Chapter 11 *Climate Change*

11.0 Introduction and Overview

The intent of this chapter is to array observed and projected climate trends and impacts affecting or potentially affecting the Yuba County IRWM region. Climate is defined as "[t]he expected average conditions, plus the characteristic range of variability of those conditions." Climate change, therefore, is the expected degree and amount of variation in climate characteristics as compared to that historic norm.[1] The State Department of Water Resources (DWR) defines climate vulnerability as the ". . . degree to which a system is exposed to, susceptible to, and able to cope with and adapt to, the adverse effects of climate change." Recent studies on prehistoric climate show prolonged and extensive droughts have occurred in California, but the following section addresses the historic record to better facilitate water management over the 20-year horizon of this Plan.

Through stakeholder involvement and deliberation, as well as technical expertise and familiarity with local conditions, the Yuba County IRWM region will be more resilient to climate impacts and better able to prevent negative effects related to human health and the local economy, as well as damages to natural resources.

Climate trends and projections indicate the following climate effects for the Yuba County IRWM region:

- reduced streamflow and water supply in the long-term that will generate hard choices for water managers, and potentially increased conflicts between human and environmental uses;
- reduced water quality from the direct effects of rising temperatures and the indirect effects of eutrophication, increased algal growth, release of mercury methylation, increased sedimentation from increased winter runoff, and decreased vegetative cover due to fire;
- increased flooding with greater storm intensity and higher winter precipitation;
- inability of water infrastructure designed for a historic flow regime to accommodate increased winter peak flows;
- increased wildfire potential and, in particular, catastrophic wildlife with consequences for forest function, ecosystem health, and social and economic costs;
- upslope movement of vegetative communities as temperatures rise;
- potential fragmentation and/or degradation of habitat for stream-dependent species and elevationally dependent species in particular (species restricted in their ability to move or re-adapt);
- greater colonization and numbers of both terrestrial and aquatic invasive species;
- reduced viability for heat-sensitive crops—berries, mandarin oranges, grapes, and apples—and a potential reduction in agro-tourism, although alternative crops may begin to be viable here; and
- effects on the region's recreation industry from lower summer flows, both rafting and reservoir-based use.

[1] Starr Consulting, Palencia Consulting Engineers, and Talavera & Richardson. American River Watershed Survey (December 2008).

Stakeholders and the project team considered these trends and effects, determined likely regional climate vulnerabilities, and offer below a range of adaptation strategies to reduce climate impacts and increase regional climate resiliency.

11.1 Process for Preparing This Chapter

To support its Robust Decision Support (RDS) process (see section 11.1.1), an advisory Core Group was formed by Stockholm Environmental Institute (SEI) in June 2013, made up of individuals from the main interest groups involved in the Regional Water Management Group (RWMG). The Core Group subsequently agreed to act as a technical advisory committee for the IRWMP climate analyses. The Core Group includes representation from Yuba County Water Agency (YCWA), Brown's Valley Irrigation District, North Yuba Water District, City of Wheatland, Hallwood Irrigation Company, Yuba County Community Development and Services Agency, South Yuba River Citizens League (SYRCL), and AquAlliance.

The initial stages of chapter preparation involved data gathering, both by SEI and the project team conducting an extensive literature and data search and stakeholder interviews. (Primary sources of this search are included in Chapter 19 *Technical Analysis and Data Management*.) The gathered climate information led to: 1) a draft synthesis of potential climate trends and impacts, vulnerabilities, adaptation strategies; and 2) a refinement of the framework of inquiry for future Water Evaluation and Planning (WEAP) hydrologic modeling from the Core Group's informed participation.

Draft narratives and background materials of climate vulnerabilities were prepared for review, and a vulnerability checklist based on the DWR's Climate Handbook (see **Appendix 11-1**) was populated with information from the data collection effort and then presented to and refined by stakeholders. Meanwhile, the SEI team continued to engage the Core Group in meetings to consider and refine influences on its hydrologic modeling, including climate.

In March 2014, the Core Group met to consider and amend the posted climate materials and to prioritize regional climate vulnerabilities under a directed exercise by the project ream that evaluated both the severity of the risk and likelihood of occurrence of vulnerabilities. The recommended prioritization was forwarded to the RWMG as part of the draft climate chapter, and is included in section 11.3.2, below.

Because the timeframe for SEI's modeling was to extend beyond the preparation period for this Plan, and because that modeling had the potential to define new as well as refine draft adaptation strategies, the Core Group made the decision not to prioritize specific adaptation strategies at this time.

Where projects were sufficiently developed, the project team conducted greenhouse gas (GHG) emission calculations. These calculations are included in **Appendix 14-4**. A summarized list of climate vulnerabilities also was briefly discussed with potential project sponsors when the project team conducted project recruitment. This served as a means of incorporating climate mitigations into implementation projects. The identification of vulnerabilities and adaptation strategies is, therefore, a culmination of several endeavors to both identify and display climate information. A side benefit of the process has been an expansion of stakeholder climate knowledge and development of projects that incorporate climate adaptations and mitigations.

11.1.1 The Role of the Robust Decision Support Process in IRWMP Preparation

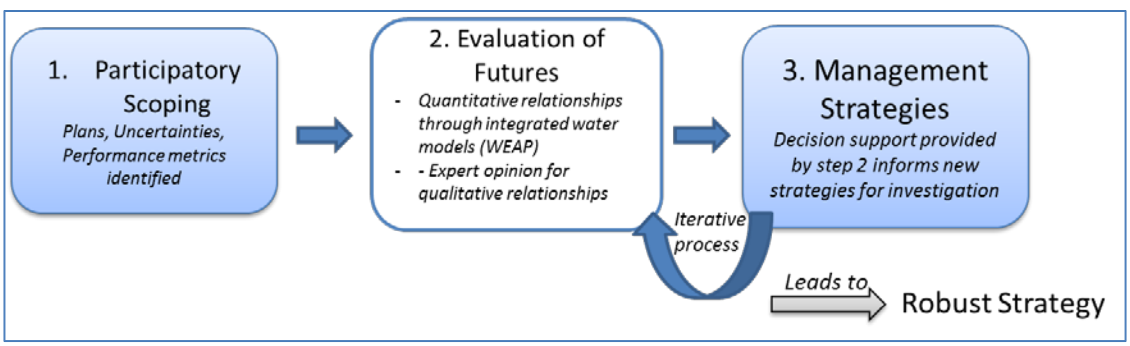
As mentioned above, a parallel process for improving regional water management decision-making was being conducted during the preparation of this Plan by SEI. RDS applies a participatory framework[2] to integrate the natural, social, and political aspects of water resource management in a quantitative model IWRMP. Water demand across sectors—agriculture, industry, energy, urban, environment—is affected by climate variability and further complicated by social and contractual issues among many users in the Yuba County IRWM region. These factors are difficult to integrate because social, political, and economic boundaries often overlap watershed boundaries and other physical delineations critical to water resources systems.

In brief, the RDS process allows the following:

- consideration of many possible futures (an ensemble) rather than a single best estimate;
- prioritization of strategies that perform well across many possible futures rather than for one particular future; and
- adaptive strategies for changing conditions.

RDS employs water resources computer models (in this case, using WEAP) and rich visualization of possible futures (in this case, using Tableau). The three steps of RDS are shown in **Figure 11-1** and described in detail in **Appendix 11-2**.

Figure 11-1. The RDS Process



The Core Group used this process in evaluating vulnerabilities and adaptation strategies for the region. Since the RDS process will be conducted over a longer timeframe than preparation of the IRWMP, updates to the IRWMP will accommodate any relevant information produced by the RDS process, after Plan preparation.

[2] This approach has been shaped by the academic literature on decision-making under deep uncertainty, most significantly by the Robust Decision Making approach described in "Shaping the Next One Hundred Years" by Lempert, Popper, and Bankes (2003). Santa Monica, CA. 187 pp. RDM is a process rather than a fixed set of practices, and SEI uses the term Robust Decision Support for its rendition of RDM, to emphasize both its own rendition of RDM, as well as the fact that our goal is to support decision-making, not to make decisions for stakeholders.

11.1.2 State Climate Strategies/Documents

In preparation for evaluating potential vulnerabilities and adaptive management strategies for the region, the project team reviewed the four primary source documents, as required by DWR in the IRWM Guidelines (see **Table 11-1**). These documents are intended to implement several state policies and legislative acts aimed at addressing the effects of climate change and reducing GHG emissions. The results of this review informed both the process and the content of the climate change evaluation. These documents included the following:

- Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water
- 2009 California Climate Adaptation Strategy
- Climate Change Scoping Plan
- Climate Change Handbook for Regional Water Planning

Table 11-1 describes the recommendations of the respective documents and briefly discusses how each document affected or was incorporated into this Plan.

Table 11-1. State Plans' Influence on the Climate Change Analysis		
Plan	**Requirements/Focus**	**Impact of State Plans on the Climate Change Analysis**
Climate Change Scoping Plan AB 32 directed the California Air Resources Board (CARB) to adopt regulations implementing actions to reduce greenhouse gases by 2020, and to prepare a Scoping Plan to achieve those reductions, including actions related to water management.	**Recommends specific strategies with a goal of cutting 15% from today's GHG emission levels via regulations, market mechanisms, and voluntary measures.**	Recommended actions most relevant to the Plan were considered by stakeholders as part of issue identification, evaluation of applicable resource management strategies, development of goals and objectives, and the project development and integration process, and are listed below: 16. Sustainable Forests – Encourages maintaining forest GHG sequestration levels, implementing sustainable land use practices, biomass projects, reducing the risk of wildfire, and conservation of the forest land base. 17. Water – Promotes water use efficiency, water recycling, water system energy efficiency, reuse of urban runoff, increase renewable energy production, and a public goods charge. 18. Agriculture – Encourages investment in manure digesters at dairy farms, fuel-efficiency of on-farm vehicles, water-use efficiency, and biomass for power production. Enhancement and restoration of riparian woodlands is suggested for carbon sequestration. Please see section 6.1 for a discussion of strategy implementation within the region.
Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water This document assesses climate effects on water resources across California and offers adaptation strategies to mitigate climate impacts on those resources.	Presents 10 strategies for adaptation measures.	This document was most applicable when considering overall climate trends and adaptive strategies for the region. The Yuba County IRWM region is employing three of the ten strategies presented in the report: ▪ **Strategy 1: *Provide Sustainable Funding for Statewide and Integrated Regional Water Management* – YCWA has provided match that helped prepare this IRWMP. Chapter 15 *Finance* explains how the Plan and its projects will be implemented.** ▪ **Strategy 2: *Fully Develop the Potential of Integrated Regional Water Management*: The preparation of the Plan and the participation of stakeholders in its development, adaptation strategies, and implementation project processes will contribute to full development potential of IRWM.** ▪ ***Aggressively Increase Water Use Efficiency:* Marysville, Olivehurst PUD, and Linda County Water District submitted 2010 Urban Water Management Plans whose average per capita use projections decrease to meet California's "20 percent by the year 2020" water use targets.**
2009 California Climate Adaptation Strategy Executive Order 2-13-08 directed state management of climate impacts from sea level rise, increased temperature, altered precipitation, and extreme variation in weather events.	Discusses how to assess vulnerabilities and outlines adaptation strategies.	**The strategy's principles were considered and incorporated into this planning process:** ▪ **Reduction of per capita water use 20% by 2020, including agricultural water use efficiency.** ▪ **Project alternatives that avoid new development in areas prone to flooding, wildfire, and erosion.** ▪ **Identifying key aquatic and terrestrial habitat vulnerable to adverse climate effects and expanding protected areas that provide amelioration of potential impacts.** ▪ **Assessments of public health, especially in vulnerable communities and populations; should include consideration of resilience to effects of climate change.** ▪ **Local general planning efforts that consider the effects of climate.** ▪ **Incorporating increased wildfire risk into agency planning.**
Climate Change Handbook for Regional Water Planning	Outline for assessing vulnerabilities and adaptation strategies.	The project team along with stakeholders identified vulnerabilities by using the Handbook's Appendix B, Vulnerability Assessment Checklist, as a primary resource, and subsequently used its direction to prioritize those vulnerabilities.

11.2 Current Climate Trends and Impacts

DWR has projected impacts for the western slope of the Sierra that include increases in temperature of 2.5°F over the next century, larger and more intense storms, decreased snowpack at lower elevations, earlier timing of spring runoff, increased evapotranspiration, changes in flora and fauna, and increased forest fire risk.[3] By 2020, projections indicate that water demand in California will exceed supply by more than 2.96 billion cubic meters.[4]

The California Emergency Management Agency and California's Natural Resource Agency's California Adaptation Planning Guide (2012) offers the following: "Climate change adaptation strategies [that] seek to reduce vulnerability to projected climate changes and increase the local capacity to adapt." The Guide breaks the state into regions based on biophysical characteristics and jurisdictional boundaries, and includes Yuba County in the Northern Central Valley Region (along with Butte, Colusa, Glenn, Madera, Sacramento, San Joaquin, Stanislaus, Sutter, Tehama, and Yolo Counties). It projects the following climate-related trends and impacts for the region.

Table 11-2. Summary of Cal-Adapt Climate Projections for Northern Central Valley

EFFECT	RANGES
Temperature Change, 1990-2100	**January increase in average temperature of 4°F to 6°F by 2050 and between 8°F and 12°F by 2100. July increase in average temperature of 6°F to 7°F by 2050 and 12°F by 2100. (Modeled high temperatures – average of all models; high carbon emission scenario.)**
Precipitation	**Annual precipitation is projected to decline by approximately 1 to 2 inches by 2050 and 3 to 6 inches by 2100. (CCSM3 climate model; high carbon emissions scenario.)**
Heat Wave	**Heat wave is defined as five days over 102°F to 105°F, except in the mountainous areas to the east. Two to three more heat waves per year are expected by 2050, with five to eight more by 2100.**
Wildfire Risk	**By 2085, the north and eastern portions of the region will experience an increase in wildfire risk, more than four times current levels in some areas. (GFDL model, high emissions scenario.)**

Source: California Emergency Management Agency and California Natural Resources Agency. *California Adaptation Planning Guide.* July 2012.

