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TECHNICAL MEMORANDUM

DATE: October 20, 2023

Project No.: 941-80-23-33
SENT VIA: EMAIL

TO: Peter Kavounas, PE

FROM: Garrett Rapp, PE, RCE #86007

GARRETT RAPP
No. C86007
Exp. 9-30-24

REVIEWED BY: Andy Malone, PG #8700

SUBJECT: Design of Projection Scenarios to Support the 2025 Safe Yield Reevaluation (#1)

This technical memorandum (TM) is the first of three TMs that will document the development of an ensemble of projection scenarios (Projection Ensemble) for the 2025 Safe Yield Reevaluation (2025 SYR). The purpose of this TM is to (1) document the proposed approach to develop various projections of water demands and supply plans (Water Plans) that will be included in the Projection Ensemble to account for uncertainties of future Water Plans and (2) articulate the questions that the Chino Basin parties and stakeholders will be asked at the first Scenario Design Workshop on October 24, 2023.

BACKGROUND

The April 28, 2017 Court Order regarding the Chino Basin Safe Yield (2017 Court Order)[1] included several provisions related to the update of the groundwater-flow model, the calculation of the Safe Yield, and the methodology used to calculate the Safe Yield, that were later incorporated into the 2022 Rules and Regulations (2022 R&R):[2]

1. Approved the 2015 Safe Yield Reset methodology (2015 methodology).
2. Approved the reset of the Safe Yield to 135,000 acre-feet per year (afy) for the period of fiscal year (FY) 2011 through FY 2020.
3. Required that the Safe Yield be recalculated for the period of FY 2021 through 2030 (2022 R&R, §6.5(a)).
4. Allowed for an update to the Safe Yield Reset methodology (2022 R&R, §6.5(d)).
5. Required that the Safe Yield be reevaluated by June 30, 2025 (2022 R&R, §6.5(f)).

In 2020, the Safe Yield was recalculated using the 2015 methodology and was reset to 131,000 afy for the period of FY 2021 through 2030 (2020 Safe Yield Recalculation[3]). During the peer review process for the 2020 Safe Yield Recalculation, the parties and peer reviewers provided several comments and

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[1] *Orders for Watermaster's Motion Regarding the 2015 Safe Yield Reset Agreement, Amendment of Restated Judgment*, Paragraph 6, Superior Court for the County of San Bernardino

[2] 2022 Watermaster Rules and Regulations

[3] 2020 Safe Yield Recalculation Report

recommendations to address the uncertainty in future Water Plans in calculating the Safe Yield.[4] These comments and recommendations included recommendations to simulate multiple pumping scenarios and address predictive uncertainty in a more comprehensive way.

2022 Safe Yield Reset Methodology

Pursuant to (4) above, the Watermaster initiated the process to update the Safe Yield Reset methodology in 2021. After extensive peer review, Watermaster developed the 2022 Safe Yield Reset methodology (2022 SYRM),[5] which was approved by the Court in December 2022.[6] The 2022 SYRM includes the following steps:

1. *Use data collected since the implementation of the OBMP to re-calibrate the Watermaster's groundwater-flow model. The re-calibration period should be long enough to include wet and dry periods relative to the long-term historical precipitation record.*
2. *Conduct an uncertainty analysis of the re-calibrated groundwater-flow model to identify a plausible range of calibrated models.*
3. *Describe current and projected future cultural conditions, including but not limited to land use and water-management practices, such as: pumping, managed recharge, managed groundwater storage, impervious land cover, water recycling, and water conservation practices. Identify a possible range of projected future cultural conditions.*
4. *Using the most current research on future climate and hydrology, identify a possible range of projected future climatic conditions in the Santa Ana River watershed.*
5. *Using the results of [3.] and [4.] above, prepare an ensemble of multiple projection scenarios of combinations of future climate/hydrology and cultural conditions (herein called the "Projection Ensemble"). Assign likelihoods to each scenario in the Projection Ensemble.*
6. *Simulate the range for the potential future water budget and groundwater conditions in the Chino Basin over no less than a 50-year future period. This is accomplished by using:*
    i. *The range of calibrated models developed in [2.], and*
    ii. *The Projection Ensemble developed in [5.] as model input data.*
7. *Using the results of [6.] above, characterize the range in the model results for:*
    i. *Groundwater conditions, including: groundwater elevations, groundwater in storage, and groundwater flow directions, and*
    ii. *The water budget, including: basin inflows, outflows, change in storage, and net recharge.*
8. *Using the set of net recharge results from [7.ii], determine a tentative Safe Yield as the likelihood-weighted average net recharge over the 10-year prospective period for which the Safe Yield is being redetermined (Tentative Safe Yield).*

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[4] See Section 1.0 of the 2022 SYRM TM for references

[5] 2022 Update of the Chino Basin Safe Yield Reset Methodology

[6] December 16, 2022 Order Granting Chino Basin Watermaster's Motion Regarding the Update to Watermaster's Safe Yield Reset Methodology

9. *Evaluate whether the groundwater production at the Tentative Safe Yield estimated in [8] above will cause or threaten to cause "undesirable results" or "Material Physical Injury." If groundwater production at Tentative Safe Yield will cause or threaten to cause "undesirable results" or "Material Physical Injury," then Watermaster will identify and implement prudent measures necessary to mitigate "undesirable results" or "Material Physical Injury," set the value of Safe Yield to ensure there is no "undesirable results" or "Material Physical Injury," or implement a combination of mitigation measures and a changed Safe Yield.*

Proposed Method to Develop Water Plan Scenarios

To execute steps (3) and (5) of the 2022 SYRM, the 2022 SYRM TM outlined a proposed method to develop Water Plan Scenarios using principles of Robust Decision Making (RDM). RDM involves considering many scenarios with the objective of evaluating uncertainties in future conditions to inform management or planning decisions. The proposed method to develop Water Plan Scenarios is summarized below:

1. Describe the major drivers that affect future water demands and supplies. Examples of these drivers include economics and demographics, technology and infrastructure, policy and regulation, and climate. Conduct a workshop with the parties and wholesale agencies that serve the Chino Basin to ensure that the most significant drivers are identified and described.
2. Develop qualitative Water Plan Scenarios based on the drivers identified in step 1. These scenarios will include assumptions of each driver and its effect on future Water Plans.
3. Select a subset of the Water Plan Scenarios developed in step 2 that will be incorporated into the projection realizations.
4. Develop quantitative water supply plans for the selected Water Plan Scenarios. This will rely on a review of relevant planning information (e.g., Urban Water Management Plans [UWMPs], regional water resources planning studies, and data on cultural conditions collected pursuant to the 2017 Court Order) and workshops with the parties and wholesale agencies. This effort will leverage existing planning studies to define the Water Plan Scenarios and will not include the development of any new planning studies.
5. Conduct two workshops with the parties and wholesale agencies to refine and iterate the Water Plan Scenarios. If desired, the parties may provide feedback to aid in the assignment of non-uniform likelihoods (probabilities) to the chosen Water Plan Scenarios. For example, one Scenario could be chosen as the “most likely” case, the results of which may be assigned a higher weight than the results of other Scenarios in the interpretation of the Projection Ensemble.
6. Translate the Water Plan Scenarios into model inputs (e.g., groundwater pumping, outdoor urban water use, managed recharge, imported water, others) and integrate into projection realizations.

DRIVERS OF WATER PLANS OF THE CHINO BASIN PARTIES

This section discusses the major drivers that affect the Water Plans of the Chino Basin parties. These drivers include (1) economics and demographics, (2) technology and infrastructure, (3) policy and regulation, and (4) climate. This list is not comprehensive, and many facets of these overlap with one another. For each of these drivers, the following questions should be answered with input from the general stakeholders:

1. How does the driver affect Water Plans?

2. How do water agencies quantify the driver and its projected impact on Water Plans?
3. What are the current projections for the driver and its impact(s) on Water Plans?
4. What is the uncertainty in these projections?

The sections below summarize each driver and provide initial responses to guide and frame further discussion.

Economics and Demographics

How do economics and demographics affect Water Plans?

Economics and demographics drive changes in water demands, patterns of use, and the availability of water supplies. Typically, population increases will increase water demands. The types of expected demographic changes (e.g., population growth in high-density versus low-density urban areas), together with land use projections, can result in changes in demands. Water agencies may choose to develop different types of supplies in response to economic and demographic changes that impact projected revenues and water demands compared to existing supplies. Other ways that economics and demographics drive water supplies include recycled water supply availability (e.g., population growth increasing recycled water availability) and changes in land use altering runoff and recharge, which impact groundwater and surface water availability.

In addition to the macro-level trends in economic and demographic effects on Water Plans, acute economic conditions, such as the recession in the late 2000's and the COVID-19 pandemic, can result in measurable impacts on water demands.

How do water agencies quantify economics and demographics and their projected impact on Water Plans?

The assumptions for economic and demographic changes that water agencies use to develop Water Plans often incorporate outside planning information, such as population growth estimates and land use development plans. Water agencies typically leverage this information and historical patterns to estimate future water demands based on land use, population, and future per capita or per customer water use (considering all residential, industrial, or commercial users as customers). These assumptions can be simplified into calculating total demand as the product of the per customer water use and the number of customers. Water agencies use these calculations to estimate total demands and ensure that water supplies are available to meet these demands.

