groundwater pumping and tile drains. Identify the basis of the surface diversions, e.g. Holding Contracts, riparian rights, pre- and post-1914 appropriative rights.
    d. Determine which diversions are reported to the SWRCB and other entities; compare those measurements and estimates of diversion amounts with alternative methods of estimating diversion amounts (such as Holding contract designations, land use maps, synoptic flow estimates, pumping sizes)
3. Better understand water transfers in the Restoration Area, including:
    a. What constitutes a reportable transfer;
    b. The rules around permitting and reporting transfers; and

c. Track what transfers occur (reported or unreported).

4. Support Reclamation and SWRCB obligations to protect Restoration Flows to the Delta:

   a. Promote implementation of effective and timely monitoring, and identification of flow issues and/or transgressions.

   b. Work with Program staff and Settling Parties to identify a viable approach to further identify, evaluate, and quantify seepage losses or river withdrawals in accordance with Paragraph 13(f) of the Settlement.

   c. Continued outreach to and coordination with SWRCB, so all may understand what role the SWRCB could/should play in monitoring and compliance activities; and

   d. Continue to promote implementation of a voluntary "rule of the river", or a compliance and/or enforcement plan by Reclamation, Settling Parties, and/or RA as appropriate

5. Follow up on SGMA GSPs. In coordination with Program staff, follow up with DWR as opportunities arise to monitor and support progress on GSP's that potentially impact the Restoration Area and potentially deplete Restoration Flows.

6. Develop (through the RFG Process) a way to smooth Restoration Year transitions (especially wet-to-dry year types). This could include a modest carryover allowance.

<u>Ongoing Priorities, or To Be Continued or Completed in 2022</u>

1. Continue improving Flow Recommendations based on best-science hydrology, fisheries, and water temperature monitoring. In coordination with Program and Implementing Agencies, evaluate different Millerton Reservoir operational strategies, including pulse flows and cold-water pool thermal management.

2. Continue development of RFG to protect Restoration Flows and future RA flow management flexibility. Continue to work with the Program and Settling Parties on the RFG 2.2 issues and task list.

3. Upper San Joaquin Watershed Forecast Discussion (formerly known as Millerton Forecast Advisory Committee) participation: continue to participate in 2022.

4. Continue participating in Spawning and Incubation Group: Develop proposed work plan for a San Joaquin River Sediment Management Plan that will inform next phases of the Spawning Habitat Improvement Plan being prepared by DWR. Continue working with the Spawning and Incubation SIG to address priority information needs for the group that may eventually inform an updated Sediment Management Plan, and contribute towards completion of the Sediment Management Plan.

8. 2021 RA and TAC Expenditures

The following summary of expenditures was provided by National Fish and Wildlife Foundation (NFWF), the administrator of the grant that funds operations of the RA and TAC.

RA and TAC Expenditures, 2021

Restoration Administrator & Technical Advisory Committee Expenditures - 2021	
Organization	**2021 Expenditure Totals**
Tom Johnson	$131,035.63
Bill Luce Consulting	$11,913.30
Hanson Environmental Inc.	$15,423.00
McBain Associates	$77,343.64
The Bay Institute	$100,795.02
Trout Unlimited, Inc.	$10,130.00
FlowWest, LLC	$26,798.50
	$373,439.09
Restoration Administrator & Technical Advisory Committee Hours - 2021	
Organization	**2021 Hour Totals**
Tom Johnson	634
Bill Luce Consulting	65.1
Hanson Environmental Inc.	79.5
McBain Associates	531.5
The Bay Institute	612.25
Trout Unlimited, Inc.	68
FlowWest, LLC	148.5
	2138.85
NFWF Fee - 2021	$30,000.00
Task Order Expenditures & Hours - 2021	
Organization	
The Bay Institute - Hours	61.35
The Bay Institute - Expenditures	$10,000.00
Total Expenditures: RA, TAC, Task Orders, & Admin	***$413,439.09***

APPENDICIES

Appendix A: URF Revenues
Appendix B: 2021 Flow Accounting
Appendix C: History of Millerton Unimpaired Runoff
Appendix D: Final Restoration Allocations

Appendix A: URF Revenues

No URF revenues in 2021

Appendix B: Previous Year (2021) Flow Accounting

Table B — Restoration Flow Accounting and Unreleased Restoration Flows, and Holding Contracts, for the period February 2021 through February 2022. Flood management releases to San Joaquin River did not occur during this period. The final Restoration Allocation was 70.919 TAF. Additionally, Unreleased Restoration Flow exchange returns of 10.435 TAF were released, plus 0.902 TAF of Buffer Flows. The Restoration Allocation was expended with 0.000 TAF ending balance by transitioning from 2021 Allocation to 2022 Allocation midday on February 18, 2022.