The following analysis takes a look at many of these projected climate-related impacts from a Yuba County region-specific point of view, but the bottom line is that most projections suggest an increasing variability from the historical climate record.

[3] Ibid.
[4] Mehta, V.K.; V.R. Haden; B.A. Joyce; D.R. Purkey; L.E. Jackson. Irrigation demand and supply, given projections of climate and land-use change, in Yolo County, California (2012). Agricultural Water Management. 117 (2013)70-82. Available from: www.elsevier.com/locate/agwat

11.2.1 Climate Trends

11.2.1.1 Temperature

According to studies and analyses of weather and climate data by US Forest Service ecologists,[5] the western United States is the country's fastest-warming region. Mean annual temperatures in the Sierras, in general, have increased by around 1°F to 2.5°F over the last 75 to 100 years. However, some localized areas, potentially including some microclimates in Yuba County, have experienced slight cooling trends. Overall warming is due to slightly warmer nights, rather than daily maximum temperatures.

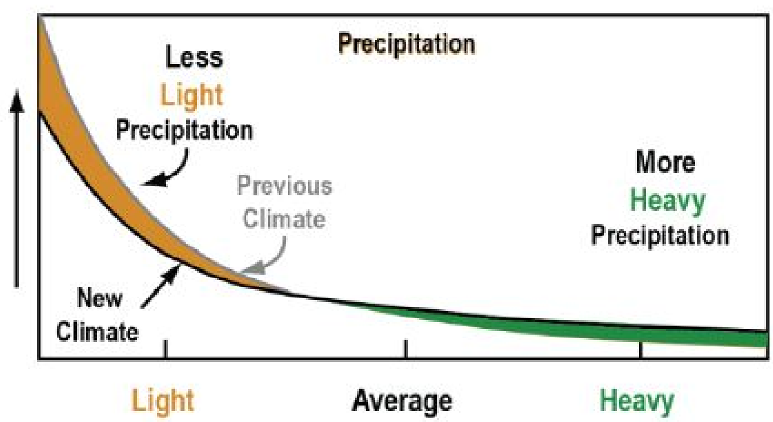
The Cal-Adapt Website[6] offers temperature projections for Marysville under low- and high-emissions GHG scenarios. Under the low-emissions scenario, Marysville average temperature is projected to rise from a historical average of 62.5°F to 66.3°F (+3.8°F), and to 69.1°F (+6.6°F) under the high-emissions scenario by 2080.

Elevation also plays a part in climate trends; there are fewer days with below-freezing temperatures at higher elevations, and more days of extreme heat at lower elevations in the Sierras.

11.2.1.2 Precipitation

Most of the west slope of the northern Sierras, including the Yuba County IRWM region, has experienced an increasing trend in precipitation between 1930 and 2000.[7] At the same time, increasing *variability* in annual precipitation is occurring year-to-year, with higher highs and lower lows totals. DWR predicts fewer total light rain events and more heavy events for Yuba County into the future.[8]

Figure 11-2. Increasing Variability in Annual Precipitation



Source: DWR Climate Change Handbook for Regional Water Planning (November 2011) pg. 36

[5] Safford, H.D., M. North and M.D. Meyer. Chapter 3: Climate Change and the Relevance of Historical Forest Conditions, Managing Sierra Nevada Forests. Albany, CA: US Department of Agriculture, Forest Service, Pacific Southwest Research Stations. No date. Available from: http://www.fs.fed.us/psw/publications/documents/psw_gtr237/psw_gtr237_023.pdf

[6] Cal-Adapt – Exploring California's Climate Change Research. (7/26/13). Available from: http://cal-adapt.org/ tools/factsheet/

[7] Ibid.

[8] US Environmental Protection Agency, CA Department of Water Resources, US Army Corps of Engineers, and the Resource Legacy Fund. Climate Change Handbook for Regional Water Planning (December 2011). Available from: http://www.water.ca.gov/climatechange/docs/Climate_Change_Handbook_Regional_Water_Planning.pdf

Even though regional precipitation may slightly increase on a near-term basis, greater variability in the climate regime has brought on increased chance for drought events. According to NOAA, the frequency with which a large percentage of California has experienced severe to extreme drought has risen significantly since 1980.[9] Agricultural disasters due to drought (declared by USDA) occurred in Yuba County in each of the years from 2001 through 2005.[10]

11.2.2 Environmental Effects of Climate Changes

11.2.2.1 Runoff and Streamflow

Runoff in the Yuba County IRWM region is affected by timing and amount of precipitation, snowpack, and the effect of temperature on snowpack. The onset of spring thaw is occurring 5 to 30 days earlier in 2002 than in 1948 in the central Sierra Nevada, due mostly to higher temperatures. Peak streamflow is also occurring 5 to 15 days earlier (Stewart et al. 2005)[11] with a concomitant reduction in summer streamflows. DWR estimates that for each 1 degree C increase in Earth's temperature, the Sierra snowpack will retreat 500 feet, resulting in less available storage flows during April through July as compared to current conditions.[12]

In a 2012 study, PG&E examined possible side effects of climate change on runoff by comparing two consecutive 35-year periods (1942-1976 and 1977-2011).[13] The company maintains daily runoff records for 100+ locations in the Sierra, southern Cascade, and Coastal Ranges of California. This study showed that out of the 13 rivers studied, the Yuba River at Smartsville has experienced the third highest reduction in unimpaired runoff between these two periods (-3.4 percent), behind only the Klamath River at Orleans (-10.6 percent) and the Feather River at Oroville Dam (-4.5 percent).

When comparing the two 35-year periods, PG&E also found that the standard deviation in runoff on the Yuba River increased by 30 percent for the unimpaired water year during the second period. While it is fairly common for rivers flowing over exposed granite (such as the Yuba River) to have a large variance in flows, this increase in percentage is abnormal. Further, it was found that a large portion of the April through June runoff has shifted into the March and even February period, corroborating the studies mentioned above. By percentage shift in timing of runoff, the Yuba River is second only to the Feather River in this trend.

YCWA's Agricultural Water Management Plan documents decreased flow trends in the Feather River over the last 100 years and predicts that the Yuba River will likely experience similar effects, based on the

[9] National Oceanic and Atmospheric Administration, Table: Percent Area of the California Basin Experiencing Severe to Extreme Drought, January 1895-March 2004 (Copyright 2004), National Drought Mitigation Center.

[10] Office of Emergency Services, Yuba County Multi-Jurisdictional Multi-Hazard Mitigation Plan, Yuba County, CA (2009). Available from: http://www.co.yuba.ca.us/departments/OES/PDM/Multi-hazard%20mitigation%20plan/Plan%20Documents/Section%204%20-%20Risk%20Assessment.pdf

[11] Stewart, I.T; Cayan, D.R.; Dettinger, M.D., Changes toward earlier streamflow timing across western North America. Journal of Climate. 18: 1136-1155 (2005).

[12] Starr Consulting, Palencia Consulting Engineers, and Talavera & Richardson. American River Watershed Survey. (December 2008).

[13] Freeman, G. J. Analyzing the Impact of Climate Change on Monthly River Flows in California's Sierra Nevada and Southern Cascade Mountain Ranges. Western Snow Conference 2012. (2012). Available from: http://www.westernsnowconference.org/sites/westernsnowconference.org/PDFs/2012Freeman.pdf

proximity of the watersheds. It states that, "Projections suggest an average decrease in total water year runoff of approximately seven percent."

11.2.2.2 Flooding

The Yuba County Multi-Jurisdictional Multi-Hazard Mitigation Plan (2009) lists flooding (and attendant levee failure) as the "greatest natural disaster to the County." The Plan states that "Yuba County has a long history of catastrophic flooding events involving both the Yuba and Feather Rivers. Five major floods since 1950 have resulted in loss of life, significant property damage, and strained economic development in the area."

The California Adaptation Planning Guide (2012) states that the Central Valley will be subject to increased extreme high-flow events due to rapid snowmelt combined with more intense rainstorms. Peak natural flows have increased on many of the state's rivers during the past 50 years. For instance, the five highest floods of record on the American River have occurred since 1950.[14]

11.2.2.3 Storm Intensity

Three significant and damaging winter storm events have occurred in the last 20 years: in 1986, 1997, and 2005-2006. Rainfall accumulations of 20-24 inches in the most recent storm make that the fourth wettest December on record since 1920.[15] Overall, California is predicted to have more heavy storm events and less light rainfall, a phenomenon that also has implications for increased flood potential.

11.2.2.4 Groundwater

According to the YCWA Groundwater Management Plan (2010), groundwater levels along the Feather River in both the North and South Yuba subbasins have been generally stable since at least 1960.

Starting in the 1970s, the North subbasin (Ramirez Water District, Cordua Irrigation District, Hallwood Irrigation Company, and Browns Valley Irrigation District), began showing groundwater level improvements coinciding with surface water deliveries to the Ramirez Water District. Similarly, groundwater elevations recovered from historical overdraft in the central South Yuba subbasin (Brophy Water District, Dry Creek Mutual Water Company, South Yuba Water District, and Wheatland Water District) when surface water deliveries were made there, starting in the 1980s. Spring groundwater flows on average from about 140 feet above mean sea level (msl) in the east to 30 feet above msl in the west county. Total freshwater storage in Yuba County's groundwater basin is estimated to be 7.5 million acre-feet (maf). However, since most wells are screened at less than 300 feet below ground surface, readily accessible freshwater is estimated at 4.0 maf.

The greatest water demand by far (80 percent or more) is for agricultural use, primarily for crop irrigation. The Groundwater Management Plan suggests that runoff and recharge from irrigation may be a significant contributor to overall groundwater, offering over 30 percent of recharge from percolation of applied surface water. About 30 percent of the region's irrigation comes from groundwater pumping, the majority of which occurs south of the Yuba River. All five municipal purveyors (Marysville, Olivehurst,

[14] California Department of Water Resources, Managing An Uncertain Future: Climate change adaptation strategies for California's water. Sacramento, CA, State of California (October 2008). Available from: http://www.water.ca.gov/climatechange/docs/ClimateChangeWhitePaper.pdf

[15] Office of Emergency Services, Yuba County Multi-Jurisdictional Multi-Hazard Mitigation Plan, Yuba County, CA (2009). Available from:http://www.co.yuba.ca.us/departments/OES/PDM/Multi-hazard%20mitigation%20plan/Plan%20Documents/Section%204%20-%20Risk%20Assessment.pdf

Linda, Wheatland, and Beale AFB) depend exclusively on groundwater for municipal and industrial water supply.

Groundwater substitution transfers have been completed in six relatively dry years since 1991; during such a year groundwater demand can double, and is then generally recharged within two to three years after pumping ends. Most recently, in 2009, during the second year of groundwater substitution transfers and the third year of a relatively dry cycle, irrigators in Reclamation District 10, located along the Feather River in the North Subbasin, experienced lower groundwater discharge rates from irrigation wells, lower than the previous six years. Reduced groundwater elevations were attributed to dry conditions, additional pumping within Reclamation District 10 due to dry conditions, and groundwater substitution transfer pumping outside of Reclamation District 10. Additional pumping-rate and groundwater level monitoring was initiated to assess and address this problem.

Wells in the region range from less than 300 feet in the east basin to about 700 feet in the west, with some well depths as much as 900 feet at the Feather River.

The above information applies generally to the valley floor and contrasts with the Sierra foothills where groundwater is highly unreliable because of fractured rock aquifers. For example, Camptonville depends on the vast majority of it water supply from groundwater, which is currently inadequate in drought years. The two existing wells have limited quantities of poor quality water.[16]

11.2.2.5 Water Quality

Surface Water Quality

Current water quality problems in the watershed include sediment and mercury deposition from past hydraulic mining; sediment from development, timber harvest, recreation, and road-building activity; temperature increases brought on by water storage and diversion, inadequate shading, and low flows; and impairment due to elevated levels of copper and zinc. Increases in air temperature and increased or prolonged drought could result in increased water temperatures, a reduced capacity for dilution, increased potential for eutrophication and total organic carbons related to increased algae presence, increased sediment and non-point source pollution from more intense storm events and higher peak flows, and increased wastewater runoff into receiving waters.

Groundwater quality

Valley groundwater quality data have been collected in the Yuba County IRWM region since 1965 in selected wells from both subbasins. In a 2008 survey, no wells less than 200 feet deep exceeded drinking water Maximum Contaminant Levels (MCL) in the North subbasin. In the South subbasin, one well less than 200 feet exceeded the MCL for nitrate. Wells greater than 200 feet deep commonly approach or exceed the MCL for total dissolved solids. Further, most areas in the region show increasing trends for Total Dissolved Solids (TDS) and alkalinity. Elevated levels of TDS are associated with deep groundwater pumping and can negatively impact irrigated agriculture and the taste of domestic drinking water.[17]

As mentioned above, Camptonville's two existing wells have poor quality water.

[16] Richard J. DicKard, Camptonville CSD, pers. comm. (February 20, 2014).
[17] Yuba County Water Agency, Yuba County Water Agency Groundwater Management Plan (December 2010).

11.2.2.6 Sea Level Rise

According to the 2030 General Plan Update EIR for Yuba County, even the upper range projections for sea-level rise (4.6 feet by 2099 [IPCC 2007]) would not directly affect Yuba County.