Many of the stakeholders in the Chino Basin obtain outside planning information from entities including:

- The Southern California Association of Governments (SCAG), which develops service area population growth estimates. SCAG develops these estimates based on models incorporating a variety of demographic, economic, and other planning data.
- Local land use planning entities (e.g., cities), which develop General Plans that include land use projections. These land use General Plans assume a future year of "buildout" when the final General Plan land use will be realized. Based on the projected land uses and assumed unit water demands of each land use type, stakeholders can derive estimates of future water demands.

What are the current projections for economics and demographics and its impacts on Water Plans?

The annual population growth rate projections in the Chino Basin region generally range from zero to two percent. The projected annual population growth rate in the Inland Empire Utilities Agency (IEUA) service area is about 0.85 percent from 2020 through 2045.[7] Most of the planning data for Chino Basin agencies indicates a buildout year of about 2040.

Per capita water demand projections add uncertainty to the effects of population growth on total water demands. Combinations of urbanization, technology improvements, regulations (such as the Water Conservation Act of 2009), and other behavioral changes have led to a decline in per capita water use over the past several decades.

What is the uncertainty in projections of economics and demographics?

The SCAG population growth projections and the land use General Plans typically do not quantify uncertainty. As the General Plan land uses are often well-controlled, the built-out state of future land use may be subject to less uncertainty than the buildout year, which can be affected by economic conditions. Prior Chino Basin surface and groundwater modeling studies typically assume a constant rate of buildout to the city's assumed final buildout year (e.g., 2040). Major uncertainties in the future per capita water use include responses to future regulations, economic conditions, climate, and water-use efficiency. These uncertainties can be challenging to quantify, and future projections of per capita water use often incorporates a mixture of assumptions based on historical data, trends, and a synthesis of other datasets (e.g., climate models).

Technology and Infrastructure

How do technology and infrastructure affect Water Plans?

Technology and infrastructure drive the development and use of water resources from the source to the end consumer. Some specific effects include (1) water efficiency improvements that reduce water demands, such as improving leak detection and repair on an agency or household scale, (2) treatment capacity enhancements that enable development of new potable or non-potable sources, (3) infrastructure investments that affect the accessibility and affordability of water, leading to changes in demand, (4) stormwater capture or other recharge infrastructure improvements that increase water supplies, and (5) new pumping wells that augment groundwater production capacity.

How do water agencies quantify technology and infrastructure and their projected impact on Water Plans?

Agencies typically engage in various forms of long-term planning to anticipate the needs for new or replacement infrastructure and develop plans to address these needs, such as the IEUA's Ten-Year Capital Improvement Plan.[8] Plans such as these drive investment in infrastructure and technologies that can alter the Water Plans of the stakeholder or nearby/member agencies. When developing projections for per

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[7] See Table 3-1 from IEUA's 2020 UWMP

[8] IEUA – FY 2018/19 Ten-Year Capital Improvement Plan

customer water use, agencies make assumptions about the potential future technologies that could result in lower unit water uses, such as low-flow toilets or drip irrigation systems.

In addition to the stakeholder-specific approaches to quantifying the impacts of technology and infrastructure, Watermaster's Recharge Master Planning process has resulted in the planning for and development of infrastructure to enhance the recharge in the Chino Basin.

What are the current projections for technology and infrastructure and its impacts on Water Plans?

Most water agencies in the Chino Basin assume that per capita water use will decline in the future in response to regulations, technology improvements, and other factors. In general, water agencies to not explicitly quantify projections of the impacts of technology on Water Plans.

Overall, water agencies in the Chino Basin are planning to build new or replacement infrastructure that will reduce water losses and increase the ability to pump, treat, and convey water across the basin. Several examples include new treatment plants in the City of Chino and the Monte Vista Water District, the Etiwanda Intervalley Water Quality and Water Resiliency Project, and IEUA's Chino Basin Program facilitating indirect potable reuse. In addition, all water agencies will be required to update their infrastructure as necessary to meet agency-specific water loss standards starting in 2028 pursuant to the State's water loss performance standards regulations (Water Loss Regulation).[9] These planned infrastructure projects have various timelines of completion, but all of them are being developed with the goal of improving water supply resiliency in the basin.

What is the uncertainty in projections of technology and infrastructure?

Technology and infrastructure changes generally have less uncertainty than the other drivers due to the longer timeframe necessary to measurably affect Water Plans. Due to permitting, design, and construction time, major infrastructure can take a decade or more to be fully realized, allowing for time to incorporate the anticipated effects into Water Plans. However, economic or regulatory shifts can alter the timing of infrastructure implementation.

Policy and Regulation

How do policies and regulations affect Water Plans?

Policy can include policies or regulations at any level (local, county, state, etc.) that affect the Water Plans in the Chino Basin. Several notable examples include the Water Conservation Act of 2009 (Senate Bill [SB] X7-7),[10] the Model Water Efficient Landscape Ordinance (MWELO),[11] and the 2018 Urban Water Use Objectives legislation (Assembly Bill 1668 and SB 606) (2018 Conservation Legislation) and the related "Making Conservation a California Way of Life" (Conservation Regulation)[12] and Water Loss Regulation. These policies have direct impacts on water demands by driving reduced water use, and indirect impacts on the water supply plans that must be adjusted to satisfy these reduced demands. Water quality regulations, such as maximum contaminant levels for constituents, can affect the cost and amount of

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[9] California Code of Regulations, Title 23, §§ 980–986

[10] SB X7-7 (ca.gov)

[11] Model Water Efficient Landscape Ordinance

[12] Making Conservation a California Way of Life Fact Sheet

available water supplies. Many other policies and regulations can have direct or indirect effects on Water Plans, including land use regulation, environmental requirements, and building codes.

Several provisions of the California Water Code (CWC) requiring the preparation of UWMPs include requirements for urban water agencies to document measures they have taken or plan to take to implement regulations such as SB X7-7, demand management measures, quantify water supply reliability, and other regulations that impact Water Plans.

How do water agencies quantify policy and regulation and their projected impact on Water Plans?

The policies and regulations that directly impact Water Plans often have specific, measurable objectives that water agencies can use to quantify their impact on their Water Plans. Several examples of quantifying the impact of policy and regulations on Water Plans can be found in UWMPs, including documenting per capita water use in relation to the targets mandated by SB X7-7 and quantifying water supply reliability. In addition, urban water agencies must develop water use projections and if possible, "display and account for the water savings estimated to result from adopted codes, standards, ordinances, or transportation and land use plans…"[13]

What are the current projections for policy and regulation and its impacts on Water Plans?

Water agencies generally expect policy and regulation to reduce urban water uses. IEUA's 2020 UWMP states that "[r]esidential, commercial, and industrial usage can be expected to further decrease as a result of the implementation of more aggressive water conservation practices." This sentiment is consistent across virtually all water agencies; however, the impacts of future policies and regulations on Water Plans are not explicitly defined.

The 2018 Conservation Legislation required standards be set for indoor and outdoor water use and water loss. The 2018 Conservation Legislation has resulted in the legislature setting specific targets for residential indoor water use that urban water suppliers are expected to meet by 2025 (47 gallons per capita per day [gpcd]) and 2030 (42 gpcd).[14] The State Water Resources Control Board (State Board) recently completed rulemaking for the Water Loss Regulation (effective April 1, 2023), which require reduction of real loss to individualized standards. The State Board has also initiated the formal rulemaking of the Conservation Regulation to set standards for residential outdoor and commercial, institutional, and industrial landscapes with dedicated irrigation meters. The Conservation Regulation, if promulgated, will complete the development of agency-specific overall urban water use objectives, which include (1) residential indoor, (2) residential outdoor, (3) commercial, institutional, and industrial landscapes with dedicated irrigation meters, (4) real water losses, and (5) any variances. The State Board issued proposed regulatory text in August 2023.[15] As of this writing, the timing of the final regulation and enforcement timeline is unclear.

What is the uncertainty in projections of policy and regulation?

Due to the diverse nature of policy and regulation, the projected impacts of policy and regulation on Water Plans are subject to a great degree of uncertainty. The uncertainties in the implementation, enforcement,

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[13] CWC 10631

[14] CWC 10609.4(a).

[15] Proposed Text of Conservation Regulation

and impact of the 2018 Conservation Legislation and related regulations are significant, and the responses to this legislation will have a measurable impact on the Water Plans and areal recharge in the Chino Basin.

Climate

How does climate affect Water Plans?

Climate drives changes in both demands and supplies. Generally, hotter and drier climates drive greater demands, with temperature being the primary driver of increased urban demands. Hotter and drier climates can also lead to less reliable water supplies, including imported water and, over a longer term, groundwater due to reduced infiltration rates and recharge potential. Other potential climate hazards such as wildfires, severe weather, and mudslides/landslides can have more acute impacts that affect the ability of water agencies to serve their customers.

How do the water agencies quantify climate and its projected impact on Water Plans?

In the development of UWMPs, water agencies must complete a water service reliability and drought risk assessment, which assesses the water agency's water service reliability during "… a normal water year, a single dry year, and a drought lasting five consecutive water years."[16] These assessments indicate how water agencies plan to respond to droughts that are projected to become longer and more severe in the future.[17] Water agencies in the Chino Basin that rely on imported water from Metropolitan Water District of Southern California (MWD) use MWD's projections of water supply reliability and plans for allocating reduced imported water supplies.

To estimate long-term impacts of climatic effects on Water Plans, water agencies sometimes employ a "climate factor" to estimate the impacts of temperature increases on demand. Studies in the western United States that have developed empirical estimates of climate factors have estimated up to a 4.3 percent increase in demand per degree Fahrenheit increase in the fall months.[18]

What are the current projections for climate and its impacts on Water Plans?