Flow Period	Gravelly Ford 5 cfs requirement (TAF)	URF disposed	Released Restoration Flow Volumes (TAF)						
			Continuity Flow	Spring Flexible Flow	Fall Flexible Flow	Riparian Recruitment Flow	Buffer Flow	Flexible Buffer Flow	URF returned
Feb 1 – Feb 28	–		–	*0*	–	–	–	–	
Mar 1 – Mar 31	*10.076*		*1.379*	*0*	–	–	*0*	–	*4.612*
Apr 1 – Apr 30	*12.922*		*0.986*	*0*	–	–	*0*	–	*5.813*
May 1 – May 31	*15.201*		*1.537*	*5.800*[1]	–	*0*	*0.783*	*0*	
Jun 1 – Jun 30	*13.172*		*1.067*	–	–		*0.119*		
Jul 1 – Jul 31	*16.322*		*0*	–	–		*0*		
Aug 1 – Aug 31	*16.701*		*0*	–	–		*0*		
Sep 1 – Sep 30	*14.957*		*0*	–	*0*	–	*0*		
Oct 1 – Oct 31	*13.743*		*0.724*	–	*0*	–	*0*	*0*	
Nov 1 – Nov 30	*13.738*		*2.878*	–	*0*	–	*0*		
Dec 1 – Dec 31	*17.213*		*21.299*	–	*0.595*	–	*0*		
Jan 1 – Jan 31	*12.182*		*26.243*	–	–	–	*0*	–	
Feb 1 – Feb 28	*14.529*		*8.412*	–	–	–	*0*	–	
	170.757	***0***	***64.525***	***5.800***	***0.595***	***0***	***0.902***	***0***	***10.425***
			70.919 *(allocated Restoration Flows)*				***0.902*** *(all Buffer Flows)*		
			71.822 *(Restoration Flows affecting Friant water supply)*						
			82.247 *(Restoration Flows released to river)*						
		70.919 *(Restoration Allocation used)*							
			253.004 *(Friant Dam releases — excludes disposed URFs)*						

[1] On May 28, 35.159 TAF of the Spring Flexible Flow account was transferred into the Continuity Flow Account, passing a Water Supply Test, and released in October through February.