11.2.3 Regional Population Trends in the Climate Context

The county has experienced population growth in the recent past. According to the California Department of Finance, Yuba County's total population increased from 60,219 in 2000 to 72,155 in 2010, with 22 percent in incorporated areas and 78 percent in unincorporated areas. The county's projected growth rate through 2050 is the second highest in the state, after neighboring Sutter County. The California Department of Finance forecasts there will be 143,973 residents of Yuba County in 2050, representing a doubling of the 2010 estimated population.[18]

Of equal interest are demographic data for vulnerable populations, often under-represented in planning decisions. Just over 26 percent of the county population is Hispanic/Latino, and just over 7 percent is Asian. The Adaptation Guide indicates that Yuba County, at 20.7 percent of its population below poverty level, is third only to Merced County at 23.1 percent and Madera County at 21.7 percent for 12 counties in the Northern Central Valley region. Yuba County also exhibits a higher-than-average population of children under five. These disadvantaged segments of the community are often the least able to respond or adapt to the impacts of climate change.

Table 11-3. Selected Population Data for the North Central Valley Region and Yuba County

	Total 2010 Pop.	Pop. <5 yrs.	Percent <5 yrs.	Pop. ≥ 65 yrs.	Percent ≥ 65 yrs.	Estimated all ages	Avg. Est. percent	Margin of Error
North Central Valley	3,725,950	276,063	7.4%	414,921	11.1%	679,162	18.9	
Yuba County	**72,155**	**6,217**	**8.60%**	**7,255**	**10.10%**	**14,708**	**20.7**	**3.5**

Source: US Census Bureau, 2010. General Population and Housing Characteristics & Small Areas and Income and Poverty Estimates

11.2.4 Modeled and Simulated Projections

11.2.4.1 MC1 Vegetation Modeling

Modeling to analyze potential climate impacts on vegetation, conducted in 2013 for the CABY IRWM region that includes Yuba County, "showed an increase in and general upslope movement of the warm temperate/subtropical mixed forest (regional examples include Douglas Fir-Tanoak forest, Ponderosa Pine-Blackoak forest, and Tanoak-Madrone-Oak forest). This is largely displacing the boreal conifer forest, less tolerant of heat and drought. The temperate mixed xeromorphic woodland moved upslope from the foothills just outside of the western edge of the CABY region, further into the region (displacing the warm temperate/subtropical mixed forest upslope). The vegetation communities at the highest elevations in the region became more complex and varied, and generally drier, moving to temperate arid

[18] AECOM, Final Yuba County General Plan, Environmental Impact Report, Sacramento, CA (May 2011). Available from: http://www.yubavision.org/EIR.aspx

and/or Mediterranean shrubland, expanded xeromorphic woodland, and grasslands[19]. All future scenarios projected an increase in the number and severity of fires, but the change became more significant toward the end of the century (Lenihan, 2008)." See Chapter 19 *Technical Analysis and Data Management* for further discussion of the methodology used for MC1 modeling.

11.3 Climate Vulnerabilities

The 2030 General Plan Update EIR for Yuba County states that "Climate change is expected to result in a variety of effects that could potentially impact Yuba County: alternations to agricultural production; changes to terrestrial and aquatic ecosystems; increased energy demand; decreased water supply; increased risk of flooding; and increased frequency and intensity of wildfire. Substantial negative effects on residents, resources, structures, and the economy could result. This impact would be potentially significant."

More specifically, the EIR lists potential vulnerabilities identified during Yuba County's General Plan development process:

- reduced agricultural production as a result of changing temperatures and precipitation patterns;
- changes in composition, health, and distribution [displacement] of terrestrial and aquatic ecosystems, particularly associated with increased saltwater intrusion into the Sacramento-San Joaquin River Delta;
- reduced hydro-electric energy production caused by changes in the timing and volume of runoff;
- increase in vector-borne diseases;
- increased energy demand associated with increased temperatures;
- water supply conflict; and
- increased risk of flooding and wildfire associated with changes to precipitation patterns.

The Adaptation Guide suggests that in the Northern Central Valley, communities should assess the effects of the following:

- temperature increases;
- reduced precipitation;
- flooding – increased flows, snowmelt, levee failure;
- reduced agricultural productivity;
- wildfire in the Sierra foothills;
- public health and heat; and
- reduced tourism.

In the following section, these impacts and the vulnerabilities they suggest are examined in closer detail to determine where the region may have the most exposure to impacts from climate change. **Table 11-4** displays a list of anticipated vulnerabilities.

[19] Perennial grasses can be classified as either C3 or C4 plants. These terms refer to the different pathways that plants use to capture carbon dioxide during photosynthesis. These differences are important because the two pathways are also associated with different growth requirements: C3 plants are adapted to cool season establishment and growth in either wet or dry environments, and C4 plants are more adapted to warm or hot seasonal conditions under moist or dry environments. C3 species also tend to generate less bulk than C4 species, but the C3 feed quality is often higher.

Table 11-4. Climate Vulnerabilities and Strategies to Increase Climate Resiliency			
Summary of Information	**Identified Vulnerabilities**	**Existing Adaptive Strategies**	**Potential Future Strategies/Proposed Projects[1]**
Water Supply/Demand	▪ Camptonville and other foothill communities/ rural areas currently suffer water shortages ▪ Camptonville's summer user demand and Title 22 requirements exceed the capacities of the water treatment system ▪ Reduced water supply reliability ▪ Agriculture water use may be the most vulnerable to climate change ▪ Environmental flows also will likely be affected by increasing temperatures, erratic rainfall, and earlier snowmelt ▪ Reservoir storage levels decline for the summer months and some lack carryover capacity (>2 yrs.) ▪ Declining snowpack increases the risk of supply uncertainty ▪ Changes will be required for basin-wide management and storage of water, especially for irrigation ▪ Groundwater extraction in reaction to climate change has the potential to affect wetland-dependent, riparian, and aquatic habitats ▪ State water policies and out-of-region demands (e.g., Delta) could affect water supply as much as the impacts from climate change ▪ Increased frequency of water transfers within the context of a finite water supply ▪ Ability to deliver water transfers may be jeopardized ▪ Out-of-region diversions may decrease ▪ State water policies and out-of-region demands (e.g., Sacramento-San Joaquin Delta) could affect water supply management as much as the direct effects of climate change	▪ Implement laser-leveling of fields, refrain from draining rice fields before cultivation ("stop irrigation"), sprinkle, and micro-irrigate orchards ▪ Line/pipe canals as in the Brophy Water District, Browns Valley Irrigation District, and Hallwood Irrigation Company ▪ Implement Basin Management Objectives as outlined in YCWA's Groundwater Management Plan ▪ Conduct conjunctive use of surface and groundwater, water transfers (artificial recharge), wastewater recycling, and irrigation water re-use ▪ Improve public understanding of water resources and need for conservation ▪ YCWA is employing locally cost-effective Efficient Water Management Practices identified by SBX7-7 to achieve water use efficiency improvements of irrigation facilities ▪ Groundwater monitoring is currently being conducted by YCWA under its groundwater monitoring plan ▪ YCWA's Groundwater Adaptive Management Tool helps model groundwater response and recovery throughout the Yuba basin ▪ Conjunctive use of surface and groundwater, water transfers (artificial recharge), wastewater recycling, and irrigation water re-use	▪ Additional storage projects, such as possible projects at Dry Creek and New York Flat ▪ New Bullards Bar mid-release outlet to allow for more flexible water management, especially during flooding ▪ Additional canal/ditch lining ▪ Additional drip irrigation ▪ Municipal water recycling ▪ Incentivize on-farm water conservation ▪ Dredge Englebright Lake to increase storage ▪ Increased groundwater monitoring to assure sustainable groundwater management ▪ Implement a network of shallow monitoring wells to detect the rate of, and cumulative change over the year of groundwater levels, the shallowest portion of the aquifer ▪ Increase ability to re-use tailwater runoff ▪ Evaluate the existing water resource requirements of native habitat ▪ Incentivize on-farm water conservation to decrease demand ▪ Increased groundwater monitoring to assure sustainable groundwater management

Summary of Information	Identified Vulnerabilities	Existing Adaptive Strategies	Potential Future Strategies/ Proposed Projects[1]
Water Supply/Demand *(continued)*	▪ Climate change-related surface water decreases could increase future groundwater demands and out-of-area transfer demands ▪ Urbanization; changes in technology; and timing of crop planting, development, and harvest could result in altered timing and demand for irrigation water ▪ Conflicts may increase among agricultural, domestic, flood control, hydrogeneration, and environmental water management ▪ Further data is needed to fully manage the region's groundwater	▪ YCWA and management units have increased recycling and re-use of municipal and industrial water discharge from Beale AFB, the City of Wheatland, and Olivehurst PUD ▪ YCWA continues to seek funding for addressing groundwater data gaps	▪ Local agency and public involvement in state policy and regulatory processes ▪ Consider crop idling as long as it does not facilitate out-of-region transfers; check resource management strategies ▪ Consider providing/expanding fee incentives for municipal and agricultural customers who meet conservation objectives (tiered pricing)
Water Quality	▪ Camptonville's water quality suffers during heavy rain events, requiring the treatment plant to be shut down due to turbidity ▪ Increased algae could reduce delivery capacity and increase the need for filtering of irrigation infrastructure in localized areas ▪ Peak storm events may increase transport of mercury from stream channels, with related potential for increased methylmercury ▪ Decreased overall supply would likely result in a higher concentration of pollutants ▪ Increased water temperatures may significantly impact aquatic ecosystems ▪ Fluctuating reservoir water levels due to increased climate variability could result in increased sedimentation and reservoir storage and maintenance problems ▪ Removal of vegetation from increased wildfire could result in increased erosion and sedimentation	▪ Water quality monitoring is currently being conducted by YCWA under its groundwater management plan ▪ YCWA coordinates with the Yuba County Agricultural Commissioner's office as part of the Sacramento Valley Water Quality Commission and to coordinate with the Irrigated Lands Regulatory Program	▪ Dredge Englebright Lake and/or above Daguerre Point Dam to remove toxic sediments (mercury) ▪ Conduct headwater meadow and forest restoration ▪ Additional monitoring is needed to fully understand groundwater quality

Summary of Information	Identified Vulnerabilities	Existing Adaptive Strategies	Potential Future Strategies/ Proposed Projects[1]
Infrastructure (water storage and conveyance)	▪ Water storage infrastructure was designed for a historic demand, and may not accommodate increased winter peak flows, or have adequate carryover storage for drought periods ▪ The conveyance system was designed for a certain demand; therefore, inadequate peaking capacity may exist during times of extraordinary heat (for irrigation demand) ▪ Conflicts over storage may increase among agricultural, domestic, hydropower, flood control, and environmental needs		▪ Additional storage projects, such as possible projects at Dry Creek and New York Flat ▪ New Bullards Bar mid-release outlet to allow for more flexible water management, especially during flooding ▪ Additional canal/ditch lining
Flooding	▪ Increased storm intensity and severity puts communities, critical infrastructure, and protective levees at greater risk ▪ Responses to increased flood risk could impact water delivery for regional demands and hinder YCWA's ability to transfer stored water ▪ Flooding infrastructure was designed for historic flood regimes and to protect substantially less human development, and may increase conflicts/complexity in managing for both storage and flood control	▪ Upgrade agricultural and municipal levees (City of Wheatland working on this goal) ▪ The Bear River and Feather River setback levees	▪ Install a New Bullards Bar mid-level outlet ▪ Petition for refinement of New Bullards Bar flood-operating rules to better capture earlier springtime snowmelt ▪ Upgrade additional levees and provide greater setbacks for levees ▪ Headwater meadow and forest restoration ▪ If necessary, work with US Army Corps of Engineers to modify flood control operations
Species and Habitat	▪ Vegetative communities are expected to move upslope with significant loss of subalpine and alpine vegetation and large increases in hardwoods and grasslands ▪ Climate variation is projected to affect foothill woodland and chaparral vegetation and the rare and unique species they support ▪ Decreases in surface flows may threaten fish and other aquatic life	▪ Tahoe National Forest will complete a climate vulnerability assessment in 2014 to prioritize areas most in need of restoration ▪ Plumas National Forest is focusing current forest activities on resilience of general forested landscapes to stand-replacing wildfire, particularly in high-value wildlife habitat ▪ PNF's forest health restoration focus is on fuels reduction work that reduces fire risk to communities, strategic watersheds, and	▪ Manage for ecosystem structure, heterogeneity, and process rather than for specific species or their habitat ▪ Set-back levees to allow for habitat re-colonization of floodplains ▪ Conduct headwater meadow restoration ▪ Create off-channel salmon habitat ▪ Dam Removal (Daguerre Point)

Summary of Information	Identified Vulnerabilities	Existing Adaptive Strategies	Potential Future Strategies/ Proposed Projects[1]
Species and Habitat *(continued)*	▪ Increased fire frequency and intensity may impact vegetative species composition, especially the size and extent of old-growth forest habitat and related fauna ▪ Water demands may jeopardize mandated environmental flows for aquatic species ▪ Significant changes in bird distribution and composition (especially wetland-dependent species), and substantial impacts to amphibians are anticipated ▪ Saltwater intrusion from sea-level rise may displace fauna from Sacramento Delta to refugia in the Yuba County IRWM region ▪ Future regional climate may favor certain invasive species, decreasing viability for native and desired species ▪ Increased demand on groundwater may desiccate groundwater-dependent ecosystems	recreation sites, and watershed work that improves connectivity and restores meadows and riparian/aquatic ecosystems ▪ Implement the Yuba Accord to help maintain in-stream flows ▪ Both TNF and PNF are incorporating invasives management into forest health management and restoration projects ▪ The Nature Conservancy is paying farmers to seasonally flood fields for critical wetland-dependent bird habitat in the Central Valley	▪ Restore specific wet meadow and/or spring habitats identified by stakeholders on private lands to improve shallow groundwater storage, increase summer base flows, improve in-stream habitat diversity ▪ Participate in large-scale planning to promote habitat connectivity, consider human-assisted dispersal of species, and prioritize refugia for conservation and restoration ▪ Consider a role to help mitigate impacts from out-of-area sea-level rise through water transfers or other means ▪ Create off-stream salmon habitat via floodplain expansion from levee setback ▪ Evaluate the existing water resource requirements of native habitat