There are multiple sources for data and projections of future climate impacts on the Chino Basin region. Many water agencies use data from Cal-Adapt, which provides publicly available data and tools to explore and analyze data from California's climate change assessments. The latest available data is from California's Fourth Climate Change Assessment,[19] which uses localized climate model data from the fifth Climate Model Intercomparison Project.[20] Based on these projections, the Chino Basin is generally expected to experience increased temperatures, more variable precipitation, and conditions that are more prone to wildfires. The snapshot report generated from Cal-Adapt for the Chino Creek watershed is included as Attachment A.

Acute or prolonged droughts are generally expected to reduce the availability of imported water from MWD and native surface water, an increased reliance on groundwater, and increased demand. IEUA's

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[16] CWC 10635

[17] San Bernardino County Vulnerability Assessment

[18] Lott, C., Tchigriaeva, E., Rollins, K.S., & Stoddard, S.W. (2014). Residential water demand, climate change and exogenous economic trends. link

[19] California's Fourth Climate Change Assessment

[20] Climate, Drought, and Sea Level Rise Scenarios for California's Fourth Climate Change Assessment

2015 Integrated Resources Plan concluded that demand in a single dry year is expected to increase by almost four percent more than demand in a normal year; this increase rises to about six percent during a prolonged drought year.

What is the uncertainty in projections of climate?

As most climate projections are based on models, they are subject to model uncertainty (e.g., model structure, resolution) and predictive uncertainty inherent in developing future scenarios. In addition, shorter-term variations in weather and climate patterns (e.g., El Niño) can add uncertainty to precise forecasts. The Cal-Adapt data quantifies the range of potential results from the ensemble of 32 climate projections that it analyzes.

HISTORICAL DATA AND PRIOR PROJECTIONS OF WATER PLANS IN THE CHINO BASIN

To help understand the potential uncertainty in future Water Plans, it is instructive to compare prior projections of Water Plans to actual water-supply data. Prior groundwater studies in the Chino Basin have compiled the then-current projected Water Plans from the parties, including in 2007 (2007 Study),[21] 2015 (2015 Study),[22] and 2020 (2020 Study).[23] Actual water-supply data were compiled from prior reports, including the Annual Reports that are prepared for the Chino Basin pursuant to the Sustainable Groundwater Management Act.

Comparison of Historical Data to Prior Projections of Water Plans

Figure 1 shows aggregated water supply plans from the Chino Basin that were compiled for prior groundwater studies compared to actual supplies for each five-year planning interval from 2005 through 2040.[24] An examination of Figure 1 shows the following:

- **Projected water demands increase over time.** This suggests that water agencies project, on aggregate, that the increases in demands from population growth and land development or intensification (i.e., denser development in existing urban areas) will outweigh any reductions in per capita water use that may result from technology improvements, regulatory responses, or other factors.
- **The total demands in each Water Plan projection are less than the projected demands from the prior study.** The projected water demands for 2020 through 2035 in the 2020 Study are about six percent less than the projections from the 2015 Study.
- **Projected water demands from all three studies were greater than the actual demands in 2015 and 2020.** The 2015 actual demands (288,000 af) were about 34 percent less than the 2015 projected demands from the 2007 Study (436,000 af) and 17 percent less than the 2015 projected demands from the 2015 Study (347,000 af).

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[21] 2007 CBWM Groundwater Model Documentation and Evaluation of the Peace II Project Description

[22] 2013 Chino Basin Groundwater Model Update and Recalculation of the Safe Yield Pursuant to the Peace Agreement

[23] 2020 Safe Yield Recalculation Final Report

[24] Note that the 2015 and 2020 Studies have projected Water Plans for 2015 and 2020, respectively, as the planning data were collected prior to that year.

Historical Water-Supply Data

Figure 2 shows the historical water-supply data compiled from Water Year (WY) 2015 through 2022. Over this period, total water demand varies from 277,000 af (WY 2017) to 307,000 af (WY 2020). There is a slight increasing trend in total water supply over the period.

Historical water supplies vary depending on hydrologic conditions. The eight-year period experienced two years that were wetter than average (WYs 2017 and 2019), with the other six years experiencing below-average precipitation. Total groundwater use drops from 67 percent of total supplies in dry years to 62 percent in wet years. Conversely, total imported and local surface water use increases from 25 percent of total supplies in dry years to 31 percent of total supplies in wet years.

SCHEDULE AND NEXT STEPS

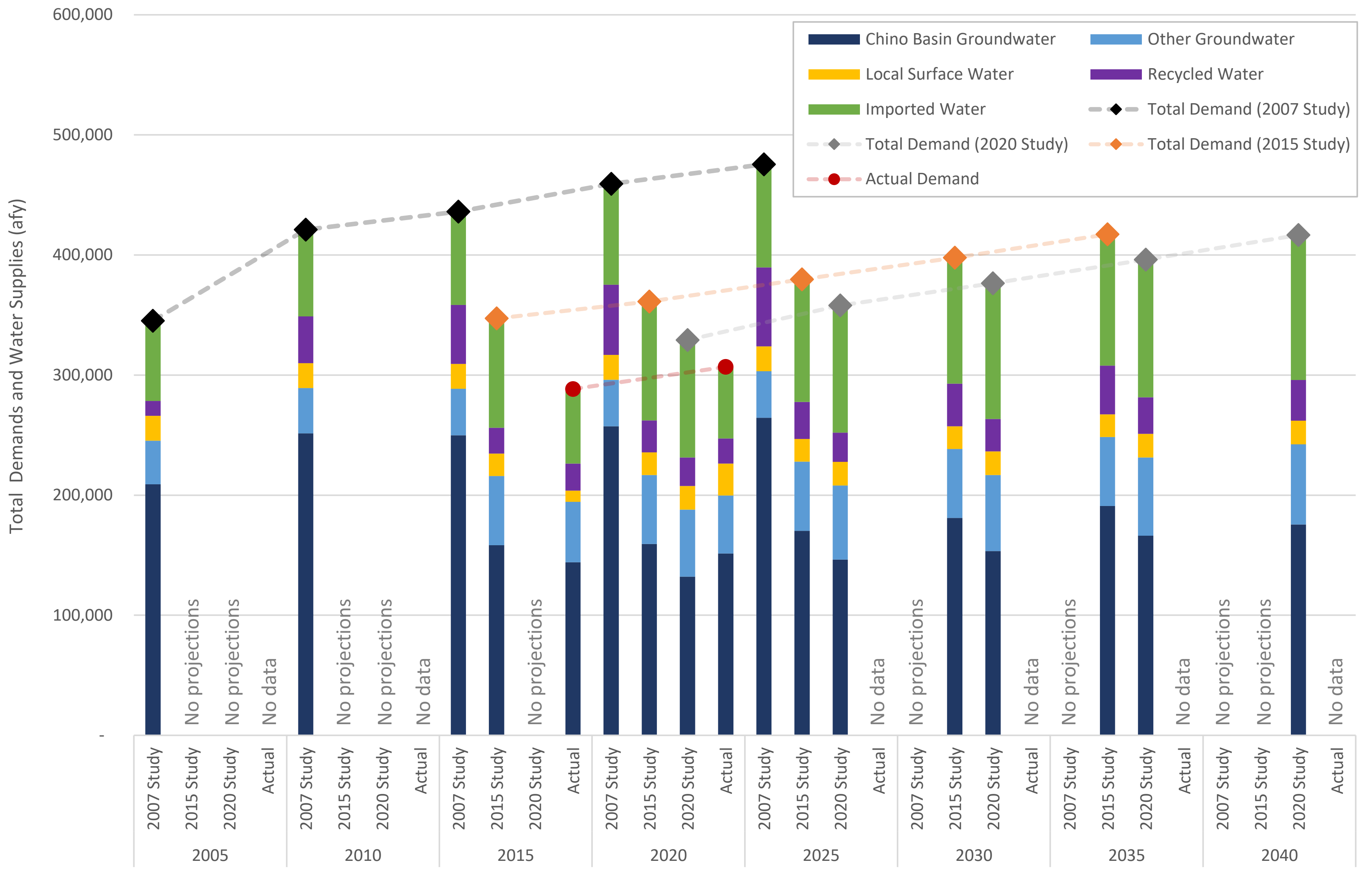
The October 24, 2023 workshop is the first of three stakeholder workshops that will aid the development of the scenarios that will be simulated during the 2025 SYR. Following the October workshop, the schedule to complete the 2025 SYR scenario development is described below.

- **October 24, 2023 through December 1, 2023:** Parties and stakeholders are asked to provide written comments or suggestions on this TM (Scenario TM #1), the drivers of Water Plans, and the 2025 SYR scenario development process.
- **February/March 2024:**
  - Watermaster's Engineer will distribute Scenario TM #2 to the parties describing the qualitative Water Plan Scenarios that will be used for the 2025 SYR.
  - Watermaster will host a second scenario design workshop to gather feedback and input from the parties and stakeholders on (1) the qualitative Water Plan Scenarios and (2) the proposed climate datasets that will be used in conjunction with the Water Plan Scenarios to develop the projection scenarios. Parties and stakeholders will be asked to provide written feedback on the scenarios and Scenario TM #2 following the workshop.
- **May/June 2024:**
  - Watermaster's Engineer will distribute Scenario TM #3 to the parties describing the quantitative Projection Ensemble (i.e., combinations of Water Plan Scenarios and climate) that will be simulated for the 2025 SYR.
  - Watermaster will host a third scenario design workshop to gather feedback and input from the parties and stakeholders on (1) the proposed Projection Ensemble and (2) the likelihood weights that will be applied to the Water Plan Scenarios. Parties and stakeholders will be asked to provide written feedback on the Projection Ensemble and Scenario TM #3 following the workshop.
- **July 2024:** Watermaster's Engineer will begin preparing projection realizations (i.e., Projection Ensemble and calibrated model realizations) for simulation with the 2025 CVM.