Appendix C: History of Millerton Unimpaired Runoff

Table C — Water Year Totals in Thousand Acre-Feet

Water Year [1]	Unimpaired Runoff [2]	SJRRP Water Year Type [3]
1901	3,227.9	Wet
1902	1,704.0	Normal-Wet
1903	1,727.0	Normal-Wet
1904	2,062.0	Normal-Wet
1905	1,795.4	Normal-Wet
1906	4,367.8	Wet
1907	3,113.9	Wet
1908	1,163.4	Normal-Dry
1909	2,900.7	Wet
1910	2,041.5	Normal-Wet
1911	3,586.0	Wet
1912	1,043.9	Normal-Dry
1913	879.4	Dry
1914	2,883.4	Wet
1915	1,966.3	Normal-Wet
1916	2,760.5	Wet
1917	1,936.2	Normal-Wet
1918	1,466.8	Normal-Wet
1919	1,297.5	Normal-Dry
1920	1,322.5	Normal-Dry
1921	1,604.4	Normal-Wet
1922	2,355.1	Normal-Wet
1923	1,654.3	Normal-Wet
1924	444.1	Critical-High
1925	1,438.7	Normal-Dry
1926	1,161.4	Normal-Dry
1927	2,001.3	Normal-Wet
1928	1,153.7	Normal-Dry
1929	862.4	Dry
1930	859.1	Dry
1931	480.2	Critical-High
1932	2,047.4	Normal-Wet
1933	1,111.4	Normal-Dry
1934	691.5	Dry
1935	1,923.2	Normal-Wet
1936	1,853.3	Normal-Wet
1937	2,208.0	Normal-Wet
1938	3,688.4	Wet
1939	920.8	Dry
1940	1,880.6	Normal-Wet
1941	2,652.5	Wet
1942	2,254.0	Normal-Wet
1943	2,053.7	Normal-Wet
1944	1,265.4	Normal-Dry
1945	2,134.633	Normal-Wet
1946	1,727.115	Normal-Wet
1947	1,121.564	Normal-Dry
1948	1,201.390	Normal-Dry
1949	1,167.008	Normal-Dry
1950	1,317.457	Normal-Dry
1951	1,827.254	Normal-Wet
1952	2,840.854	Wet
1953	1,226.830	Normal-Dry
1954	1,313.993	Normal-Dry
1955	1,161.161	Normal-Dry
1956	2,959.812	Wet
1957	1,326.573	Normal-Dry
1958	2,631.392	Wet
1959	949.456	Normal-Dry
1960	826.021	Dry
1961	647.428	Critical-High
1962	1,924.066	Normal-Wet
1963	1,945.266	Normal-Wet
1964	922.351	Dry
1965	2,271.191	Normal-Wet
1966	1,298.792	Normal-Dry
1967	3,233.097	Wet
1968	861.894	Dry
1969	4,040.864	Wet
1970	1,445.837	Normal-Dry
1971	1,416.812	Normal-Dry
1972	1,039.249	Normal-Dry
1973	2,047.585	Normal-Wet
1974	2,190.308	Normal-Wet
1975	1,795.922	Normal-Wet
1976	629.234	Critical-High
1977	361.253	Critical-Low
1978	3,402.805	Wet
1979	1,829.988	Normal-Wet
1980	2,973.169	Wet
1981	1,067.757	Normal-Dry
1982	3,317.171	Wet
1983	4,643.090	Wet
1984	2,042.750	Normal-Wet
1985	1,135.975	Normal-Dry
1986	3,031.600	Wet
1987	756.853	Dry
1988	862.124	Dry
1989	939.168	Normal-Dry
1990	742.824	Dry
1991	1,027.209	Normal-Dry
1992	807.759	Dry
1993	2,672.322	Wet
1994	824.097	Dry
1995	3,876.370	Wet
1996	2,200.707	Normal-Wet
1997	2,817.670	Wet
1998	3,160.759	Wet
1999	1,527.040	Normal-Wet
2000	1,735.653	Normal-Wet
2001	1,065.318	Normal-Dry
2002	1,171.457	Normal-Dry
2003	1,449.954	Normal-Dry
2004	1,130.823	Normal-Dry
2005	2,826.872	Wet
2006	3,180.816	Wet
2007	684.333	Dry
2008	1,116.790	Normal-Dry
2009	1,455.379	Normal-Wet
2010	2,028.706	Normal-Wet
2011	3,304.824	Wet
2012	831.582	Dry
2013	856.626	Dry
2014	509.579	Critical-High
2015	327.410	Critical-Low
2016	1,300.986	Normal-Dry
2017	4,395.400	Wet
2018	1,348.979	Normal-Dry
2019	2,734.772	Wet
2020	886.025	Dry
2021	521.853	Critical-High

[1] Water year is from Oct 1 through Sept 30, for example the 2010 water year began Oct 1, 2009. Unimpaired Runoff is based on Reclamation calculations, and hypothetical water year types are shown here; actual Restoration water year types are based on the final allocation, which may sometimes differ slightly from the calculated water year total.

[2] Also known as “Natural River” or “Unimpaired Runoff into Millerton” – This is the total runoff that would flow into Millerton Lake if there were no dams or diversions upstream. There was a lower level of precision prior to 1945. Friant Dam uses 1.9835 conversion from cfs to AF.

