



Central Valley Regional Water Quality Control Board

Central Valley Region Climate Change Work Plan

Current State of Knowledge & Considerations for Addressing Climate Change

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Acronyms and Abbreviations

AB 32	Assembly Bill 32
BMP	best management practice
BOD	biochemical oxygen demand
CAL FIRE	California Department of Forestry and Fire Protection
CARB	California Air Resources Board
CDFA	California Department of Food and Agriculture
Central Valley Water Board	Central Valley Regional Water Quality Control Board
CNRA	California Natural Resources Agency
CUPA	Certified Unified Program Agencies
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
Delta	Sacramento-San Joaquin Delta
DDW	State Water Resources Control Board Division of Drinking Water
DFA	State Water Resources Control Board Division of Financial Assistance
DWQ	State Water Resources Control Board Division of Water Quality
DWR	California Department of Water Resources
FY	fiscal year
GGRF	Greenhouse Gas Reduction Fund
GHG	greenhouse gas
HAB	harmful algal bloom
ILRP	Irrigated Lands Regulatory Program
IRWM	Integrated Regional Water Management
NPDES	National Pollutant Discharge Elimination System
Regional Water Board	Regional Water Quality Control Board
Resolution 2017-0012	State Water Resources Control Board Resolution 2017-0012: Comprehensive Response Climate Change

San Francisco Bay Water Board	San Francisco Bay Regional Water Quality Control Board
SB 32	Senate Bill 32
SGMA	Sustainable Groundwater Management Act
SNMP	Salt and Nitrate Management Plan
State	state of California
State Water Board	State Water Resources Control Board
SWAMP	Surface Water Ambient Monitoring Program
TMDL	Total Maximum Daily Load
USBR	Bureau of Reclamation
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
WDR	Waste Discharge Requirements
Work Plan	Central Valley Region Climate Change Work Plan
WQO	water quality objective
WWTP	wastewater treatment plants
°F	degrees Fahrenheit

1. Introduction

Over the last century, human activities have released large quantities of carbon dioxide and other greenhouse gases (GHGs) into Earth’s atmosphere, which has driven changes to the global climate. Increased temperatures, reduced snowpack levels, increased frequency of extreme weather events, and rises in sea level have all been observed, and are expected to continue in the future. These changes have and will continue to impact water quality and water supply throughout the Central Valley Region.

While many studies have focused on the impact of climate change on water availability, less attention has been given to the impact of climate change on water quality. The observed and anticipated impacts of climate change will directly impact and potentially degrade the quality of surface water and groundwater. Climate change deserves immediate attention, as scientists now believe that the impacts of climate change are already being observed. The State Water Resources Control Board (State Water Board) is taking an active role in responding to the effects of climate change. *State Water Resources Control Board Resolution No. 2017-0012: Comprehensive Response Climate Change (Resolution 2017-0012)*, which was adopted on 7 March 2017, lays the foundation for a robust response to climate change that is integrated into all State Water Board actions. The planned climate change response includes actions aimed at reducing GHG emissions, improving ecosystem resilience, responding to climate change impacts, and employing sound modeling and analyses to guide decision-making. On September 25, 2012, Governor Edmund G. Brown signed Assembly Bill 685, making California the first state to recognize that “every human being has the right to safe, clean, affordable and accessible water adequate for human consumption, cooking, and sanitary purposes.” The law requires that all relevant state of California (State) agencies consider this statement when revising, adopting, or establishing policies or regulations. As such, protection of the human right to drinking water is an important aspect of *Central Valley Region Climate Change Work Plan (Work Plan)*, and planned actions aimed at mitigating the impacts of climate change will not compromise public access to clean and accessible water. Key focus areas for this *Work Plan* include addressing impacts due to drought and flooding, issues related to groundwater quality, changes in surface water flow and water supply, and impacts on facilities with National Pollutant Discharge Elimination System (NPDES) permits and Waste Discharge Requirements (WDR) permits.