Next Steps

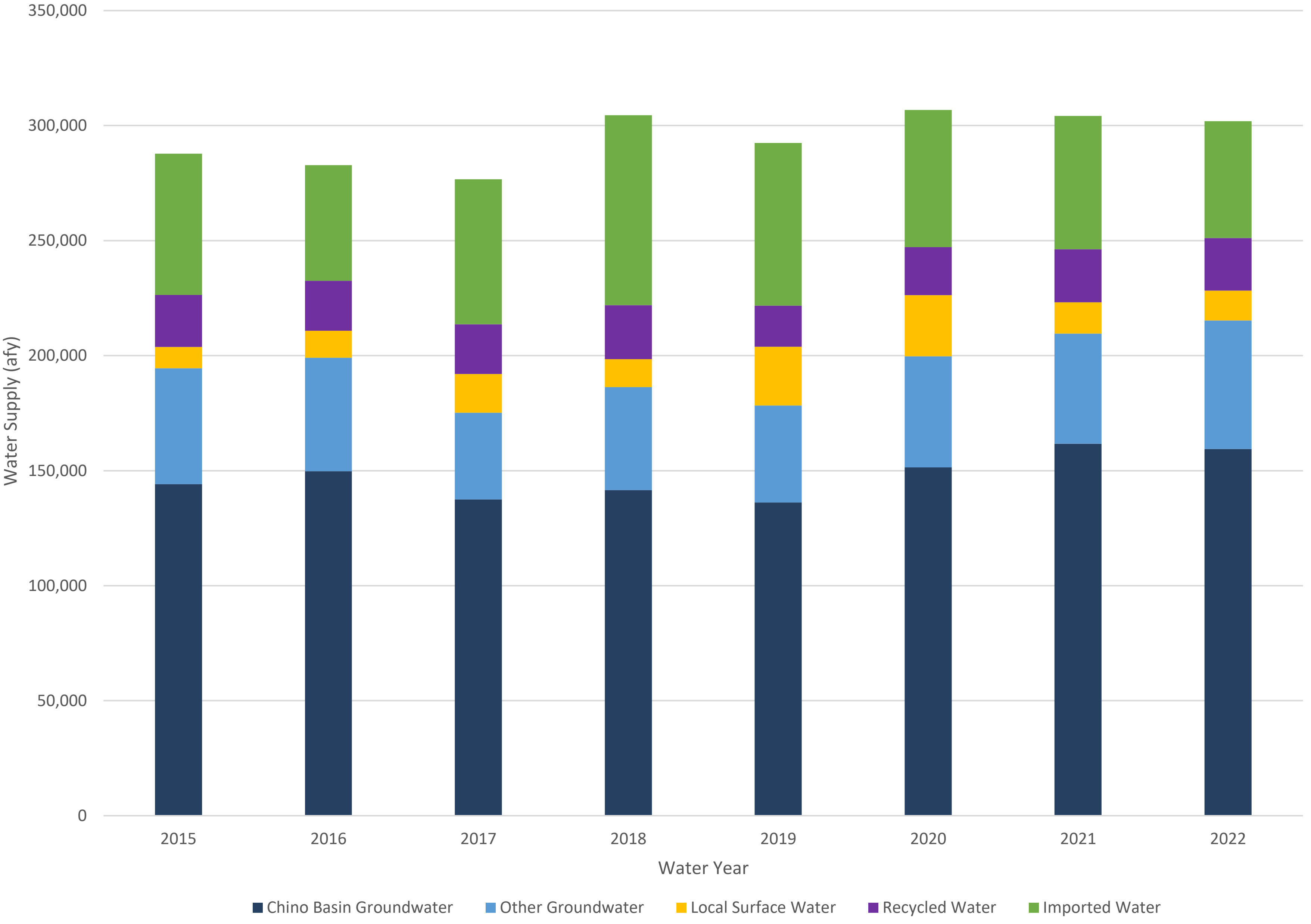
This TM is intended to inform the parties and general stakeholders of the scope and schedule of the scenario design process for the 2025 SYR and articulate the questions that will guide the initial stage of the scenario design. Following the October 24, 2023 workshop, Watermaster invites additional written input from the parties or other stakeholders that may assist the development of the Projection Ensemble. Please submit written input to Garrett Rapp at grapp@westyost.com by Friday, December 1, 2023.

Figure 1. Projected versus Actual Water Plans in the Chino Basin



2007 Study: 2007 CBWM Groundwater Model Documentation and Evaluation of the Peace II Projection Description
2015 Study: 2013 Chino Basin Groundwater Model Update and Recalculation of the Safe Yield Pursuant to the Peace Agreement
2020 Study: 2020 Safe Yield Recalculation Final Report

Figure 2. Historical Water Supplies of the Chino Basin Parties



Attachment A

Cal-Adapt Local Climate Change Snapshot for the Chino Creek Watershed

Local Climate Change Snapshot

Chino Creek Watershed

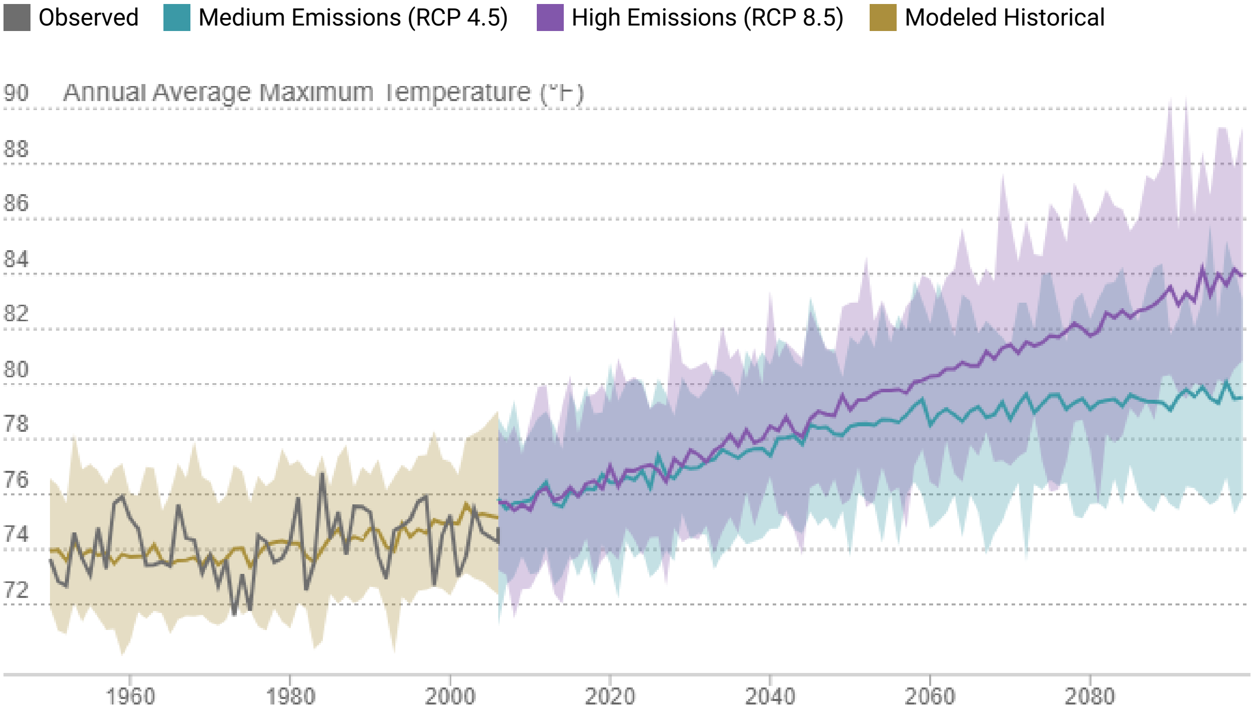
California

Temperature

Overall temperatures are projected to rise in California during the 21st century. While the entire state will experience temperature increases, the local impacts will vary greatly with many communities and ecosystems already experiencing the effects of rising temperatures.

Annual Average Maximum Temperature

Average of all the hottest daily temperatures in a year.