[3] The six SJRRP Water Year Types are based on Unimpaired Runoff and are not updated as climatology changes as per the Settlement. Critical-Low= <400 TAF, Critical-High=400-669.999 TAF, Dry= 670-929.999 TAF, Normal-Dry 930-1449.999, Normal-Wet 1450-2500, Wet>2500

Appendix D: Final Restoration Allocations and Error

Table D — History of Restoration Allocations

Year	Type	Date of Final Allocation Issuance[2]	Unimpaired Runoff Forecast in Final Allocation (TAF)	Restoration Allocation in Final Issuance (TAF)	Observed Unimpaired Runoff on Sep. 30 (TAF)	Unimpaired Runoff Forecast Error	Allocation Error
2009	Interim Flows			261.5	1,455.379	—	—
2010	Interim Flows			98.2	2,028.706	—	—
2011	Interim Flows			152.4	3,304.824	—	—
2012	Interim Flows			183	831.582	—	—
2013	Interim Flows			65.5	856.626	—	—
2014	Restoration Flows	Mar 3	518	0[1]	509.579	+8.421	0[1]
2015	Restoration Flows	Sep 28	327	0	327.410	-0.410	0
2016	Restoration Flows	Sep 30	1300.986	263.295	1,300.986	0	0
2017	Restoration Flows	Jul 10	4,444	556.542	4,395.400	+48.600	0
2018	Restoration Flows	May 22	1,427	280.258	1,348.979	+78.021	+10.503
2019	Restoration Flows	May 20	2,690	556.542	2,734.772	-44.772	0
2020	Restoration Flows	June 19	880	202.197	886.025	-6.025	-1.345
2021	Restoration Flows	June 25	529	70.919	521.853	+7.147	0

[1] No water was provided under this Critical-High designation due to necessity for Friant Dam to release flows for the Exchange Contract.

[2] In 2018 with the completion of Version 2.0 of the Restoration Flows Guidelines, the date of final Restoration Allocation issuance was advanced from September 30 to May (or June under dry hydrologic conditions).

Appendix E: 2021 Restoration Allocation History, Hydroclimate, Forecasting Challenges, and Millerton Storage and Operations

This appendix documents the Restoration Allocation History in 2021 and provides additional detail on the 2021 water year (October 2020 through September 2021) hydroclimate and the resulting challenges in forecasting runoff.[1] Additionally it provides an overview of Millerton Lake reservoir operations.[2]

Restoration Allocation History

The progression of the Restoration Allocation from the Initial allocation on January 21, 2021 to the Final Allocation on June 25, 2021 is shown in Table 1. The methods and data used to develop the forecasts and allocations are described in the Restoration Allocations memos the Program issues on the dates in Table 1. The Restoration Flow Guidelines Version 2.1 provide guidance for the development of the Forecasts and Restoration Allocation.

2021 Water Year Hydroclimate

The October 2020 through September 2021 water year (2021) followed the dry 2020 (SJR runoff 51% of average), and began with the September 2020 Creek Fire, which impacted about 38% of the watershed area, and burned into November. The San Joaquin River watershed above Friant Dam, received 45% of its average precipitation in the 2021 water year, making it drier than about 95% of the years in the historic record. The 2021 unimpaired runoff inflow to Millerton Lake of 522 thousand acre-feet (TAF) and the April-July unimpaired runoff of 360 TAF, were both the 6th driest in the 121-year record. The August and September unimpaired monthly runoff were the driest on record. The total runoff in the 2020 and 2021 two-year sequence was the 3rd driest in the historical record.[3]

The 2021 hydroclimate– rainfall, snow accumulation and depletion, temperature, and resulting runoff - had the following notable characteristics, amplifying the usual runoff forecast uncertainty.

- Very dry autumn with very low runoff, resulting in very low soil moisture at the time of first snowfall
- Mid-January snowpack was nearly the driest on record
- Nearly half of the water year precipitation and more than half of the 2021 snow accumulation occurred in one cold storm (January 28-29)
- Cold winter with snow extending to low elevations persisting into March and inhibiting runoff, which continued at very low levels. Lower elevation snowpack melted relatively quickly with warmer spring temperatures.
- Second driest April–June watershed precipitation with above average temperatures, intensifying the drought-induced dry soils and soil moisture depletion.
- Unexpected deficit in snow depth above 10,000’ because of the lack of accumulation at high elevation and possible increased sublimation— a process that can deplete the snowpack through evaporation, bypassing the usual snowpack depletion through melting into the liquid phase.
- Rapid melt of multiple elevation bands at once, early in melt season

Runoff Forecast Challenges

Figure 1 plots the seasonal progression of the forecasts of the water year unimpaired runoff Millerton Lake issued by California Department of Water Resources (DWR) and the National Weather Service

[1] Table 1, Figures 1 and 2, and hydroclimate and forecasting key points are derived from the San Joaquin River Restoration Program (Program) and the Reclamation Joint Forecasting Team documents.
[2] Figure 3 is from the US Army Corps of Engineers
[3] The driest 2-year runoff sequence in the historical record was 2014/2015 and 1976/1977 was the 2nd driest.