Disadvantaged communities, rural, and low-income populations of the Central Valley Region are especially vulnerable to the impacts of climate change. Water and wastewater infrastructure in these communities is often aging, in need of upgrades, and already facing treatment difficulties that may be exacerbated by climate change impacts. Water supply challenges also exist in many of these communities. During the 2011 to 2017 drought, more than 2,000 domestic water supply

wells went dry in Tulare County alone, denying these residents their right to safe and accessible water. Groundwater tables in many areas remain depressed, and climate change may prompt heavier reliance on groundwater supplies in the future. In response to the over-drafting of groundwater aquifers, the Sustainable Groundwater Management Act (SGMA) was enacted in 2014. SGMA requires local groundwater management agencies to adopt groundwater sustainability plans which include measurable objectives for achieving basin sustainability goals within 20 years of plan implementation. Still, disadvantaged communities will be a focal point of climate change initiatives to ensure that their basic needs are met, and they do not disproportionately bear the burden of climate change.

This *Work Plan* has been prepared to present current and proposed tasks that Central Valley Regional Water Quality Control Board (Central Valley Water Board) is undertaking in response to climate change. Central Valley Water Board programs will assess staffing needs and coordinate efforts with other State and local agencies to ensure successful completion of these tasks. The Central Valley Water Board will also prioritize major efforts that promote climate change resiliency. An approximate timeline is presented for implementation of these efforts.

2. Climate Change in California

The unique climate and topography of California, and the Central Valley in particular, influence how global climate trends are expressed at the regional level. The impacts of climate change on Central Valley Region climate, natural environment, and water resources are discussed in Section 2.1. Central Valley Region surface water and groundwater beneficial uses that may be vulnerable to climate change impacts are discussed in Section 2.2. State-wide climate change response measures being implemented to protect these beneficial uses are presented in Section 2.3.

2.1 Expected Impacts in the Central Valley

The impacts of climate change on the Central Valley Region climate, natural environment, and water resources are discussed below.

2.1.1 Temperature

Climate change models predict that California will experience higher ambient temperatures in the future, while extreme heat events are likely to increase in frequency and duration. The average annual surface temperature in California is projected to increase by between 2 and 5 degrees Fahrenheit (°F) by 2050 and between 4 and 9 °F by 2100, depending on the GHG emissions scenario assumed (California Natural Resources Agency [CNRA] 2009). Within the Central Valley, a median increase in annual temperature of approximately 2 °F by 2025 and 4 °F by 2060 is projected. Climate models project a greater amount of warming during summer months, especially during nighttime, and in the interior regions of California (California Department of Water Resources [DWR] 2016). Heat waves are also expected to increase in frequency, with individual heat waves also showing a tendency towards becoming longer and extending over a larger area (CNRA 2009).

2.1.2 Wildfires

Wildfire frequency and intensity is expected to grow as temperatures increase, snowpack levels drop, and vegetation dries out. In one study, the middle 50% of climate change projections showed State-wide burned area increases of 41% to 69% by 2085 (Westerling et al 2011). An increase in wildfire frequency and magnitude will accelerate the rates of soil erosion, pollutant runoff, and habitat loss. Wildfires are also a source of GHG emissions, fine particulates, and other byproducts which impair air quality.

2.1.3 Precipitation and Snowpack

Most of California’s precipitation falls in the winter as snow. California’s water supply system is dependent on water stored as snowpack, as more than 60% of California’s developed water supply originates in the Sierra Nevada mountain range. Up to 50% of the flow entering the Sacramento-San Joaquin Delta (Delta) also originates in the Sierra Nevada (Sierra Nevada Conservancy 2011).

While there is variability amongst precipitation rate projections, 11 of the 12 precipitation models run by the Scripps Institution of Oceanography suggest a 12% to 35% overall decrease in precipitation levels by mid-century (CNRA 2009). The character of the precipitation is also expected to change, resulting in more frequent rainfall events and less frequent snowfall events (DWR 2016). It was projected that the Sierra Nevada snowpack will experience a 25% to 40% reduction from its historic average by 2050 (DWR 2008). Changes in snowpack and the timing of spring runoff have already been observed in the Sierra Nevada over the past century (Moser et al 2009). Rising temperatures have resulted in more precipitation falling as rain instead of snow, and snowmelt occurring earlier in the spring.