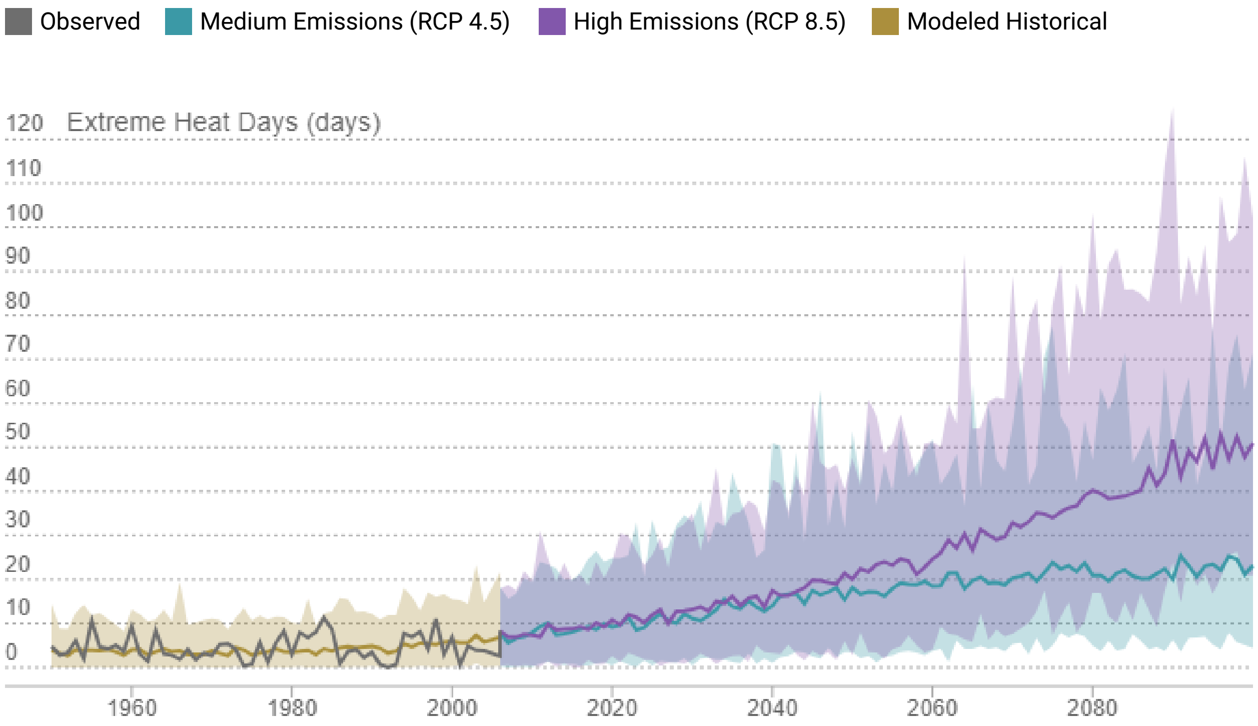
Observed (1961-1990) 30yr Average: 74.1 °F

	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	74.0 °F	73.6 - 74.4 °F
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+4.4 °F	78.4 °F	76.1 - 80.9 °F
HIGH EMISSIONS (RCP 8.5)	+5.2 °F	79.2 °F	76.7 - 81.4 °F
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+5.4 °F	79.4 °F	77.3 - 82.5 °F
HIGH EMISSIONS (RCP 8.5)	+8.6 °F	82.6 °F	79.7 - 86.5 °F

1. Data derived from 32 LOCA downscaled climate projections generated to support California’s Fourth Climate Change Assessment. Details are described in Pierce et al., 2018.
2. Observed historical data derived from Gridded Observed Meteorological Data. Details are described in Livneh et al., 2015.
3. Data presented are aggregated over all LOCA grid cells that intersect Chino Creek Watershed boundary.

Extreme Heat Days

Number of days in a year when daily maximum temperature is above a threshold temperature



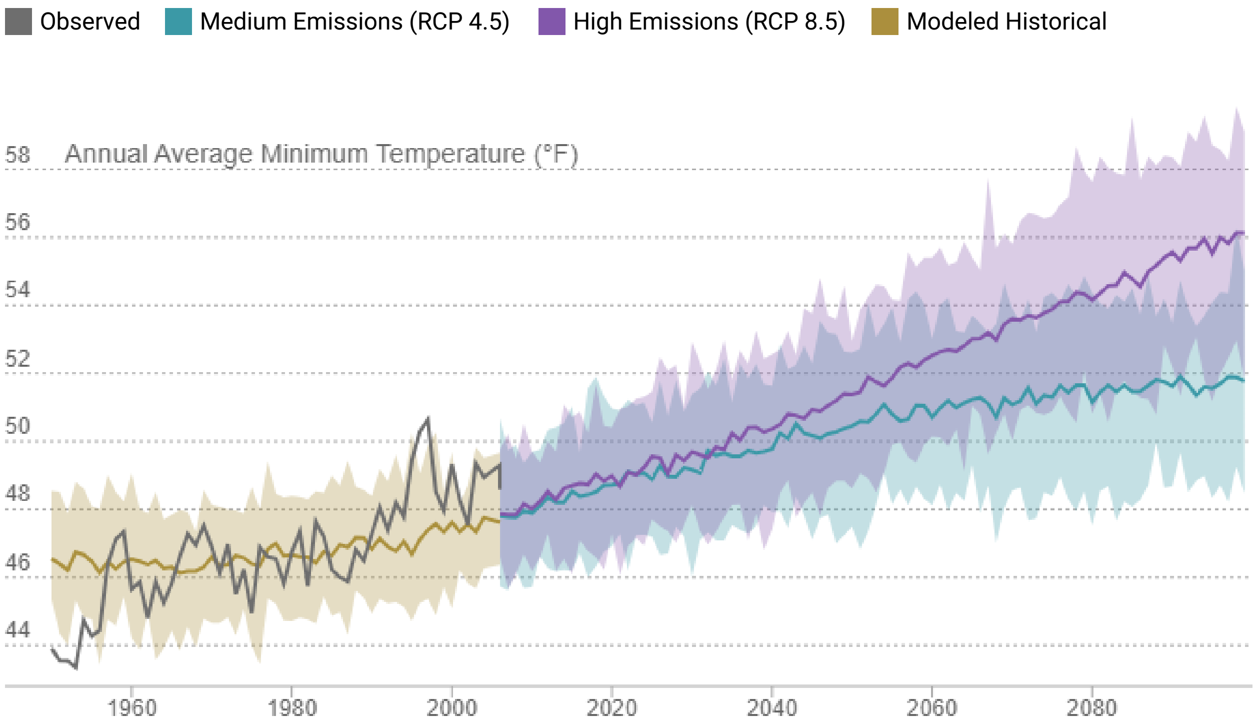
Observed (1961-1990) 30yr Average: 4 days

	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	4 days	2 - 5 days
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+13 days	17 days	10 - 39 days
HIGH EMISSIONS (RCP 8.5)	+17 days	21 days	12 - 43 days
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+18 days	22 days	14 - 57 days
HIGH EMISSIONS (RCP 8.5)	+37 days	41 days	27 - 88 days

1. Data derived from 32 LOCA downscaled climate projections generated to support California's Fourth Climate Change Assessment. Details are described in Pierce et al., 2018.
2. Observed historical data derived from Gridded Observed Meteorological Data. Details are described in Livneh et al., 2015.
3. Data presented are aggregated over all LOCA grid cells that intersect Chino Creek Watershed boundary.
4. Threshold temperature for a location is defined as the 98th percentile value of historical daily maximum/minimum temperatures (from 1961–1990, between April and October) observed at that location.

Annual Average Minimum Temperature

Average of all coldest daily temperatures in a year.



Observed (1961-1990) 30yr Average: 46.4 °F

	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	46.6 °F	46.4 - 46.8 °F
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+3.8 °F	50.4 °F	48.6 - 51.9 °F
HIGH EMISSIONS (RCP 8.5)	+4.8 °F	51.4 °F	49.7 - 52.9 °F
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+4.9 °F	51.5 °F	49.2 - 53.2 °F
HIGH EMISSIONS (RCP 8.5)	+8.2 °F	54.8 °F	52.2 - 57.1 °F

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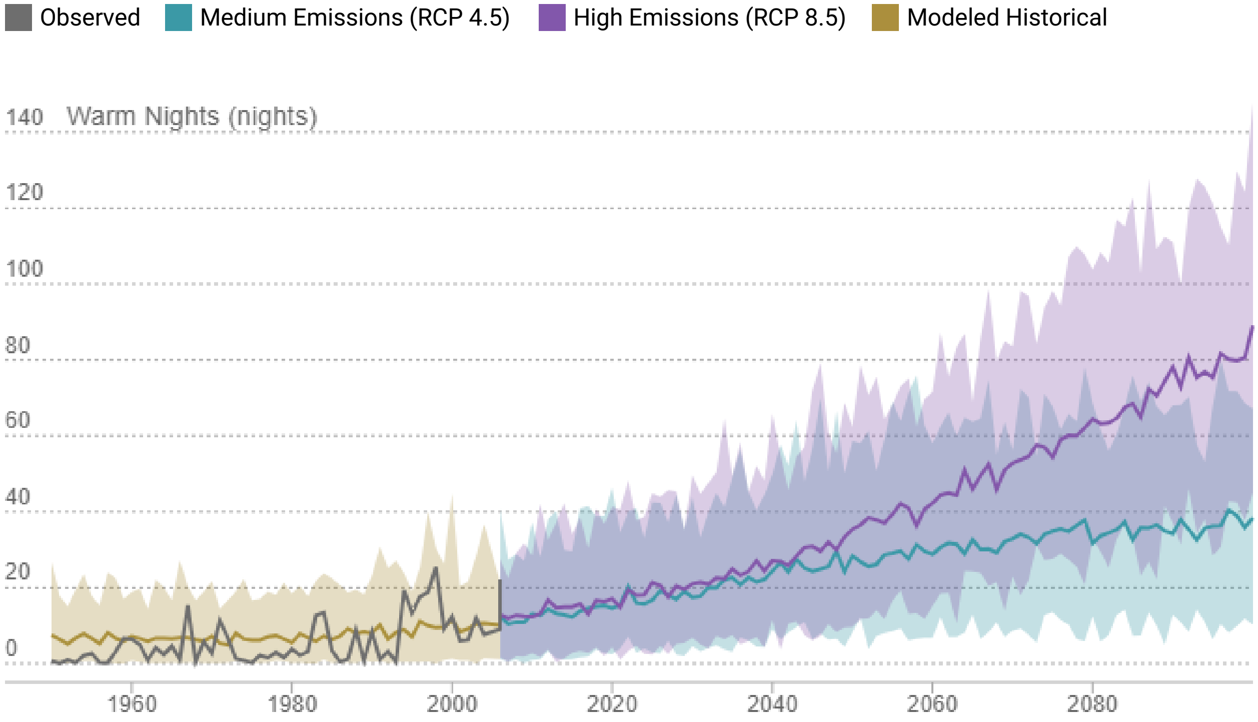
Warm Nights