(NWS) via the California Nevada River Forecast Center (CNRFC). Except for the significant increase after the late January storm, the forecasts steadily declined as the season progressed because of the lack of significant snowpack accumulation and continuing low runoff. The 2021 hydroclimate characteristics combined with the following measurement and analytical challenges, further compounded the normal uncertainty in runoff forecasts.

- 5 snow pillow sensors not properly operating, some of which were damaged in the Creek Fire
- Relatively large differences between modeled snowpack volumes by six different entities contributed to the differences in the published runoff forecasts made by DWR and CNRFC. The three Airborne Snow Observatory (ASO) LIDAR surveys of the watershed snowpack were consistently lower than the other modeled estimates. Figure 2 shows the watershed precipitation received from January through early June and the progression of the modeled snowpack volumes by the different entities. Note the large precipitation event in late January and the relative lack of precipitation after that, especially in April and May.
- ASO surveys provided confirmation of the surprisingly low ratio of runoff to volume of water accumulated in the snowpack (runoff efficiencies).
- Drought years such as 2021 are particularly sensitive to runoff efficiency, with runoff yields varying from month to month. Runoff efficiencies climbed quickly from <20% in January to 43% in April to 54% in May, making it difficult to predict runoff. The Creek Fire effects on runoff efficiencies was uncertain.
- In 2021, 1,670 TAF fell on watershed, producing about 530 TAF of runoff (32% runoff efficiency over the entire WY); 2021 received 84% of 2020's precipitation but only had 60% of the runoff, demonstrating the comparatively low runoff efficiency in 2021.

2021 Millerton Lake reservoir operations

Figure 3 plots (from top to bottom) the 2021 time series of:

a) Precipitation at Friant Dam — note about ½ of the 2021 total of 8.87" was received in late January
b) Reservoir storage volume (blue line) in relation to the allowable conservation storage (top of grey shaded area). Low snowpack and spring runoff kept the storage far below its conservation pool limits.
c) Inflow (green line) — because of the low runoff, the inflow was entirely controlled by upstream SCE and PGE hydropower operations
d) Outflow (orange line) — sum of River releases (for Holding Contracts and Restoration Flows) and Canal releases (Madera and Friant-Kern canals)

The low runoff kept storage at a relatively low level though much of the water year. Storage reached its high point at the end of September, an abnormal condition due in part to the low Friant allocation, the retention of Restoration allocation in storage, and storage retention in case an Exchange Contractor release from Friant was needed. Storage kept rising through the Fall and early winter reaching its high point around 358 TAF at the end of December.

Table 1. 2021 Restoration Allocation History

Allocation Type	Issue Date	Forecast Blending Applied	Unimpaired Inflow Forecast (at forecast exceedance)	Year Type	Restoration Allocation at Gravelly Ford	Restoration Flows and URFs Released
Initial	January 21, 2021	30/70	296 TAF (@ 90%)	Critical-Low	0 TAF	0 (thru 1/20/2021)
Update	February 5, 2021	50/50	657 TAF (@ 75%)	Critical-High	70.919 TAF	0 (thru 2/4/2021)
Update	February 19, 2021	20/80	739 TAF (@ 75%)	Dry	170.732 TAF	0 (thru 2/4/2021)
Update	March 19, 2021	40/60	642 TAF (@ 75%)	Critical-High	70.919 TAF	3.390 (thru 3/18/2021)
Update	April 16, 2021	30/70 (-25 TAF Offset)	567 TAF (@ 50%)	Critical-High	70.919 TAF	9.503 (thru 4/15/2021)
Update	May 21, 2021	30/70 (-15 TAF Offset)	524 TAF (@ 50%)	Critical-High	70.919 TAF	17.774 (thru 5/19/2021)
Final	June 25, 2021	60/40	529 TAF (@ 50%)	Critical-High	70.919 TAF	22.290 (thru 6/23/2021)