Summary of Information	Identified Vulnerabilities	Existing Adaptive Strategies	Potential Future Strategies/ Proposed Projects[1]
Socioeconomics	**Public Health and Safety** ▪ Increased potential for flood risk could result in human and economic losses ▪ Flooding and heat waves may have the greatest effects on disadvantaged/under-represented communities ▪ The northern two-thirds of the county's critical facilities are exposed to fire threat hazard ▪ Residential development is taking place in fire-adapted vegetation, increasing potential for human and economic loss ▪ Increased fire-threat hazards will increase fire management costs	▪ Partner with public health community outreach to prepare under-represented and DACs for flooding, wildfire, and heat-wave events ▪ Provide bilingual climate vulnerability outreach for Hispanic residents	▪ Install a New Bullards Bar mid-level outlet ▪ Upgrade levees ▪ Conduct headwater meadow restoration ▪ Site critical public facilities out of fire-prone areas ▪ Create fire-safe zones around critical facilities ▪ Provide more public education in fire-prone areas for local residents
	Agriculture ▪ Greater evapotranspiration may lead to conditions less suitable for traditional crop types ▪ Heat-sensitive crops and livestock likely will be vulnerable to prolonged high temperatures ▪ Lost revenues from climate-related events will potentially negatively affect regional income, employment, and tax revenues ▪ Water deficits could hasten conversion of agricultural land to urban uses	▪ Upgrade municipal and agricultural levees to 100-year resilience ▪ Employ agricultural water conservation measures suggested above ▪ Implement the Yuba Accord and employ forest restoration action mentioned above ▪ Plumas National Forest is improving the economics of forest product removal and capitalizing on opportunities for partnerships, particularly to leverage declining appropriated dollars ▪ Plumas National Forest is completing a Strategy for Sustainable Recreation to integrate recreation projects with forest health restoration projects ▪ Work with county agricultural groups to publicize Yolo County's agricultural climate adaption website, prepared in collaboration with U.C. Davis (http://agadapt.ucdavis.edu/)	▪ Anticipate and plan for a shift in crops/crop patterns, or crop mixes ▪ Fuel treatments would provide employment opportunities for the regional economy while decreasing future wildfire related expenses

Summary of Information	Identified Vulnerabilities	Existing Adaptive Strategies	Potential Future Strategies/ Proposed Projects[1]
Socioeconomics *(continued)*	**Hydropower Production** ▪ Climate impacts on high-elevation hydropower production would have wide-ranging effects ▪ Climate adaptation will likely require a combination of operating changes to hydro-generation facilities, with related secondary impacts to water facilities and delivery; even so, generation losses are probable ▪ Revenue losses from hydropower are projected. Decreased hydropower production coupled with increased summer energy demands could affect the local economy		▪ Hydrogeneration managers may increase storage in the winter in anticipation of critical summer needs and to provide flexibility in management options ▪ Explore environmentally acceptable and economically feasible ways of producing and using power from biomass
	Recreation ▪ Recreational pursuits and tourism could be affected by low flows ▪ Projected low flows may not be sufficient to sustain FERC-licensed rafting flows, having secondary negative effects on the local economy ▪ Recreational forest resources are likely to be affected by changes in flow regime		
	Timber Harvest ▪ Potential climatic changes are expected to affect type, location, and amount of timber inventories, but may generate need for alternative timber management/production and fuels reduction project		▪ Create value-added markets for forest biomass, including local biomass power generation

[1] Many of these adaptation strategies will need to be further refined. Future WEAP modeling and analyses will help provide better direction for designing successful strategies.

11.3.1 Projected and Anticipated Vulnerabilities

11.3.1.1 Water Supply

- **Reduced water supply reliability.** YCWA's flexibility in supplying water is constrained by amount and timing of runoff, available storage, minimum in-stream flow requirements, flood control operational requirements, and power purchase agreements with PG&E. Reduced total inflows and less certain timing of flow into Yuba River reservoirs in the future from climate variability would increase the probability that agricultural, environmental, and other demands might not be met.[20]
- **Declining snowpack increases the risk of supply uncertainty**. Snowpack that does occur is expected to melt earlier in the spring, leaving a longer period of time between the period of bulk spring runoff and summer agricultural irrigation demands for water. An increasing risk of supply uncertainty is expected to result.
- **Agricultural water use may be the most vulnerable to climate change**. Modeled data indicate that agricultural water use may be the most vulnerable to climate change as urban users' willingness to pay for water outstrips agricultural water users' ability to pay.[21] Further, agriculture is the only identified industry requiring cooling and process water in the county. This industry could be impacted by rising utility costs from additional air-conditioning due to rising temperatures, and eventually by higher power costs if hydropower generation is impacted as projected.
- **Reservoir storage levels decline for the summer months.** Reservoir storage levels are projected to peak earlier in the year and decline for the summer months.[22] Freeman (2003) states that "system-wide dams were built under a historical flow regime that depended on 1) 25% of precipitation from snowfall, 2) 37% from snowmelt, and 3) 38% from groundwater (primarily springs). Changes from the historic norm have the potential to change spill frequency and magnitude compared with historical data and design of the system."[23]
- **Changes will be required for basin-wide management and storage of water, especially for irrigation.** Management of basin-wide storage and conveyance operations will have to adapt to changes in precipitation and snowpack, and must have the capacity to capture the bulk of spring snowmelt earlier in the year and store it for a longer period of time until irrigation begins. This may become difficult given current reservoir capacity and operations within the basin. By way of example, in the Browns Valley Irrigation District subregion, Browns Valley Reservoir, and other area reservoirs don't have sufficient capacity to carry over surpluses (less than a two-year capacity). Further, conflicts between water users will likely increase, especially under the likelihood of increased drought conditions.

11.3.1.2 Water Demand

- **Camptonville and other rural foothill areas currently suffer water shortages.** Though small in comparison to Central Valley agricultural demands, Camptonville's water demand varies by more

[20] Yuba County Water Agency, Agricultural Water Management Plan, Final (December 2012).
[21] California Climate Change Center, Water management adaptation with climate change. Prepared by: Azuara, J.M.; Connell, C.R.; Madani, K.; Lund, J.R.; and Howitt, R.E. (Final paper August 2009).
[22] Ibid.
[23] Freeman, G. J. Climate change and California's diminishing low elevation snowpack - a hydroelectric scheduling perspective. Western Snow Conference 71:39-47 (2003). Available from: http://www.westernsnowconference.org/proceedings/pdf_Proceedings/2003%20WEB/Freeman,%20G._Climate%20Change%20and%20CA's%20Diminishing%20Low-Elevatio.pdf

than 50 percent during the summer as compared to the winter. Camptonville has faced water shortages during drought conditions; water rationing has been required in the past. The Oregon House and Dobbins areas have also experienced well depletion during drought periods.

- **Increased frequency of groundwater transfers within the context of a finite water supply.** YCWA has water delivery obligations under the: 1) Sacramento Valley Water Management Program Short-term Settlement Agreement (to help meet water quality standards in the Sacramento-San Joaquin Delta, as set forth by the 1994 Delta Accord; 2) Yuba Accord, (to enhance Lower Yuba River fisheries, employ conjunctive use for regional water district needs, and conduct long-term transfer of enhanced Lower Yuba River flows); and 3) YCWA Transfer Program (aimed at supplemental water transfers in dry years to supply additional agricultural and urban uses). An analysis by the Water Environment Federation[24] suggested that due to urban growth and development and other uses, the groundwater transfer program "may be exercised with greater frequency and/or larger quantities." Warming and drying of the climate will likely contribute to the increased frequency of transfers and to overall limitations on a finite water supply.
- **Ability to deliver water transfers may be jeopardized.** Even if annual totals in precipitation remain relatively constant in the near future, as many climate models suggest, the frequency and magnitude of rain events are predicted to vary dramatically from previous decades. Large floods, long droughts, and a higher number of both very wet and very dry years are expected in the region. This too raises concerns regarding the ability to reliably store and deliver water for downstream users within the basin. These problems may be compounded by the fact that if rainfall occurs during fewer but larger storms and less snowpack is on the ground, groundwater basins may not be fully replenished each year (an especially problematic issue if substitution transfers are expected to increase during future dry years).
- **Out-of-region diversions may decrease.** Currently diversions southward to the Bear/American basin complex amount to an average of ~17 percent of total Yuba basin flows in a given year, via the Drum/Spalding diversion project. Recent studies demonstrated that were temperatures to increase, decreasing snowpack and altering the shape of the annual hydrograph, exports out of the Yuba basin would likely decrease to maintain compliance with in-stream flow requirements within the Yuba basin. This decreasing export trend would be even more accentuated were in-stream flow requirements to become more stringent in the future.
- **State water policies and out-of-region demands could affect water supply management as much as the direct effects of climate change.** The Yuba County IRWM region is partially within the Sierra Nevada, a source for the majority of the state's fresh water. As such, its water is under complex management by multiple agencies, and of considerable and competing value to out-of-region interests. Some regional stakeholders maintain that policies adopted by state agencies beyond the purview of the region (e.g., to address Sacramento Delta supply and ecological concerns in response to climate change, FERC relicensing for hydro power) could have as much effect on the region's water supply and management as direct climate impacts. By way of example, with continuing studies and concerns regarding declines of the native aquatic habitat putting higher pressure on managing water quality and quantity sustainably, there may be more pressure placed upon the Yuba basin to allow more of its surface water to flow south via the Feather and Sacramento Rivers, although the timing of these outflow demands are not certain. In dry years, there are often severe shortages in the Delta due to low inflows and high pumping export demands from southern California water contractors.

[24] Water Environment Federation, Groundwater management program for Yuba County Water Agency: a conjunctive use pilot project. Prepared by: Onsoy, Yuksel S.; Bonds, C.L.; Petersen, C.E.; Aikens, C.; and Burke, S.M.

- **Climate change-related surface water decreases could increase future groundwater demands and out-of-area transfer demands.** US Department of the Interior, Bureau of Reclamation's SECURE Water Act 9503(c) fact sheet states that climate change-related surface water decreases in the Sacramento-San Joaquin drainages are "likely to significantly increase future groundwater demands."[25] Moreover, in dry years, water contractors south of the Bay-Delta (and the Bay-Delta itself) will likely experience severe shortages, in turn increasing the market-demand for transfer of Yuba water southward, often in the form of groundwater substitution transfers. This will have impacts upon the types of water and land-use practices within the Yuba basin (e.g., changing crop types, increased pumping), which is relatively "water-rich" in comparison to much of the state.
- **Urbanization, changes in technology, and timing of crop planting development and harvest could result in altered timing and demand for irrigation water.** Modeling conducted by the California Climate Change Center projects a 22.2 percent increase in urbanized land in Northern California, with a corollary decrease in agricultural land of -3.3 percent by 2050. In the same study, water demand is expected to drop by 2050, mostly due to increasing urbanization, but also to changes in technology, a warming climate, and crop demand related to income projections.[26] Changes in timing of crop planting, development, and harvest could result in altered timing for irrigation demands.
- **While YCWA is carrying out a Measurement and Monitoring Program, need exists for further monitoring and groundwater data to address the gap in knowledge necessary to fully and efficiently manage this resource. Further data is needed to fully manage the region's groundwater.** Conservation interests have identified potential habitat impacts associated with potential changes in water management practices in response to climate change, especially on shallow groundwater resources.

11.3.1.3 Water Quality

- **Increased algae could reduce delivery capacity and increase the need for filtering of irrigation infrastructure in localized areas.** Increased algae could result in additional challenges to YCWA and member agencies in controlling aquatic plants in distribution systems that could, in turn, reduce delivery capacity. Increased turbidity and algae growth could increase the need to filter surface water for micro-irrigation of orchard crops.[27]
- **Peak storm events may increase transport of mercury from stream channels, with related potential for increased methylmercury.** Peak storm events exacerbated by climate change could transport mercury from stream channels, which in turn could be converted to methylmercury. The methylation of mercury makes the pollutant "bio-available" and, if consumed, a neurotoxin. Methylmercury readily accumulates in organisms and concentrates in fish and wildlife at the top of the food chain. Documented consequences of methylmercury pollution and consequent dietary exposure include: 1) direct adverse effects on the health of fish, wildlife, and humans; 2) contamination of fishery resources that diminishes their nutritional, cultural, socioeconomic, and recreational benefits; and 3) socio-cultural damage to indigenous peoples who fish for subsistence.
- **Decreased overall supply would likely result in a higher concentration of pollutants.** Increased concentrations of pollutants may occur from increased groundwater pumping for agriculture and/or municipalities. Local pollution from landfills may impact neighboring surface and/or

[25] SECURE Water Act 950(c) – Reclamation Climate Change and Water 2011, Section 7 – Basin Report: Sacramento and San Joaquin. Available from: www.usbr.gov/climate

[26] California Climate Change Center, Water management adaptation with climate change, Prepared by: Azuara, J.M.; Connell, C.R.; Madani, K.; Lund, J.R.; and Howitt, R.E. (Final paper August 2009).

[27] Yuba County Water Agency, Agricultural Water Management Plan, Final (December 2012).

groundwater quality, especially when combined with other agricultural pollutants such as nitrate and various pesticides. Pollutants may be concentrated in surface water from a combination of lower flows and return flows from irrigation. Salinity concentrations may also begin to pose increasing threats to arable land in the face of a changing climate, irrigation practices, or water supply regime.

- **Sedimentation could result from reservoir bank erosion and wildfire.** The anticipated increase in drought duration/intensity will increase the extent of dewatered reservoir banks and removal of vegetation due to wildfire. Subsequently, the projected increase in extreme precipitation events will likely increase the erosion of reservoir banks and upstream riparia. This could lead to increased erosion and sedimentation, and subsequent reservoir storage and maintenance problems, along with attendant management costs.
- **Camptonville water quality compromised during heavy rain events.** Camptonville's water quality suffers during heavy rain events, requiring that the treatment plant be shut down due to turbidity in the surface water source.