Number of days in a year when daily minimum temperature is above a threshold temperature



Observed (1961-1990) 30yr Average: 4 nights

	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	7 nights	2 - 12 nights
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+20 nights	27 nights	15 - 45 nights
HIGH EMISSIONS (RCP 8.5)	+27 nights	34 nights	20 - 54 nights
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+28 nights	35 nights	20 - 53 nights
HIGH EMISSIONS (RCP 8.5)	+61 nights	68 nights	43 - 94 nights

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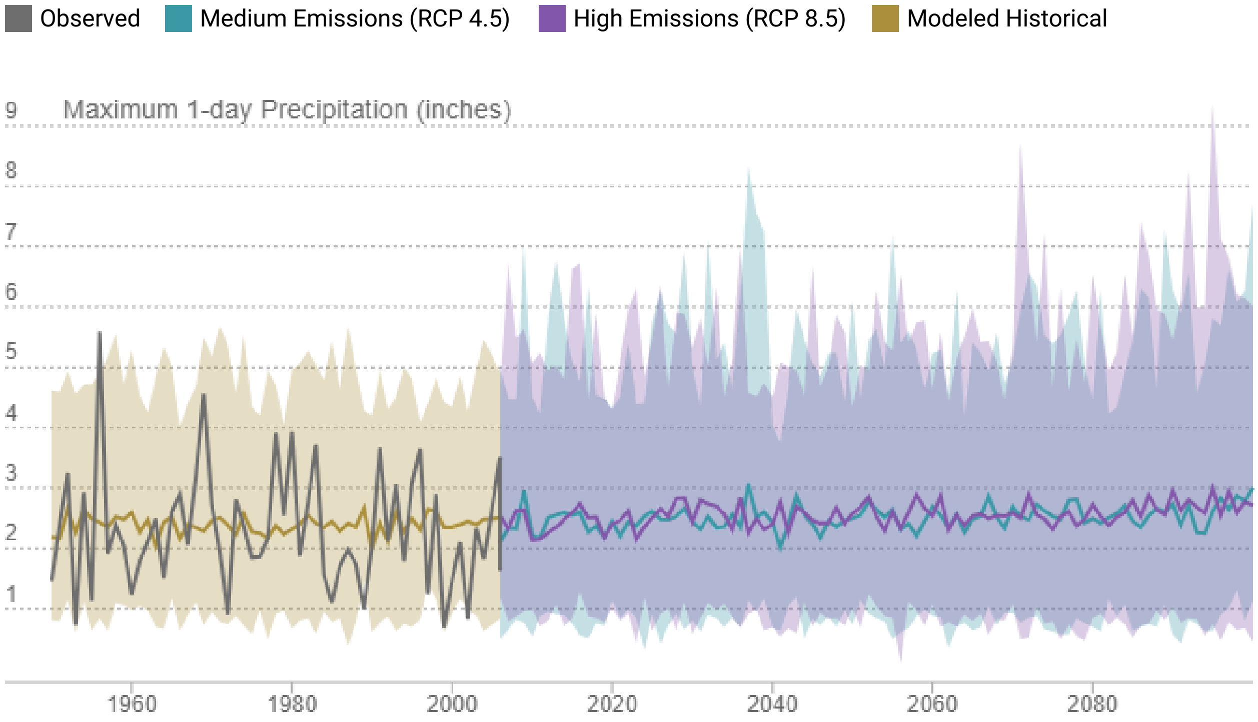
4. Threshold temperature for a location is defined as the 98th percentile value of historical daily maximum/minimum temperatures (from 1961–1990, between April and October) observed at that location.

Precipitation

California's climate varies between wet and dry years. Research suggests that for much of the state, wet years will become wetter and the dry years will become drier. Dry years are also likely to be followed by dry years, increasing the risk of drought. While California does not see the average annual precipitation changing significantly in the next 50-75 years, precipitation will likely be delivered in more intense storms and within a shorter wet season. We are already seeing some of the impacts from a shift towards larger year to year fluctuations.

Maximum 1-day Precipitation

The maximum daily precipitation amount for each year. In other words, the greatest amount of daily rain or snow (over a 24 hour period) for each year.



Observed (1961-1990) 30yr Average: 2.322 inches

	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	2.353 inches	2.023 - 2.671 inches
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+0.135 inches	2.488 inches	2.097 - 2.896 inches
HIGH EMISSIONS (RCP 8.5)	+0.178 inches	2.531 inches	2.119 - 2.920 inches
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+0.230 inches	2.583 inches	2.095 - 3.029 inches
HIGH EMISSIONS (RCP 8.5)	+0.280 inches	2.633 inches	1.886 - 3.308 inches

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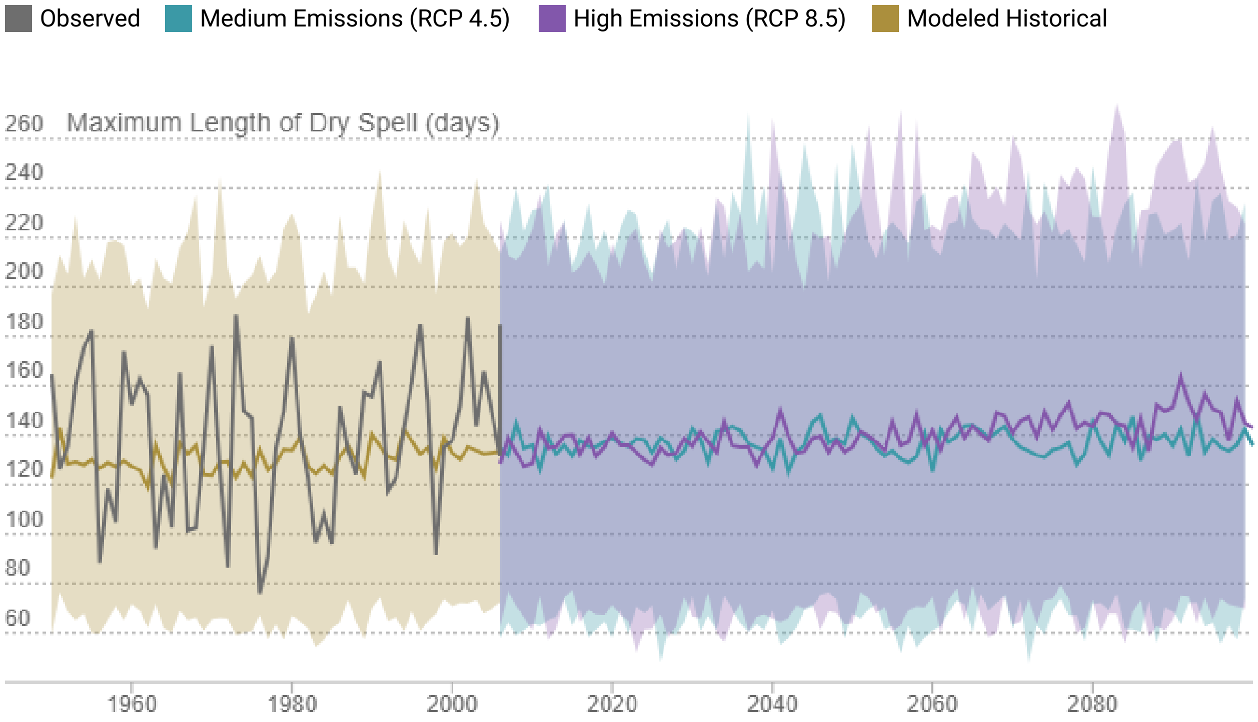
Maximum Length of Dry Spell

The maximum length of dry spell for each year. In other words, the maximum number of consecutive days with precipitation < 1mm for each year.