Figure 1. Plot of 2021 Water Year forecasts, including both NWS Ensemble Streamflow Prediction Forecasts and DWR Forecasts

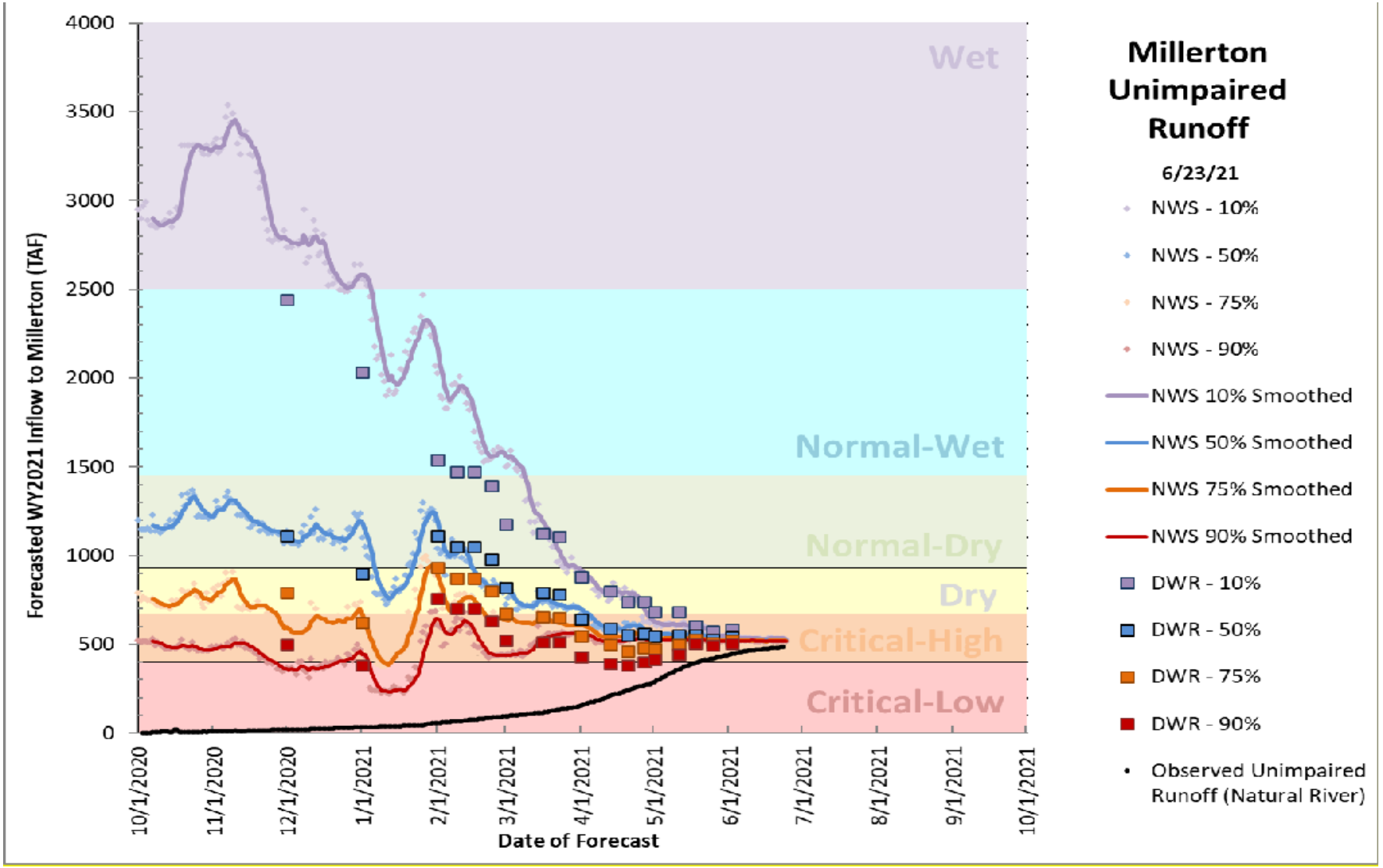

Figure 2.