11.3.1.4 Flooding

- **Increased storm intensity and severity puts communities, critical infrastructure, and protective levees at greater risk.** According to the Yuba County Multi-Hazard Plan, roughly one-third of the county's population lives in the 500-year floodplain, along with emergency evacuation routes, sewer and water treatment plants and other infrastructure, and numerous critical community facilities. Floods in 1986 and 1997, exacerbated by levee failures on the Yuba and Feather Rivers, inundated large areas south of Marysville in the Linda and Olivehurst communities. Levees are instrumental in protecting vulnerable populations in Marysville, Wheatland, and an area of Reclamation District 10 as well. At higher elevations, damage to roadways occurred from landslides and debris flows. Increased storm intensity and severity brought on by climate variation could exacerbate the types of impacts discussed above.

  The California Adaptation Guide suggests that communities should evaluate areas where increased flood height would potentially threaten structures, infrastructure, agricultural fields, and public safety.
- **Responses to increased flood risk could impact water delivery for regional demands and hinder YCWA's ability to transfer stored water.** Potential responses to increased flooding, such as increasing reservoir capacity and modification of flood control operations could result in earlier spilling and potentially less available irrigation water and environmental demands, and hinder YCWA's ability to transfer stored water.

11.3.1.5 Infrastructure (water storage and conveyance)

Water infrastructure may be inadequate under greater climate variability. Water storage infrastructure was designed for historic flow regime and development levels, and may not accommodate increased winter peak flows, or have adequate carryover storage for drought periods. The conveyance system was designed for a certain demand, and inadequate peaking capacity may exist during times of extraordinary heat (for irrigation demand). Conflicts over storage may increase among agricultural, domestic, hydropower, flood control, and environmental needs.

11.3.1.6 Wildfire

- **Fire risk is projected to rise significantly at higher elevations.** The Cal-Adapt website facilitates projections for fire risk based on climate modeling under high and low GHG emission scenarios for specific areas in California. However, it does not account for localized fuel loads or atmospheric changes. All things being equal, it currently projects that fire risk will rise by about 200 percent in the Smartsville area and by about 300 percent in the Camptonville area by 2085.
- **Local conditions exacerbate future fire risks for Yuba County.** Highly flammable fuels, long dry summers, some management practices (e.g., conversion of some forest stands to even-aged plantations), and steep slopes and canyons, especially when combined with projected warming and drying of the climate, pose significant fire risks for Yuba County in the future. The Yuba County Multi-Hazards Mitigation Plan (2009) suggests that from May to October each year, two-thirds of the county faces a serious threat from wildfires, and local stakeholders report fire occurrences in every month of 2013, as well as a general extension of the fire season.[28] Research has identified high fire hazards in even-aged silvicultural systems (clear-cut conifer plantations) such as those located north and east of New Bullards Bar Reservoir.[29]

11.3.1.7 Species and Habitat

- **Groundwater extraction combined with a drying climate has the potential to impact water-dependent habitat.** The long-term health of riparian vegetation, wetlands (in particular, for wetland-dependent bird species in the Delta), and a number of other native habitats are commonly associated with a minimum range of groundwater levels and an appropriate level of interaction between surface and groundwater. Reduced groundwater levels due to climatic changes coupled with the potential need for increased groundwater extraction under a drying climate have the potential to impact the native habitat areas.
- **Vegetative communities are expected to move upslope with significant loss of subalpine and alpine vegetation and large increases in hardwoods and grasslands.** The highest resolution vegetation modeling to date is the MC-1 model used by Lenihan et al. (2003, 2008) to project climate impacts on Sierra west slope vegetation. All GHG emission scenarios project that vegetative communities will move upslope, with significant loss of subalpine and alpine vegetation, and most project lower cover of shrubland, including westside chaparral (resulting mostly from increased frequency and extent of fire). Large increases in hardwoods are projected, except under the most extreme hot-dry scenario in the foothills. Grasslands are expected to expand.[30]
- **Climate variation is projected to affect foothill woodland and chaparral vegetation and the rare and unique species they support.** Foothill woodland and chaparral vegetation communities are most frequently documented to contain rare and unique species, yet are experiencing fragmentation and damage from agricultural practices and development.[31] Climate variation may further stress these communities, or it may influence their shift to higher elevations.

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[28] Core Group meeting, January 16, 2014.

[29] Stephens, Scott L. and J. J. Moghaddas, Silvicultural and reserve impacts on potential fire behavior and forest conservation: Twenty-five years of experience from Sierra Nevada mixed conifer forests, Division of Ecosystem Science, Department of Environmental Science, Policy and Management, 137 Mulford Hall, U.C. Berkeley (February 2005). Available from: www.sciencedirect.com

[30] Lenihan, J.M.; Bachelet, D.; Neilson, R.P.; Drapek, R., Response of vegetation distribution, ecosystem productivity, and fire to climate change scenarios for California. Climate Change. 87(Suppl.): S215-S230, (2008).

[31] Sacramento River Watershed Program/Yuba River Watershed. Available from: www.sacriver.org/aboutwatershed/roadmap/watersheds/american/yuba-river-watershed

- **Increased fire frequency and intensity may impact vegetative species composition, especially the size and extent of old-growth forest habitat and related fauna.** Increased frequencies and intensities of fires in coniferous forests are expected to drive changes in vegetative species composition, and in turn, reduce the size and extent of old-growth forest habitat and the fauna it supports.[32]
- **Decreases in surface flows may threaten fish and other aquatic life.** Low flows and high temperatures in the South and Middle Fork Yuba Rivers, along with sediment from the legacy of mining, already compromise habitat for aquatic life. While the Lower Yuba River Accord attempts to safeguard populations of threatened fish species below Englebright Dam (green sturgeon, Chinook salmon, steelhead trout) by means of implementing legally binding in-stream flow requirements, warming water temperatures and highly variable hydrology within the basin will further stress these delicate populations despite such protective measures.
- **Water demands may jeopardize mandated environmental flows for aquatic species.** Without substantive water conservation and technological advances in water efficiencies, and careful operation of water delivery, water demands may outstrip regional supplies into the future, jeopardizing mandated environmental flows (such as under the Yuba Accord) for aquatic species.
- **Significant changes in bird distribution and composition, and substantial impacts to amphibians are anticipated.** Safford et al. suggest that substantive changes in regional species composition and distribution are already taking place and are expected to accelerate over the next century. Current and future species distribution models for 60 focal bird species in California found that avian assemblages would dramatically shift, as would patterns of species interactions. The Avian Data Center projects that about 60 percent of coniferous forest bird species in the Sierra will exhibit substantial range reductions within the next 40 to 90 years. Similarly, high vulnerability is projected for California's amphibians,[33] with lesser effects on mammalian fauna.
- **Salt-water intrusion from sea-level rise may displace fauna from Sacramento Delta to refugia in the Yuba County IRWM region.** While sea-level rise is not expected to directly affect the region, salt-water intrusion from sea-level rise may displace fauna from the Sacramento Delta that may seek refuge in the region.
- **Future regional climate may favor certain invasive species, decreasing viability for native and desired species.** Future regional climate is likely to favor certain invasive species. Additional invasive species act as stressors on native species that, when combined with greater climate variability and its impacts (such as increased fire risk), can cause decreased viability for native and desired species.

11.3.1.8 Socioeconomics

Public Health and Safety

- **Increased potential for flood risk could result in human and economic losses.** The cost of flood/levee failure is estimated at over $487 million for a 100-year event and at over $648 million for a 500-year event. Over 4 percent of all jurisdictional critical facilities are located in the 100-year floodplain in Yuba County, while 14 percent of such facilities are exposed to 500-year events. About 15,000 people were located in the 100-year floodplain in 2000, and of these, 2,300, or 15 percent were severely disadvantaged (annual incomes under $10,000). Increased potential for

[32] Lenihan, J.M.; Bachelet, D.; Neilson, R.P.; Drapek, R., Response of vegetation distribution, ecosystem productivity, and fire to climate change scenarios for California, Climate Change, 87(Suppl.): S215-S230, (2008).
[33] Yarnell, Sarah M., J. H. Viers, and J. F. Mount. Ecology and Management of the Spring Snowmelt Recession. Bioscience, Vol. 60, No. 2, (February 2010). Available from: https://watershed.ucdavis.edu/pdf/Yarnell_etal_BioScience2010.pdf

flood risk due to intense storm events and higher peak flows could result in loss of life, damage to critical facilities, property damage, and loss of business and tax receipts.[34]

- **Flooding may have the greatest effects on disadvantaged/under-represented communities.** The elderly and the young, and populations that lack resources or knowledge due to language or economic status are potentially the most vulnerable to the effects of flooding; adaptation strategies may require coordination with public health officials.
- **Increased potential for heat waves may disproportionately affect under-represented communities.** The elderly and the young, and populations that lack resources or knowledge due to language or economic status are potentially the most vulnerable to the effects of heat waves; adaptation strategies may require coordination with public health officials.
- **Heat-sensitive crops and livestock will be vulnerable to prolonged high temperatures.** Rice is projected to experience only a moderate loss (<10 percent), while nut trees may suffer from a lack of nighttime cooling. Each crop will react differently and specific production losses are difficult to project because they are subject to factors additional to temperature, such as precipitation, pests, and management. The severity of heat stress can also affect the level of milk production in dairy cattle.[35]
- **The northern two-thirds of the county's critical facilities are exposed to fire-threat hazard.** According to California Division of Forestry data, the northern two-thirds of the county's critical facilities are exposed to fire-threat hazard, and several are in the "Very High Fire Hazard Severity Zone," including YCWA's Colgate Power House and Narrows #2 Power House.
- **Residential development is taking place in fire-adapted vegetation, increasing potential for human and economic loss.** Many existing and new homes are built in fire-adapted vegetation types, such as oak woodlands (with two- to eight-year fire return intervals) and remaining forest types with five- to sixteen-year fire return intervals. Recent fires include the 1997 Dobbins-Oregon House fire that destroyed 417 structures and numerous vehicles valued at $20 million. The 1999 Pendola fire covered nearly 12,000 acres and caused $3 million in damages.[36]

Agriculture

- **Greater evapotranspiration may lead to conditions less suitable for traditional crop types.** If other atmospheric conditions remain similar to the present (such as humidity levels), temperature rise will lead to greater evapotranspiration, which in turn could lead to greater water demand and conditions less suitable for traditional crop types.[37]
- **Water deficits could hasten conversion of agricultural land to urban uses.** Water deficits that impact agricultural production and livelihoods could hasten conversion of agricultural land to urban uses.[38]
- **Agricultural employment may be less stable.** Agriculture is the primary economic driver in Yuba County. Agricultural operators and their employees may be increasingly affected by climate-related impacts on agriculture, a water- and weather-reliant industry. According to the agadapt.edu

[34] Ibid.
[35] California Emergency Management Agency, and California Natural Resources Agency, California Adaptation Planning Guide (July 2012). Available from: http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html
[36] Office of Emergency Services, Yuba County Multi-Jurisdictional Multi-Hazard Mitigation Plan, Yuba County, CA (2009). Available from:http://www.co.yuba.ca.us/departments/OES/PDM/Multi-hazard%20mitigation%20plan/Plan%20Documents/Section%204%20-%20Risk%20Assessment.pdf
[37] Ibid.
[38] Mehta, V.K.; V.R. Haden; B.A. Joyce; D.R. Purkey; L.E. Jackson, Irrigation demand and supply, given projections of climate and land-use change, in Yolo County, California (2012). Agricultural Water Management. 117 (2013)70-82. Available from: www.elsevier.com/locate/agwat

website, created collaboratively by Yolo County and UC Davis to prepare agricultural operators for climate change effects, summer (April-August) growing degree days have risen by 500 in the last 100 years (1909 to 2009), while winter (November-February) chill hours have decreased by about 100 (20 percent) between 1912 and 2013.[39] Lost revenues from climate-related events will potentially negatively affect regional income, employment, and tax revenues.

Hydropower Production

- **Climate impacts on high-elevation hydropower production would have wide-ranging effects.** High-elevation hydropower production in the Sierras accounts for almost 20 percent of California's in-state energy production.[40] Impacts to that production will be felt both within and beyond the region.
- **Climate adaptation will likely require a combination of operating changes to hydrogenation facilities, with related secondary impacts to water facilities and delivery; even so, generation losses are probable.** PG&E research shows that continued operation of a mountain hydroelectric system will require adaptation to climate change specific to the region, namely a combination of operational changes, including higher winter carryover reservoir storage levels, reduced conveyance flows in canals and flumes during winter storm period, reduced reservoir releases during the late spring and summer period, and increased sediment sluicing releases from diversion dams. It is observed that as snowpack continues to disappear, in effect, the ability to fully and efficiently use reservoir storage also diminishes due to the increasing uncertainty of filling the reservoirs. Negative impacts to hydroelectric generation will likely occur with sufficient frequency to cause overall generation losses for PG&E's hydroelectric system by about 2025 on the Yuba River.[41] While it has been suggested that impacts to high-elevation systems could be mitigated by storage of enough water for generation in summer months, Freeman (2008) states that many of PG&E's forebays and afterbays are incapable of storing significant quantities of rainfall generated runoff.
- **Revenue losses from hydropower are projected.** Revenue losses from both low- and high-elevation hydropower are projected under both warm-dry and warm-only climate scenarios.[42]
- **Decreased hydropower production coupled with increased summer energy demands could affect the local economy.** Energy demands in the region would likely increase from need for air-conditioning and cooling during summer months. Major industries and institutions requiring heating and cooling could be affected, both economically and by potential losses of power, from hydropower generation losses over time.