Observed (1961-1990) 30yr Average: 131 days

	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	129 days	114 - 145 days
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+8 days	137 days	117 - 163 days
HIGH EMISSIONS (RCP 8.5)	+9 days	138 days	112 - 165 days
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+8 days	137 days	115 - 159 days
HIGH EMISSIONS (RCP 8.5)	+18 days	147 days	107 - 185 days

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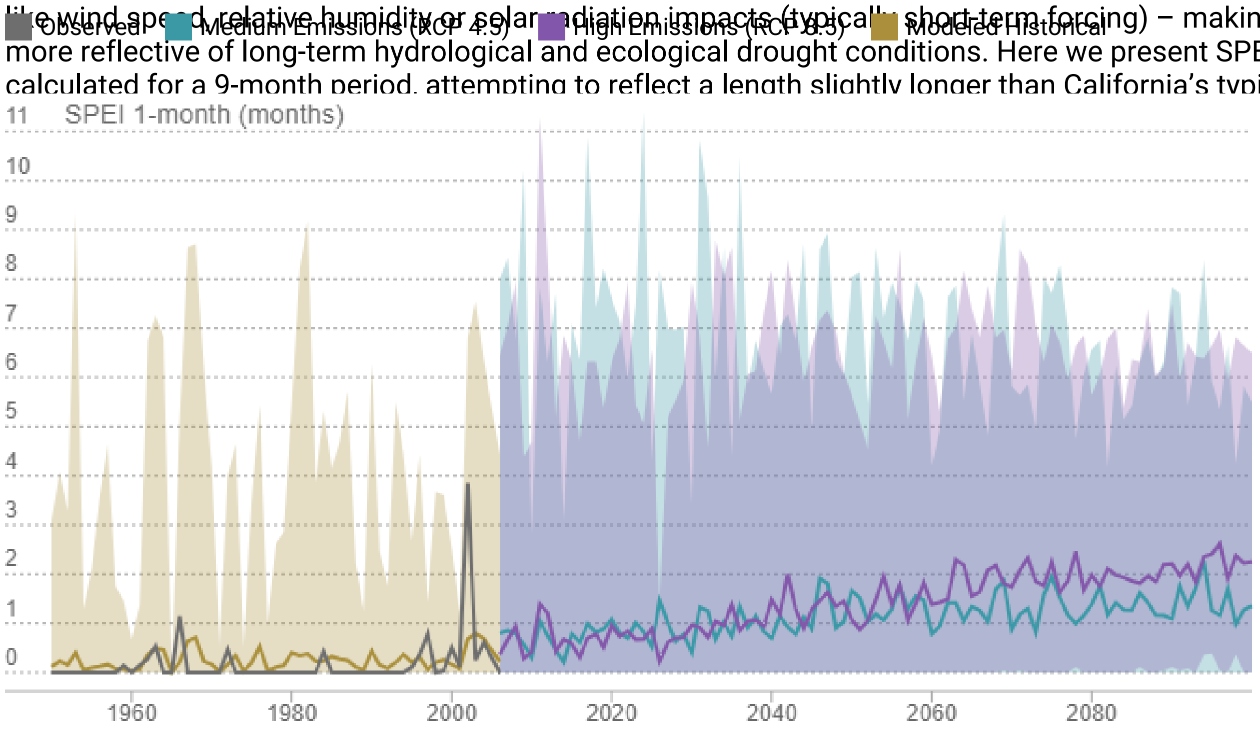
SPEI 1-month

Number of months in a year with a Standardised Precipitation-Evapotranspiration Index (SPEI) <= -1. SPEI is a multi-scalar drought index and can be used to detect, monitor and analyze droughts.

The standardized precipitation-evaporation index (SPEI) depicts the combined impacts of precipitation deficits and potential evapotranspiration on soil moisture. SPEI does not include impacts from effects like wind speed, relative humidity or solar radiation impacts (typically short-term forcing) – making it more reflective of long-term hydrological and ecological drought conditions. Here we present SPEI calculated for a 9-month period, attempting to reflect a length slightly longer than California's typical



Observed (1961-1990) 30yr Average: 0.1 months

	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	0.3 months	0.0 - 0.9 months
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+0.9 months	1.2 months	0.2 - 2.4 months
HIGH EMISSIONS (RCP 8.5)	+1.1 months	1.4 months	0.4 - 2.5 months
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+1.1 months	1.4 months	0.3 - 2.5 months
HIGH EMISSIONS (RCP 8.5)	+1.7 months	2.0 months	0.8 - 3.8 months

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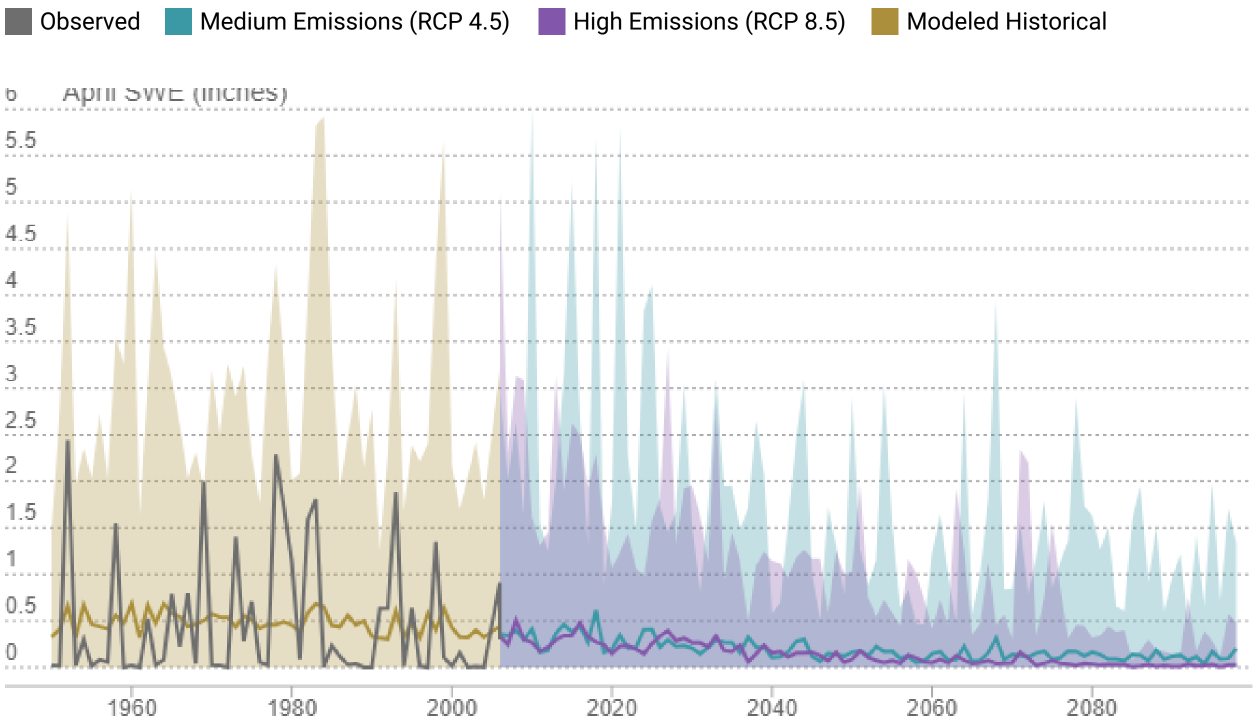
April SWE

Snow Water Equivalent (SWE), is a commonly used measurement used by hydrologists and water managers to gage the amount of liquid water contained within the snowpack.



Observed (1961-1990) 30yr Average: 0.5 inches

	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	0.5 inches	0.3 - 0.9 inches
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	-0.3 inches	0.2 inches	0.0 - 0.6 inches
HIGH EMISSIONS (RCP 8.5)	-0.4 inches	0.1 inches	0.0 - 0.4 inches
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	-0.4 inches	0.1 inches	0.0 - 0.4 inches
HIGH EMISSIONS (RCP 8.5)	-0.5 inches	0.0 inches	0.0 - 0.2 inches

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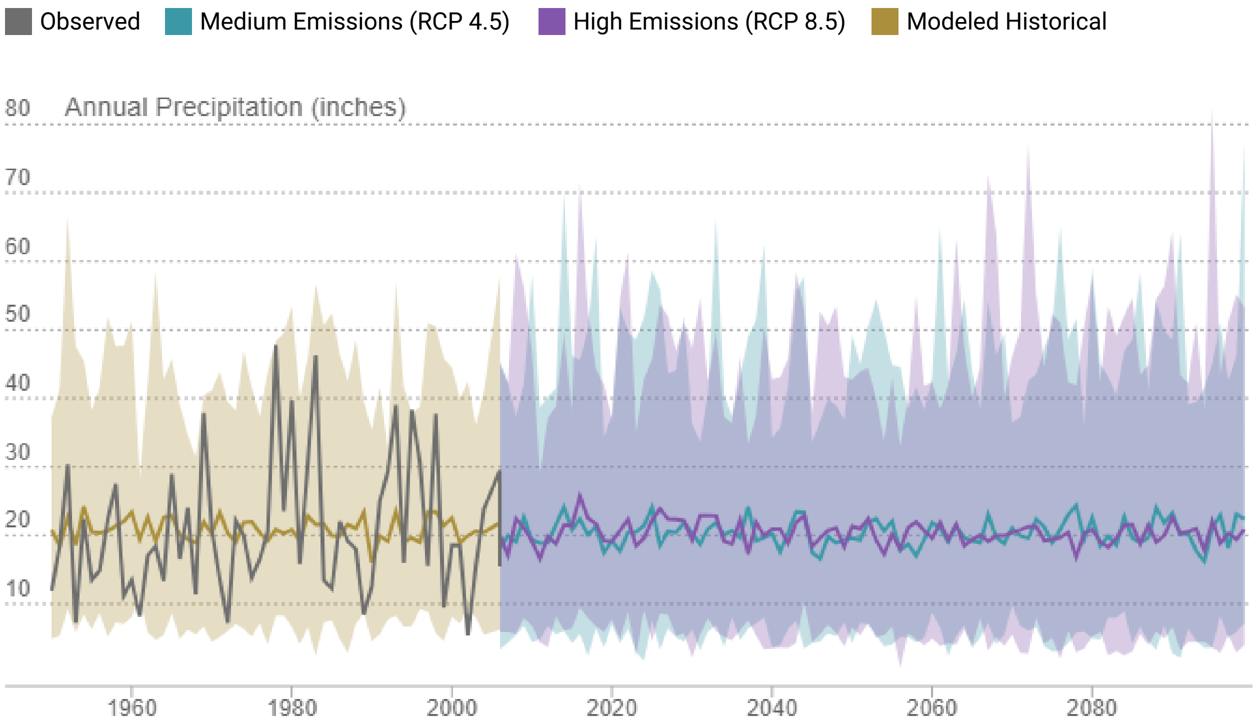
Annual Precipitation