Snowpack Model Progression WY 2021

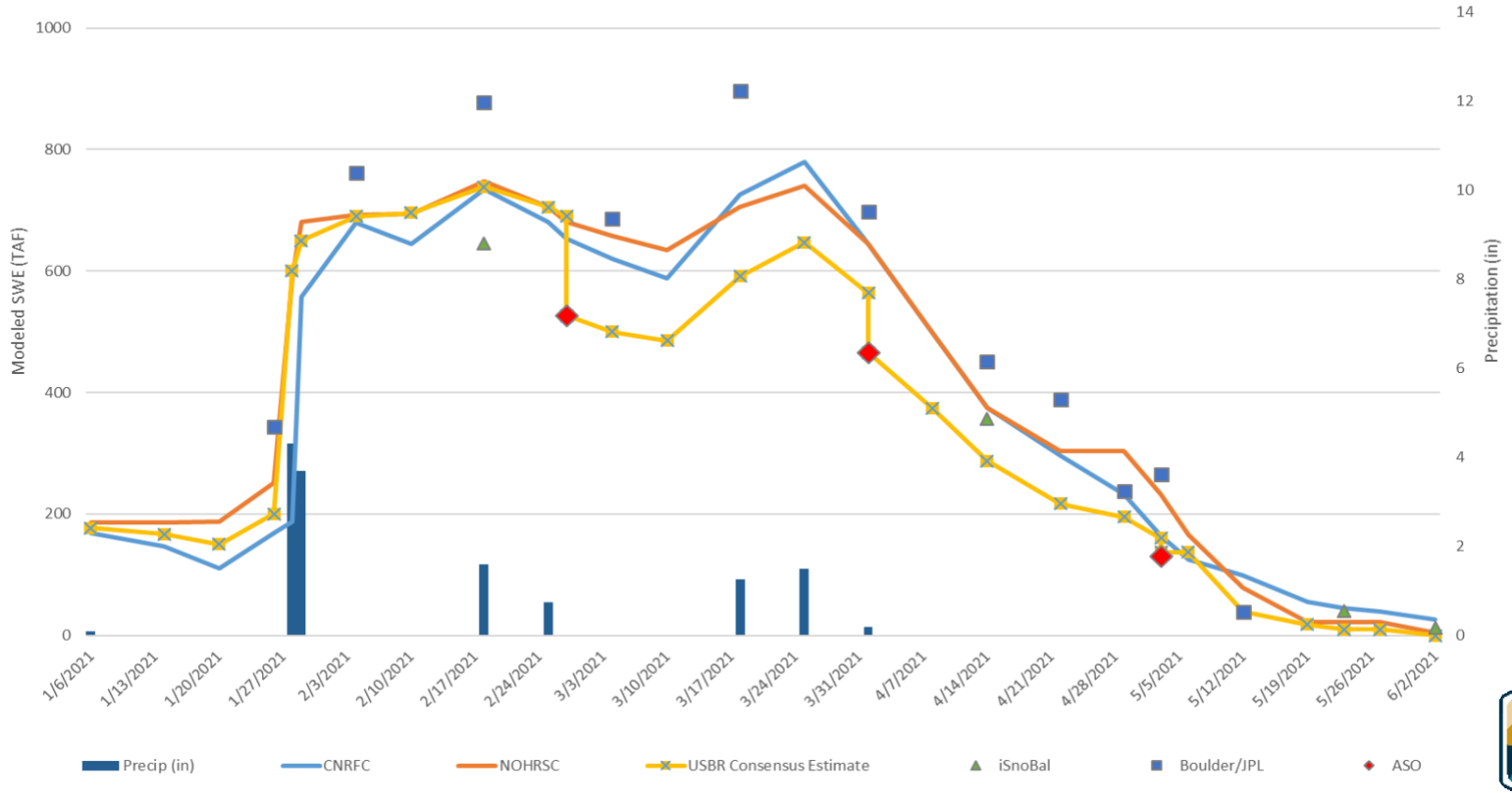

Figure 3. 2021 Water Year Millerton Lake Storage and Operations