Recreation

- **Recreational pursuits and tourism could be affected by low flows.** Recreational floating and tourism is a primary driver of the economy; 39 miles of the lower South Yuba River are designated as a California Wild and Scenic River and recommended as a federal Wild and Scenic River. Low

[39] http://agadapt.ucdavis.edu/changingclimate/

[40] Mehta, V.K.; D. E. Rheinheiimer; D.Y. Yates; D.R. Purkey; J.H. Viers, C.A. Young; and J.F. Mount. Potential impacts on hydrology and hydropower production under climate warming of the Sierra Nevada. Journal of Water and Climate Change. 02.1 (2011).

[41] Freeman, G. J., Runoff impacts of climate change on northern California's watersheds as influenced by geology and elevation-a mountain hydroelectric system perspective. Western Snow Conference 76:23-34 (2008). Available from: http://www.westernsnowconference.org/proceedings/pdf_Proceedings/2008/Freeman.RunoffImpactsOfClimateChangeOnNorthernCalifornia'sWatersheds.pdf

[42] California Climate Change Center, Water management adaptation with climate change, Prepared by: Azuara, J.M.; Connell, C.R.; Madani, K.; Lund, J.R.; and Howitt, R.E. (Final paper August 2009).

flows brought on by warming and drying of the climate may increase competition for adequate flows to support recreational pursuits.

- **Projected low flows may not be sufficient to sustain FERC-licensed rafting flows, having secondary negative effects on the local economy.** Most rafting flows have been set by FERC licenses, but projected low flows may not be sufficient to sustain current-day recreational pursuits. This could have secondary negative effects on the local economy.
- **Recreational forest resources are likely to be affected by changes in flow regime.** Forest infrastructure such as bridges, culverts, campgrounds, and roads may be damaged by increased variation in flows, while recreational game fish species may be negatively affected by diminished water quality.

Timber Harvest

- **Potential climatic changes are expected to affect type, location, and amount of timber inventories, but may generate need for alternative timber management/production.** Modeled data suggest potential climatic changes that are expected to shift forest types and species mixtures within the watershed. Coupled with increased fire risk and an anticipated elevation of invasive species, timber inventories could shift in type, location, and number. However, economic stimulus may come from the need for fuels reduction projects and possible local energy production from biomass.

11.3.2 Prioritizing Climate Vulnerabilities for the Region

The climate Core Group met in March 2014 to consider prioritization of climate vulnerabilities. The Group first reviewed and modified the list of vulnerabilities that had been filled out by stakeholders using the framework of DWR's Climate Checklist (see **Appendix 11-1**) from DWR's Climate Handbook and a table of vulnerabilities and adaptation strategies that had been previously posted and reviewed by stakeholders.

The project team explained that DWR requires prioritization of climate vulnerabilities and that the recommended methodology for prioritization had taken guidance from the California Adaptation Planning Guide. A vulnerability rating system of high, medium, and low was based on the likelihood of climate impact to the issue (e.g., water supply, species and habitat); the sensitivity level for critical facilities, essential economies, sensitive species and habitats, or vulnerable populations; and the level of risk for public safety, economic sectors, the environment, or critical facilities.

The Group subsequently rated all vulnerabilities and completed a table with its recommendations as displayed in **Table 11-5**.

Table 11-5. Yuba County IRWMP Climate Vulnerability Prioritization					
Vulnerability	**Likelihood of occurrence: Are climate effects occurring or projected within a 50-year timeframe?**	**Sensitivity Level: Does this involve critical facilities, essential economies, sensitive species and habitats, or vulnerable populations?**	**Level of Risk: Could this involve critical public safety, severe economic or environmental damage, and/or critical facility loss?**	**Priority High (H), Medium (M), Low (L)**	**Justification**
Water Supply/Demand					
Reduced streamflow and water supply will likely generate hard choices for water managers, and potentially increase conflicts among agricultural, domestic, hydropower, flood control, and environmental needs. State water policies and out-of-region demands (e.g., Sacramento-San Joaquin Delta) could affect water supply management as much as the direct effects of climate change. Decreased surface flows from climate change could increase future groundwater demands and out-of-area transfer demands.	Earlier Sierra snowmelt is occurring and is a primary contributor to regional surface flows. The runoff season is shifting from March-June to a February-May period; this shift is projected to become more pronounced as the climate warms. Valley groundwater supplies could be affected during prolonged droughts and decreased snowpack and rain versus snow events; shallow wetland habitats are currently affected. During drought conditions foothill communities have required water rationing.	In foothill communities, wells are a significant water supply source. Several regional imperiled species are wetland and riparian dependent.	Level of risk is high for foothill populations and some subregions — could face severe domestic and irrigation shortages. Level of risk is high for imperiled species that could further decline or disappear.	**H** for foothill communities (e.g., Camptonville), and rural areas served by private wells (e.g. Oregon House and Dobbins) **H** for wetland-dependent, riparian, and/or aquatic habitat **H** for irrigation demands in some subregions (e.g., North Yuba and Browns Valley)	Climate variation is already affecting area water supply and the impacts are expected to increase. Sensitivities to these effects on water supply exist in foothill communities, for wetland-dependent habitat, and for irrigation in specific subregions. The level of risk for local economic health and environmental damage is **high** in specific locations/districts.
Water Quality					
Reduced water quality could occur from the direct effects of rising temperatures and to the indirect effects of eutrophication, increased algal growth, release of mercury methylation, increased sedimentation from high peak winter runoff, and decreased vegetative cover	Several water bodies are state-listed as impaired for heavy metals, chemicals, and/or temperature. Several fish species exceed safety levels for human consumption from mercury bioaccumulation.	Involves sensitive species and habitats, and communities needing to treat for turbidity.	Level of risk high for localized effects on species; occasionally severe effects on communities.	**H** for localized effects on wetland, riparian, and aquatic species. **H** for rural community	Water quality is already compromised and impacts are expected to increase. Warming and drying will compound water quality problems. Imperiled species and local communities affected by turbidity in municipal water sources

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and resulting erosion/sedimentation due to fire. Decreased flows in some water bodies will likely result in a higher concentration of pollutants/reduced assimilative capacity.	During some peak flow events, Camptonville's and North Yuba Water District's surface supplies are compromised by turbidity. Drought and higher temperatures are projected to increase and likely will further reduce assimilative capacity and increase water temperatures.			treatment systems (e.g., Camptonville and North Yuba Water District).	are especially sensitive. The level of risk is **high** for imperiled species and occasionally severe for communities.
Flooding					
Infrastructure (water storage and conveyance)					
Water storage infrastructure was designed for historic flow regime, and may not accommodate increased winter peak flows, or have adequate carryover storage for drought periods. The conveyance system was designed for a certain demand, and inadequate peaking capacity may exist during times of extraordinary heat (for irrigation demand). Conflicts over storage may increase among agricultural, domestic, hydropower, flood control, and environmental needs.	Generally, peak flows are only a problem following wet years when reservoirs and groundwater basins are at capacity. Storage capacity varies by facility, from 1.5 to 2 years' capacity; in 2014, many facilities are suffering severe shortages. Severe drought and projected warming and drying will increase these impacts.	Involves critical flood control facilities and could affect vulnerable populations and the agricultural economy.	Level of risk is potentially severe depending on frequency of flood events	**H** for reservoirs with less than 2 years' capacity, and for communities with inadequate backup supply. **M** for New Bullards Bar.	Communities dependent on reservoirs with less than 2 years' capacity are at high risk for public health and safety and economic loss.

Table 11-5. Yuba County IRWMP Climate Vulnerability Prioritization					
Vulnerability	**Likelihood of occurrence: Are climate effects occurring or projected within a 50-year timeframe?**	**Sensitivity Level: Does this involve critical facilities, essential economies, sensitive species and habitats, or vulnerable populations?**	**Level of Risk: Could this involve critical public safety, severe economic or environmental damage, and/or critical facility loss?**	**Priority** **High (H), Medium (M), Low (L)**	**Justification**
Wildfire					
Increased fire frequency, intensity, and duration of the fire season may impact vegetative species composition, especially the size and extent of old-growth habitat and related fauna; impact water quality due to sedimentation; threaten critical facilities located in fire-prone areas; and increase chances for human and economic loss due to development in fire-prone areas. The northern two-thirds of critical facilities are exposed to fire threat hazard; several in the "very high fire hazard" category, including YCWA's Colgate Power House and Narrows #2 Power House (CDF data), and in even-aged clear-cut conifer plantations such as those located north and east of New Bullards Bar.	Up to two-thirds of Yuba County is exposed to increased fire risk from May through October annually, and the fire season has extended in recent years. Wildfire frequency, intensity, and duration are projected to increase during the planning horizon.	Wildfire threatens all sensitivity areas in the foothills.	In the foothills, wildfire threatens homes, critical facilities, habitat, and puts residents at risk.	**H** for foothills and higher elevations.	The region is already experiencing increased wildfire risk, expected to increase over the Plan horizon. Sensitive resources and communities are at **high** risk, particularly in the foothills where homes, critical facilities, and habitats are vulnerable.
Agriculture					
Regional agriculture will likely suffer from the direct climate effects of greater extremes in drought and loss of snowpack, heavier storm events, and temperature extremes. Secondary effects on agriculture	Climate impacts of increased variability in temperature, storm events, and drought are occurring or projected. Both DWR and CVP have	Significant economic losses are likely to occur. Agriculture is the	The level of risk to agriculture is high.	**H**	Level of risk is **high**: Widespread and/or high-value crop losses would affect most sectors of the local and, potentially, statewide economy due to reduced profits, job loss, and

Table 11-5. Yuba County IRWMP Climate Vulnerability Prioritization					
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could include higher costs associated with irrigation, cooling and processing water, reduced viability for heat-sensitive crops, overall crop loss, reduced profits, local and state tax revenues, and employment. Summer irrigation demand could increase if not offset by agricultural water efficiencies, cropping techniques, and change in crop mix.	indicated no water delivery for agriculture in 2014 that will result in crop loss and increased groundwater use. Foothill communities (e.g., Camptonville) have faced summer water shortages during drought conditions; water rationing has been required.	primary economic driver of the region. Could also affect DACs, such as farming and non-English speaking communities.			reduced tax revenues. DACs may suffer the greatest impacts from job loss. Foothill agriculture may suffer the most prolonged effects due to recurring water shortages.
Species and Habitat					
Warming and drying are causing fragmentation and/or degradation of habitat for stream-dependent species and, in particular, species restricted in their ability to move or re-adapt (e.g., amphibians). Increased water temperatures are also affecting aquatic species such as spring-run Chinook salmon. **Increased demand on groundwater may desiccate groundwater-dependent ecosystems.** Greater colonization and numbers of both	Upslope movement of vegetative communities is occurring or anticipated as temperatures rise during Plan horizon. Significant changes in bird distribution and composition (especially wetland-dependent species), and substantial impacts to amphibians are occurring or anticipated during Plan horizon.	Involves sensitive species and federally listed species already at risk.	High level of risk for imperiled habitat and species, especially wetland-dependent, riparian, and aquatic species and habitat.	**H** for severely imperiled habitat and species, especially for wetland-dependent, riparian, and aquatic species. **M** for species and habitat covered by the Yuba Accord.	Climate impacts of increased variability in temperature, storm events, and drought are occurring or projected, and are already impacting habitat and species. Sensitive populations of imperiled species are at **high** risk, especially wetland-dependent, riparian, and aquatic species. **Medium** for species covered by the Yuba Accord. Minimum in-stream flows are routinely met in the Yuba River in compliance with the Yuba Accord and FERC-license conditions. This may be impacted by climate

Table 11-5. Yuba County IRWMP Climate Vulnerability Prioritization					
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terrestrial and aquatic invasive species is expected, favored by warming and drying conditions.					warming and drying, and state water regulations/policies. Research is ongoing to best identify opportunities for improvement.
Public Health and Safety					
Increased potential for risk of flooding, wildfire, and heat waves could result in human and economic losses, with the greatest effects on DACs and under-represented communities.	Flooding, heat waves, and wildfire are projected to increase during the planning horizon. The northern 2/3 of the county's critical facilities are exposed to fire-threat hazard. Development is taking place in fire-adapted vegetation, and flood-prone areas.	Elderly, young, and populations lacking resources or knowledge due to language or economic status are potentially the most vulnerable.	The level of risk is high based on existing and projected intervals and intensities of wildfires, floods, and heat waves.	**H**	Current and projected natural events suggest a high likelihood of occurrence. Sensitivities include geography and location of population and critical facilities. Level of risk is **high** for the economy and public health and safety.
Timber Harvest					
Potential climatic changes are expected to affect type, location, and amount of timber inventories, but may generate need for alternative timber management/production and fuels reduction project **New text –please vet with group.**	Upslope movement of vegetative communities is occurring or anticipated as temperatures rise during Plan horizon.	The timber industry is an important but not primary economic driver.	The timber industry will be affected, but may benefit from added fuel reduction projects.	**M**	The timber industry is important but not a primary economic driver. It will likely be affected, but may also benefit from additional fuel reduction projects. Affects are judged to be **medium**.

Table 11-5. Yuba County IRWMP Climate Vulnerability Prioritization					
Vulnerability	**Likelihood of occurrence: Are climate effects occurring or projected within a 50-year timeframe?**	**Sensitivity Level: Does this involve critical facilities, essential economies, sensitive species and habitats, or vulnerable populations?**	**Level of Risk: Could this involve critical public safety, severe economic or environmental damage, and/or critical facility loss?**	**Priority** **High (H), Medium (M), Low (L)**	**Justification**
Recreation					
Intermittent effects are likely on the region's recreation industry from lower summer flows, both rafting and reservoir-based use.	Low flows have occurred and may increase from warming and drying.	Recreation is an important, but not a primary economic driver. Economic impacts greatest in foothills.	Not a severe level of risk to critical resources.	**M**	Recreational floating and tourism are important drivers of the economy; however, sensitivity factors are low and risk level for damage to critical resources is **medium**.
Hydropower Production					
Climate impacts on high-elevation hydropower production will likely have wide-ranging effects. Climate adaptation will likely require a combination of operating changes to hydrogenation facilities, with secondary impacts to water facilities and delivery; even so, generation losses are probable. Revenue losses from hydropower are projected. Decreased hydropower production coupled with increased summer energy demands could affect the local economy	PG&E currently experiencing hydrogeneration impacts due to drought and projects additional impacts to hydrogenation at some facilities by 2025.	Involves critical facilities. Costs could rise, particularly affecting DACs and the local economy in general.	Medium-term risks to economy; long-term risks from water-supply trade-offs to other sectors.	**M**	Although this may become a high priority vulnerability, the level of risk, timing of risk, and lower sensitivity were judged to make this a **medium** priority at this time. Secondary impacts will occur to DACs in particular and to the local economy in general.