Total precipitation projected for a year



Observed (1961-1990) 30yr Average: 20.7 inches

	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	20.7 inches	18.0 - 22.7 inches
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	-0.6 inches	20.1 inches	15.5 - 26.5 inches
HIGH EMISSIONS (RCP 8.5)	-0.4 inches	20.3 inches	15.4 - 27.0 inches
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+0.0 inches	20.7 inches	14.7 - 24.9 inches
HIGH EMISSIONS (RCP 8.5)	-0.6 inches	20.1 inches	13.2 - 29.1 inches

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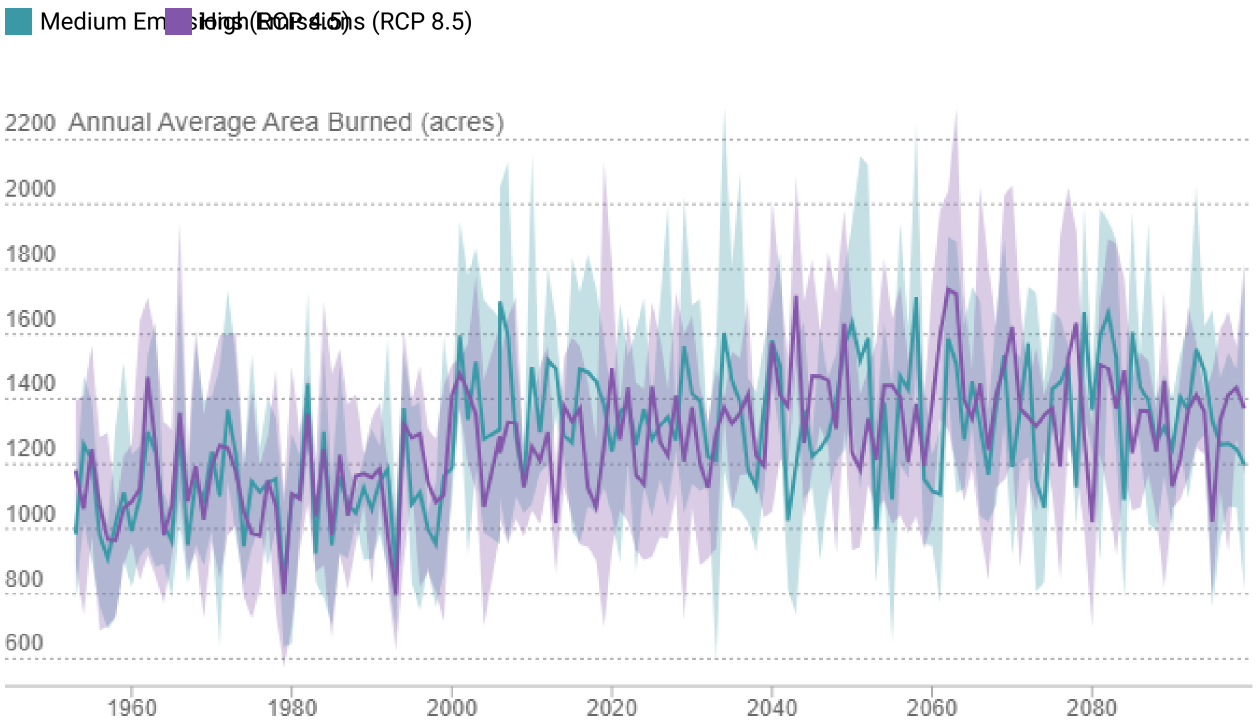
Wildfire

The frequency, severity and impacts of wildfire are sensitive to climate change as well as many other factors, including development patterns, temperature increases, wind patterns, precipitation change and pest infestations. Therefore, it is more difficult to project exactly where and how fires will burn. Instead, climate models estimate increased risk to wildfires. The Annual Average Area Burned can help inform at a high level if wildfire activity is likely to increase. However, this information is not complete - many regions across the state have no projections (such as regions outside combined fire state and federal protection responsibility areas), and more detailed analyses and projections are needed for local decision-making. These projections are most robust for the Sierra Nevada given model inputs. However, as we have seen in recent years, much of California can expect an increased risk of wildfire, with a wildfire season that starts earlier, runs longer, and features more extreme fire events. Fire danger is complex. It is impacted by human activity, vegetation, wind, temperature, relative humidity, atmospheric stability, etc. The Keetch-Byram Drought Index (KBDI) represents a simplified proxy for favorability of occurrence and spread of wildfire but is not itself a predictor of fire.

Annual Average Area Burned

Average of the area projected to be at risk to burning in a year.



	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MEDIUM EMISSIONS (RCP 4.5)	-	1122.2 acres	1089.6 - 1177.0 acres
HIGH EMISSIONS (RCP 8.5)	-	1135.4 acres	1073.1 - 1200.6 acres
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+227.1 acres	1349.3 acres	1224.8 - 1463.9 acres
HIGH EMISSIONS (RCP 8.5)	+267.7 acres	1403.1 acres	1263.2 - 1494.9 acres
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+249.8 acres	1372.0 acres	1281.6 - 1489.7 acres
HIGH EMISSIONS (RCP 8.5)	+218.2 acres	1353.6 acres	1212.3 - 1466.9 acres

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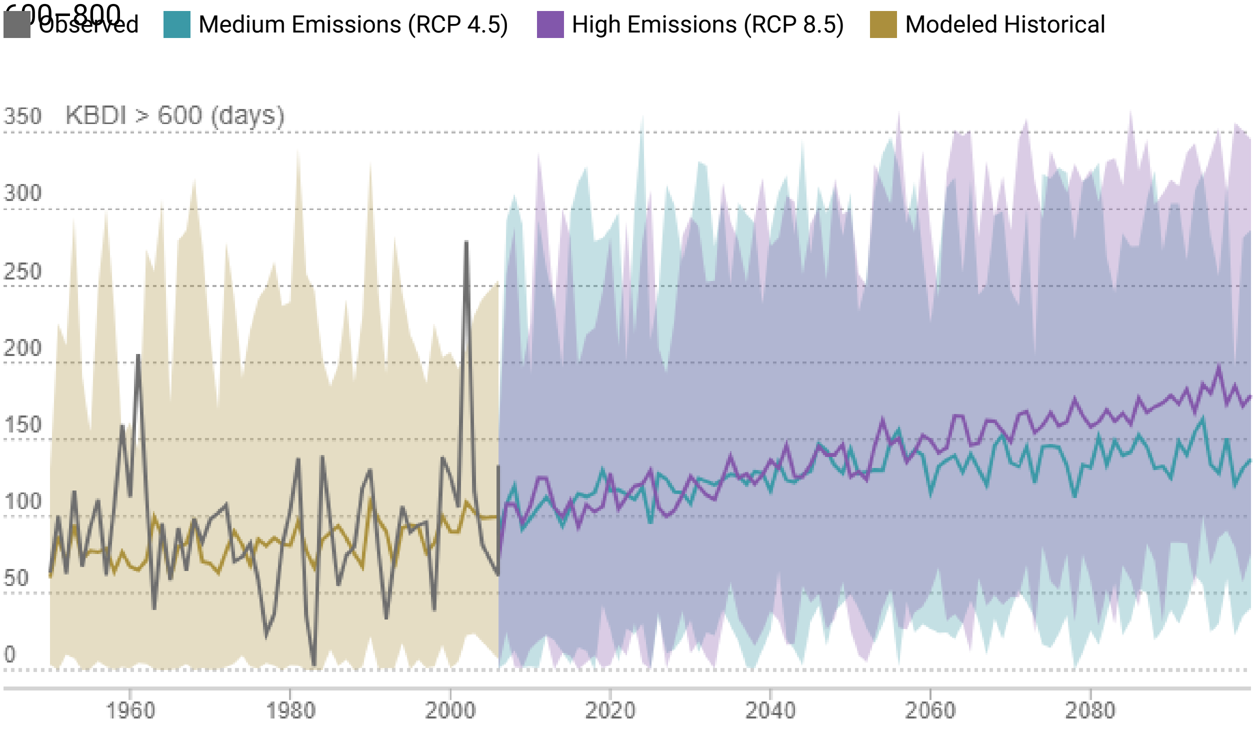
4. Chino Creek Watershed boundary may contain locations outside the combined fire state and federal protection responsibility areas. These locations were excluded from wildfire simulations and have no climate projections.

KBDI > 600

Number of days in a year where Keetch-Byram Drought Index (KBDI) > 600. KBDI provides an estimate for how dry the soil and vegetative detritus is.

KBDI is cumulative. The KBDI values increase on dry and warm days and decrease during rainy periods. In California we would expect KBDI to increase from the end of the wet season (spring) into the dry season (summer & fall). The list below explains what values of KBDI represent:
0–200
200–400
400–600
600–800



Observed (1961-1990) 30yr Average: 85 days

	Change from baseline ⓘ	30yr Average	30yr Range
Baseline (1961-1990)			
MODELED HISTORICAL	-	81 days	43 - 117 days
Mid-Century (2035-2064)			
MEDIUM EMISSIONS (RCP 4.5)	+51 days	132 days	97 - 173 days
HIGH EMISSIONS (RCP 8.5)	+59 days	140 days	97 - 184 days
End-Century (2070-2099)			
MEDIUM EMISSIONS (RCP 4.5)	+57 days	138 days	95 - 183 days
HIGH EMISSIONS (RCP 8.5)	+89 days	170 days	127 - 212 days

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