11.4 Adaptive Management Strategies

As discussed above, the identification of regional climate vulnerabilities logically required development of adaptation strategies. The adaptation strategies discussed below were developed to aid the region in becoming more climate-resilient and in fortifying itself against climate impacts. A summarized list of adaptive management strategies is included in **Table 11-4**.

The project team and SEI investigated several avenues to address adaptation approaches for the Yuba County IRWM region: 1) existing strategies employed by entities, agencies, and NGOs; 2) state- and locally generated adaptation strategies that help fulfill water planning goals and mandates; 3) strategies identified during climate Core Group (RDS) participatory exercises; and 4) conversations with stakeholders during the project development process.

Many of the strategies identified in **Table 11-4** are currently underway. For example, YCWA 1) has adopted a Groundwater Management Plan that includes Basin Management Objectives aimed at protecting groundwater quality and quantity, 2) has investigated water conservation credits[43] that induce conservation in irrigation practices, 3) monitors groundwater quality and quantity, and 4) conducts basin water transfers to stabilize regional groundwater.

The region's water delivery system is complex, intertied, and variable, and therefore limited or restricted capacity exists for adaptive management to address projected climate change impacts. Adaptive management usually requires flexible infrastructure and flexible management policies and approaches. Further, higher elevation storage was built with the assumption that snowpack would be a reliable, slow-release "reservoir" lasting through June or July.

Mid-elevation infrastructure is usually built to accommodate multiple management considerations, which could include flood flows, recreational use, municipal/industrial/institutional water supply, agricultural water supply, hydropower needs, and the capacity for pumped storage. While more flexibility may exist here, competition for use may lead to individual sector sacrifice. Infrastructure in lower elevations, below the snow line (about 1,000 feet), may have the greatest potential for adaptive management.

As well, programs to remove sediment to maintain or increase storage capacity are being proposed in SB 848, the Safe Drinking Water, Water Quality and Water Supply Act of 2014, and the Wolk water bond.

11.4.1 Adaptation Strategies Developed by SEI/Climate Core Team

For purposes of future WEAP modeling and to address some of the most pressing climate vulnerabilities in the region, SEI and the Climate Core Group identified several plausible regional adaptation strategies. These strategies may benefit from further refinement during future WEAP modeling under differing

[43] Irrigation Training and Research Center, Yuba County Water Agency Water Conservation Credit Study. Prepared by: Dr. Charles Burt and Monte Solo, California Polytechnic State University, San Luis Obispo, CA (August 2009). Prepared for: Yuba County Water Agency.

climatological, social, and regulatory scenarios. Additional adaptation strategies are included in **Table 11-4.**

11.4.1.1 Water Supply

Additional Storage Projects: Small storage projects, such as suggested on Dry Creek and New York Flat, would offer additional capacity to capture water during big flood events, as well as increase the overall annual storage capacity of the system to increase flexibility of supply and deliver during dry years. However, such infrastructure projects are costly and may disrupt aquatic habitat as well as in-stream flows downstream.

Water Conservation/Recycled Water: Conservation techniques are important strategies in sustainable water management and can often be less costly ways to supplement water supply than constructing new storage infrastructure. One proposed technique within the Yuba basin is the lining of irrigation canals, or converting them to closed pipe conveyances. One such project has already been implemented by the Browns Valley Irrigation District (BVID): construction of the Upper Main Water Conservation Project, which consisted of a new pipeline to convey water that previously would have traveled through the open and unlined Upper Main Canal. An estimated 3,100 af of water was conserved as a result of this project, water that had been lost to evaporation, seepage, and consumptive use by vegetation adjacent to the canal. This extra water is now available for use by BVID, which has proposed a transfer plan of the water in coming years to generate income for the district. This transfer water is exported downstream of the Feather River confluence, and thus contributes to in-stream environmental flows as well, and may be released in a more ecologically advantageous way.

Potential issues with such projects pertain to the cost of implementation, as well as the loss of local groundwater recharge from the seepage in unlined canals. In areas where soils are highly permeable and seepage losses are high, such a project would greatly increase conveyance efficiency, and be a viable option, but the potential impacts on the local water table would need to be well-understood before implementation. In many areas on the valley floor and adjacent to major waterways, where fine-grained alluvial clays are dominant and seepage losses are minimal in unlined canals, such projects may not be a preferable option.

Recycled water is another method of conservation, which may be implemented to achieve multiple benefits. Water may be recycled by municipalities (e.g., by outdoor irrigation/purple pipe systems), or by agricultural members, such as seen in the BVID proposed Agricultural Return Flow Recapturing Project that aims to capture and pump water from Dry Creek just before the confluence with the Lower Yuba River, and potentially achieve benefits for agricultural yield as well as the ecological well-being of the river system.

Other conservation efforts, such as public awareness, restrictions on landscaping, alternative cropping techniques, and on-farm technology (e.g., drip system irrigation) may serve as effective tools in both adding resilience in the face of climate change and changing water-use demands, as well as preventing the need for more storage infrastructure. One compelling example of on-farm conservation is seen in Southern California as part of the Quantification Settlement Agreement, in which the City of San Diego, with its growing urban water demand, offered to fund farm-conservation techniques in the Imperial Valley Irrigation District (IVID). The outcome was that IVID farm production remained constant while requiring less water, with this saved water then transferred to the City of San Diego. Such transfers are becoming increasingly common throughout the state as urban populations grow, and provide opportunities for multi-benefit solutions such as this.

***New Bullards Bar Mid-Level Outlet*:** YCWA is considering retrofitting New Bullards Dam with a new mid-level outlet, which would allow for the faster release of water in the dam in the event of a flood. Currently the dam is required to maintain at least 170 af of empty storage space from September 30 to March 31 due to flood protection concerns. However, if the release capacity were increased, YCWA could potentially capture and store more water, even during the flood season, with the ability to more quickly release water in the event of a flood which threatened dam stability. With spring snowmelt recession making more runoff occur before March 31, when current storage capacity is limited due to these flood space restrictions, it may become increasingly difficult to capture and store enough runoff in New Bullards to meet summer irrigation demands, especially in dry years. Other potential benefits of this project may be the higher potential for water temperature mixing to favor aquatic habitat from dam releases with this new release gate. However, the effects that such an outlet could have upon reservoir release operations may prove harmful for downstream ecosystems, especially if late-winter and early-spring outflows are reduced due to potentially reduced flood-pool requirements.

Dredging Reservoirs: While rates of sedimentation throughout the basin have decreased in recent decades, recent sedimentation studies on Englebright Lake have estimated that more than 25 percent of the reservoir's original storage capacity has been filled in. While the dam itself was originally built to trap sediment, as much of it is highly laden with toxic pollutants (i.e., mercury), it may be beneficial to begin dredging some of this sediment both to increase the storage capacity of the reservoir in the face of changing flood and drought patterns, as well as to begin efforts to remove this toxic material from the system. If future environmental regulations mandate the removal of Englebright Dam, such a process will have to be done to mitigate the effects that sediment would have downstream. However, Englebright is not currently undergoing the FERC-relicensing 2016 process, and such decisions may sooner be influenced by pending Biological Opinions from the National Marine and Fisheries Service.

11.4.1.2 Flooding

***Upgrade Levees*:** As existing levees become older and less stable, FEMA regulations become more stringent, and climate models project larger and more unpredictable flood events, upgrading or replacing existing flood-protection infrastructure is an important piece in integrated management of the region. The main benefits are to human safety and protection of urban and agricultural land. However, older levees tended to be constructed without considering the effects they would have upon the adjacent aquatic habitats, both by channelizing the river, causing incision, and disturbing in-channel habitat, as well as cutting off access to floodplains when high discharges occur. Floodplains are highly productive and nutrient rich environments that are of great benefit to fish and other aquatic species during flood events. Floodplains also serve to buffer high flows. The replacement of existing levees can achieve ecological benefits while providing flood protection. Building set-back levees, while expensive, offers potential long-term benefits for flood protection, groundwater recharge, and the ecosystem.

Headwaters Meadow Restoration: Restoring meadows in the Yuba headwaters region offers similar benefits of flood attenuation by increasing the storage capacity of headwater soils and decreasing the rates of runoff that occur during storms. Historical impairment of these meadows has contributed to downstream erosion, conversion to drier vegetation types, loss of aspen communities, reduced groundwater recharge, decreased ability to filter contaminants (especially from the legacy of gold mining in the region), and decreased base-flows coming from the upper basins, especially in drier months, which will become increasingly problematic as spring snowmelt continues to recede. Restoration of meadow ecosystems improves vegetation conditions and would also likely decrease sedimentation rates downstream, helping to preserve existing storage space in existing storage reservoirs.

11.4.1.3 Wildlife and Habitat

Off-Channel Salmon Habitat: As described in the levee upgrading section, many benefits to the ecosystem may be achieved by increasing access to floodplains and off-channel areas for aquatic species. For example, recent research in California has shown that rice fields adjacent to waterways may be used to simulate floodplains, and provide great opportunities for off-channel salmon rearing and migratory waterfowl habitat, as well as buffering flood-flows. Juvenile salmon reared in these fields exhibit much higher growth rates than those living only in main river channel without access to floodplains. In addition, the waterfowl activity has been shown to assist in the decomposition process of the rice fields. This is an example of an innovative management strategy which provides significant flood, agricultural, and environmental benefits, at a relatively low cost.[44] However, improving access to existing natural floodplains and other side-channel or oxbow channel is the most beneficial strategy to increase access to nutrients and habitat, and should be prioritized before alternatives are explored.

Dam Removal (Daguerre Point): While not under immediate scrutiny in the Yuba Development Project FERC-relicensing process, Daguerre Point Dam has long been a point of contention between environmental advocates and other water users. While providing roughly 15 to 20 feet of head for diversion canals used for irrigation to YCWA member units both to the north and south, the dam obstructs fish passage upstream, with its current fish passage infrastructure deemed largely inadequate by the US Army Corps of Engineers. A number of improvement action alternatives are assessed, including both total removal of Daguerre, as well as less costly measures such as installing a series of step-pool weir structures along the dam in order to improve passage without removing the structure itself.[45] Similar to Englebright Dam, Daguerre Point retains large amounts of potentially toxic sediment that would need to be addressed prior to its removal. It is also cited as being a source of local groundwater recharge through the highly porous sedimentary material of the neighboring Yuba Gold Fields region, and therefore understanding effects upon the local water table would need to be accounted for as well, were this dam to be removed.

11.4.1.4 Fire and Fuels

Fuel Reduction: Removing excess groundcover and vegetation (especially non-native) would benefit both native vegetation populations, as well as reduce the risk of forest fires in the upper parts of the Yuba County IRWM area watershed. As climate patterns become increasingly sporadic, and the risk of larger and more frequent forest fires becomes a real threat, it is essential to think critically about management of excess bio-material in Yuba County forests. In a dry year, excess fuel due to many past years of forest fire suppression, as well as the propagation of non-native vegetation, could result in a devastating fire similar to the neighboring Rim Fire in September 2013. This would have major impacts upon water quality as well as flood abatement, as heavily burned landscapes have very low soil-water storage capacity (due to lack of soil stability, hydrophobicity of certain ash deposits, and the absence of interception and evapotranspiration by plants) and erode easily, greatly increasing the potential for high volumes of rapid runoff that carries large amounts of sediment and increasing the potential for downstream flooding.

[44] Katz, J. The Knaggs Ranch Experimental Agricultural Floodplain Pilot Study 2011-2012 Year One Overview. Center for Watershed Sciences, University of California, Davis & California Department of Water Resources (2012)

[45] Daguerre Point Dam Fish Passage Improvement Project – Alternative Concepts Evaluation, USACE, DWR (September 2003).

11.4.1.5 Socioeconomics

Changing Cropping Practices: Altering cropping practices in the face of changing climate, markets, or regulations can be viewed both as an uncertainty as well as a management strategy. Farmers may begin to shift to more drought-resilient crops as extreme climate events become more common and unpredictable, or if environmental regulations require additional flows be made available for in-stream benefits. In addition, market demands may shift as well as legalities regarding certain crops. These changes could have various impacts upon the water demands of the region's agriculture. However, relatively little cropping shift has occurred in recent years, and further insight from stakeholders is required to identify possible crop-shift scenarios in response to various climate and regulatory uncertainties.

Local Agency and Public Involvement in State Policy and Regulatory Processes: Increasing involvement with regulatory processes and a "place at the table" during state policy discussions, as well as public awareness campaigns to encourage integrated water management outcomes within the Yuba County basin are important methods for influencing relevant water policy. Much of the regulatory uncertainties may be influenced by lobbying or offering constructive/regionally protective solutions for beneficial outcomes, and much of the vulnerability to climatic uncertainties may better be addressed through public awareness and an active citizenry. In addition, future potentially harmful developments such as natural gas exploration may be prevented or better regulated if well-scrutinized and/or addressed by the public.

Increased Monitoring: General monitoring of both surface and groundwater processes and quality is an essential foundation to truly integrated basin management, as it provides transparency as to the actual effects of various physical processes or human activities. Reliable basin-wide data collection is one of the best tools for informing the best management or development strategies, and can help engage the public to participate in their water management as well. Monitoring ecosystem and species response to management actions is equally important as it helps to gauge how management actions are impacting or benefits species and ecosystems that rely on healthy water quality and hydrologic function.

11.5 Strategies Elevated To Programs or Projects in This Plan

Table 13-2 lists the potential climate adapt strategies that could be used to address climate effects within the region. As the Plan progressed, representative projects emerged that address the majority of these listed adaptive strategies, as shown in Chapter 14 *Project Application, Development, and Review*, **Table 14-2**.

These project review criteria within the table were used to evaluate the merit and benefits of proposed projects, and included a criterion that evaluated whether the project would help ameliorate the effects of climate change. All projects listed in this Plan will, to a greater or lesser degree, help reduce climate impacts, and many are likely to reduce GHG emissions.

11.5.1 Risks of the Region Taking No Action

Projected increases in temperature, larger more intense storms, decreased snowpack at lower elevations, earlier timing of spring runoff, increased evapotranspiration, greater occurrence of flooding from higher intensity storm events and greater climate variability, changes in flora and fauna, and increased forest fire risk[46] are all identified as potential regional climate impacts.

Taking no action to curb the climate vulnerabilities identified in this Plan could result in both minor and major climate-related impacts on quality of life, human safety, the local and regional economy, and natural systems and wildlife species. Implementing projects identified in this Plan can enhance resilience (protecting habitat for endangered fish and wildlife), and potentially save lives and property (e.g., flood-mitigation projects).

Actions not taken by the region also affect the remainder of the state. By 2020, projections indicate that water demand in California will exceed supply by more than 2.96 billion cubic meters.[47] Therefore, cumulative water savings and efficiencies effected in the Yuba County IRWM region could contribute to the state's ability to support its citizens and economy. Further, the state has adopted several climate and GHG-reduction goals and objectives to address climate impacts. Failure of the Yuba County IRWM region to contribute toward climate mitigations could reduce the overall ability to meet these goals and objectives and their beneficial outcomes.

11.6 Climate Change Mitigation/Greenhouse Gas Reduction

11.6.1 Mitigation Strategies

California Water Code Section 10504 specifically states that IRWM Plans are required to include GHG emissions of identified programs and projects. As discussed previously, Executive Order S-3-05, and subsequently AB 32 established GHG reduction targets so that by 2050, GHG emissions would be reduced 80 percent from 1990 levels in California. Further, as SB 97 directed lead agencies to determine baseline conditions and levels of significance for GHGs and to evaluate mitigation measures. Lead agencies need to establish these levels of significance (see Section 11.6.3 Environmental Compliance). To comply with these directives, this section discusses relevant measures that can address GHG emissions related to water management in the Yuba County IRWM region.

The Scoping Plan prepared by CARB identifies recommendations relating to different sectors, of which the water supply, sustainable forests, and agriculture recommendations are most relevant to this region. In particular, six GHG mitigation strategies are suggested for the water sector, that if implemented could substantively reduce GHG emissions:

- water use efficiencies;
- water recycling;
- water system efficiencies;
- reuse of urban runoff;
- increased renewable energy production; and
- public good charge.

[46] Ibid.

[47] Mehta, V.K.; V.R. Haden; B.A. Joyce; D.R. Purkey; L.E. Jackson, Irrigation demand and supply, given projections of climate and land-use change, in Yolo County, California (2012). Agricultural Water Management, 117, 70-82 (2013). Available from: www.elsevier.com/locate/agwat

Yuba County water agencies are already responding to the Scoping Plan mitigation measures, in large part through their respective Urban Water Management Plans. These plans contain targets for reducing per capita use over time, and for water system efficiencies.

The largest forest management agencies in the region, the Plumas and Tahoe National Forests, currently consider climate effects on forest management and maintaining opportunities for carbon sequestration to reduce GHG emissions.

CARB strategies associated with agriculture typical of this region include improving fuel efficiency of on-farm equipment, water-use efficiency, and carbon sequestration from restoration of riparian and forested areas. As previously mentioned, a water-use efficiency project, the Upper Main Water Conservation Project, has already been implemented by the BVID. This consisted of a new pipeline to convey water that previously would have traveled through the open and unlined Upper Main Canal. It is estimated that roughly 3,100 af of water was conserved as result of this project, water that had been lost to evaporation, seepage, and by vegetation adjacent to the canal. BVID has proposed a future transfer plan of the conserved water to generate income for the district. This transfer water is exported downstream of the Feather River confluence, and thus contributes to in-stream environmental flows as well.

BVID has also proposed an Agricultural Return Flow Recapturing Project that aims to capture and pump water from Dry Creek just before the confluence with the Lower Yuba River, and potentially achieve benefits for agricultural yield, as well as for the ecological well-being of the river system.

Regional NGOs in cooperation with the US Forest Service have also played a substantive role in stabilizing regional ecosystems that help capture carbon, and thus reduce GHGs. American River Conservancy, South Yuba River Citizens League, and Sierra Streams Institute have accomplished forest restoration and protection projects relevant to this issue.

Moreover, Yuba County's 2030 General Plan Update contains numerous policies that would promote consistency with AB 32 and that may now or in the future overlap with GHG reduction mitigations in this Plan. A snapshot of some of the most relevant policies is displayed below:

- Policy NR7.11: "The County and Yuba County Water Agency should explore opportunities related to future access to hydroelectric power, energy provision; strategic use of local energy resources for employment development, and other programs that have dual environmental-economic benefits."
- Policy NR12: "The County will encourage financing programs designed to facilitate the installation of renewable energy systems, including those that establish a benefit district and allow property owners to repay over the long term through a special assessment on the property tax bill."
- Action NR7.13 addresses energy efficiency in the public realm and includes a statement that, "The County will also consider the feasibility of using fees or actions required to meet County greenhouse gas efficiency policies on a fair-share basis to fund energy efficiency improvements and renewable energy systems in existing developed buildings and the public realm."
- Policy NR132.4: "The County will also encourage the use of recycled water for outdoor irrigation, toilet flushing, fire hydrants; commercial and industrial processes, carwashes, concrete batching, laundromats; dust control; park golf courses and other landscaped areas, and other appropriate water-intensive uses."

- Policy NR12.5 and 12.5 address climate-appropriate landscaping in parks and open spaces and water conservation and efficiencies in all types of new development.
- Policy HS5.1 is a policy encouraging GHG-efficient development patterns and underscores the many policies in the General Plan encouraging efficient land use patterns, minimize travel, and support infill development and protection of agricultural land. Policy HS5.1 states that the county will use its fees and programs to encourage more GHG-efficient development patterns.
- Policy HS5.2 states that, "In evaluating operational emissions of development projects and plans, the county will use a threshold of an annual net increase of 6.4 metric tons of CO2 equivalent per-capita and 4.4 per metric tons of CO2 equivalent per service populations. This threshold does not apply to agricultural operations or processing industrial projects of other types of stationary sources.
- Action HS5.1 says that the county will adopt a plan to reduce GHG emissions.
- Action HS5.2 makes a commitment that the county will meet with local agricultural groups to discuss best practices to reduce GHGs related to agricultural production, and that it will seek funding, such as through carbon offsets, to provide incentives to local producers to participate in consensus GHG reduction.

11.6.2 GHG Reduction Considerations for Project Design and Alternatives

The Yuba County IRWM process used to consider GHG reduction among project alternatives and to mitigate for GHG emissions from projects consisted of a questionnaire to be filled out by project sponsors, based on the level of development of a specific project. Please see Chapter 14 for the project review process.

These initial vetting of GHGs offer a means of considering and incorporating mitigations to reduce projected GHG emissions among project alternatives.

IRWM Guidelines suggest that common emissions sources from projects are related to the following:

- operations of construction equipment;
- passenger vehicle trips during construction and operation;
- transportation of construction materials and equipment;
- transportation of material inputs for O&M;
- transportation of material outputs or production;
- generation of electricity used for operation of projects; and
- waste generation and disposal of materials during construction and operation.

Reduction strategies during project design and project mitigations under California Environmental Quality Act (CEQA)/National Environmental Policy Act review could include any of the applicable measures listed below:

Project construction-related transportation

- Offer local contractor preference and local purchase of construction materials where possible to reduce transportation-related emissions.
- Encourage or require carpooling within construction contracts.
- Encourage use of B20 fuels in construction equipment and other diesel machinery.
- Restrict inappropriate OHV use, particularly in sensitive or restored areas where project investments have been made.

Project construction-related emissions

- Encourage or require recycling of construction waste, such as brick, concrete, lumber, metal, and dry wall, as may be required within Yuba County from the proposed Lumber Waste Diversion Ordinance.
- Pursue projects in this Plan that would use biomass from fuels reduction projects.
- Capture sequestration opportunities with forest, sage-steppe, riparian, and grassland revegetation, stabilization, and restoration projects.

Water supply and water efficiency improvements

- Select project components and upgrades, such as pumps, based on energy efficiency.
- Schedule pumping to reduce peak hour (Noon to 5:00 p.m., highest carbon output) energy use.
- Select projects that offer the best water conservation options among project choices (e.g., greatest reuse/recycling, greatest reduction in leakage or evaporation per mile).
- Install solar generation equipment for pumping and other energy-generation needs to reduce both emissions and long-term O&M costs.
- Increase conservation/reduce water use (and thus the energy and emissions related to its delivery) with increased metering, favorable rate incentives for conservation, and education within utility bills.

11.6.3 Environmental Compliance

Senate Bill 97 directed the amendment of the CEQA Guidelines so that the effects of climate change were incorporated into environmental review. These CEQA guideline amendments became effective in March 2010, and have some flexibility; they allow a lead agency to conduct analyses at their own discretion under consideration of credible evidence. The RWMG will need to document through its project review process that: 1) emissions from a proposed project have been determined, 2) GHG mitigations have been incorporated into the project, 3) the project may help in adapting to climate change over the 20-year planning horizon, and 4) a determination of significance has been made (if available from the lead agency).

In the Yuba County IRWM region, the regulatory agency for air quality is the Feather River Air Quality Management District (FRAQMD). As of the writing of this document, FRAQMD had not yet adopted a significance threshold for GHG emissions against which to analyze projects. However, it is working with other regional air quality agencies to draft a significance threshold that can be presented to its board in fall 2014.[48]

11.7 Climate Change Discussion Elsewhere In This Plan

Climate is addressed in several other sections of this Plan, as appropriate. Please find references to those sections in **Table 11-6**, below.

Table 11-6. Climate Change Discussion Elsewhere in this IRWMP		
Item	Description	Chapter
Region Description	Section 6.6.1 describes anticipated climate impacts and vulnerabilities for the region as derived from the climate assessment in Chapter 11.	Chapter 6
Plan Objectives	Table 12-1 addressed how climate is linked to regional issues and conflicts; section 12.2.2 discusses aligning regional objectives with existing climate policies and regulations; and section 12.2.3 illustrates goals and objectives to address climate vulnerabilities and reduce GHG emissions.	Chapter 12
Resource Management Strategies	Table 13-4 discusses how resource management strategies are considered in light of climate change. Existing and proposed RMSs address water use efficiency, practice integrated flood management, and seek to enhance and sustain ecosystems.	Chapter 13
Project Review Process	Sections 14.1.1.1, 14.4 discuss how climate change is integrated and considered within the project review process, and between project alternatives.	Chapter 14
Local Water Planning	Chapter 10 discusses how available water plans address climate change. Section 10.2.1.3 specifically addresses how involving the City of Wheatland and Yuba County in the RWMG has and will likely elevate the issue of climate change in future water planning.	Chapter 10
Local Land Use Planning	Chapter 10 discusses how available land use and resource management plans address climate change. Section 10.2.1.1 specifically addresses how involving the City of Wheatland and Yuba County in the RWMG has and will likely elevate the issue of climate change in future land use and resource management planning.	Chapter 10
Plan Performance and Monitoring	Section 17.1.2 anticipates that new climate data will emerge in coming years and that the Plan will need to be revised and/or updated in light of that information.	Chapter 17
Coordination	Section 4.2.2 identifies one benefit of coordination as the ability to better manage overall watersheds for climate adaptability.	Chapter 4

[48] Spaethe, Sondra, pers. comm., Air Quality Planner-FRAQMD (February 13, 2014).

11.8 Future Program for Data Gathering and Analysis of Prioritized Vulnerabilities

The Yuba County IRWM proposes a practical and attainable future climate program for enhancing the region's climate resiliency. Implementing the resource management strategies, objectives, and projects proposed in this Plan will help assure regional adaptation to a changing climate. Further, data collection and analysis, information sharing, and GHG reductions related to water agency management and project development are practical responses to ensure the ability of the region to adapt to climate change.

The following program helps assure that the region addresses its highest priority climate vulnerabilities as well as continues to produce high-quality water, reliable water supply, clean hydroelectric energy generation, sustained healthy and diverse ecosystems, and reduced socioeconomic impacts under an altered climate future.

11.8.1 Data Analysis and Information Sharing

The localized effects of climate change will manifest in coming decades, and additional relevant information and data will be generated to supplement this Plan. Therefore, the RWMG will revisit climate projections and data in this Plan and supplement it at appropriate intervals to be determined by the RWMG. Revisions to the Plan will accommodate these new data and studies accordingly. IRWM Guidelines encourage RWMGs to stay involved with the California Natural Resource Agency's California Adaptation Strategy process and to consider joining the California Climate Action Registry at http://www.climateregistsry.org.

New information and climate-related revisions to the Plan will be shared during RWMG meetings, project development processes, and on the Yuba County IRWM website.

11.8.2 Reducing GHG Emissions

Project review criteria included in this Plan will allow project sponsors to incorporate GHG mitigations into project design and implementation. The RWMG will monitor the outcomes of project implementation over time to determine if adaptive management strategies and mitigations appear effective, based on technical input from project sponsors, and if the list of project mitigations can be supplemented as guidance for project development.

Further, as water management agencies implement their respective UWMPs and projects in this Plan, increased water efficiencies, reductions in water use, increased recycling, and other measures to reduce GHGs will likely result.