Historically, the most powerful California storms have been warm and wet storms that occur during the winter and produce intense rainfall over large areas. Many of these storms are identified as “atmospheric rivers,” which are characterized by narrow intense bands of water vapor transported in the lower atmosphere. Atmospheric rivers are increasingly understood to be a source of most of the largest floods in California. Over the next century, years with many atmospheric rivers are expected to become more frequent, as is the frequency of storm intensities characterized as “much-larger-than-historical-range” (Dettinger 2011).

2.1.4 Sea Level Rise

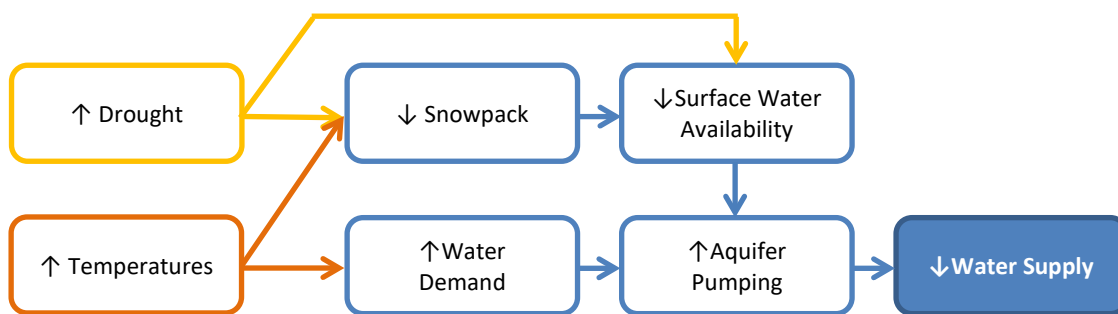
An overall rise in sea levels over time is expected as a function of the thermal expansion of seawater and the melting land-based ice. Sea level rise along the California coast is expected to accelerate during this century. It is projected that sea level rise for the city of San Francisco will be approximately 4.8 to 23.9 inches by the year 2050, and 16.7 to 65.5 inches by the year 2100 (National Research Council 2012). Sea level rise has the potential to inundate previously dry areas, alter the salinity gradient of the Delta, and influence natural tidal variations along the coast (DWR 2016).

The Central Valley Region is especially vulnerable to flooding from sea level rise, as much of the Delta land surface is below sea level (Moser et al 2009). Prior to agricultural development, Delta soils were water-logged and anaerobic. The drainage of Delta lands for agricultural purposes led to the soil aeration, oxidation of soil organic carbon to carbon dioxide, and subsequent

subsidence of Delta lands (USGS 2000). Delta lands are protected from inundation by approximately 1,100 miles of earthen levees (DWR 2010), but rises in sea level would place added stress on the aging levee system. Sea level rise also exacerbates the problem of saltwater intrusion in the Delta. Approximately two-thirds of Californians receive at least a portion of their drinking water from the Delta (USGS 2000), and the majority of the Delta’s land surface is devoted to agriculture, which is also dependent on a reliable freshwater supply and could be threatened by sea level rise and saltwater intrusion (DWR 2017b).

2.1.5 Water Supply

As discussed in Section 2.1.3, most climate change projections show a general drying trend over California, resulting in reduced water deliveries from a decreasing Sierra Nevada snowpack. This trend may lead to water supply reliability risk for agriculture, and more competition among water users (CNRA 2009). To offset diminished surface water supplies, reliance may shift toward groundwater sources. Unfortunately, groundwater sources are already threatened in many parts of California. In 2016, DWR identified several Central Valley groundwater basins as being “critically overdrafted,” indicating that continuation of current water management practices would likely result in significant adverse over-draft related impacts, including seawater intrusion, land subsidence, or chronic lowering of groundwater levels (DWR 2017a). Climate change impacts have the potential to accelerate the trend towards water supply depletion which is already being observed in many parts of the State. For example, even with an increase in rain events, limited recharge areas may mean that there may not be an accompanying increase in groundwater replenishment. A simplified schematic summarizing the anticipated impacts of climate change on Central Valley water supplies is presented below.

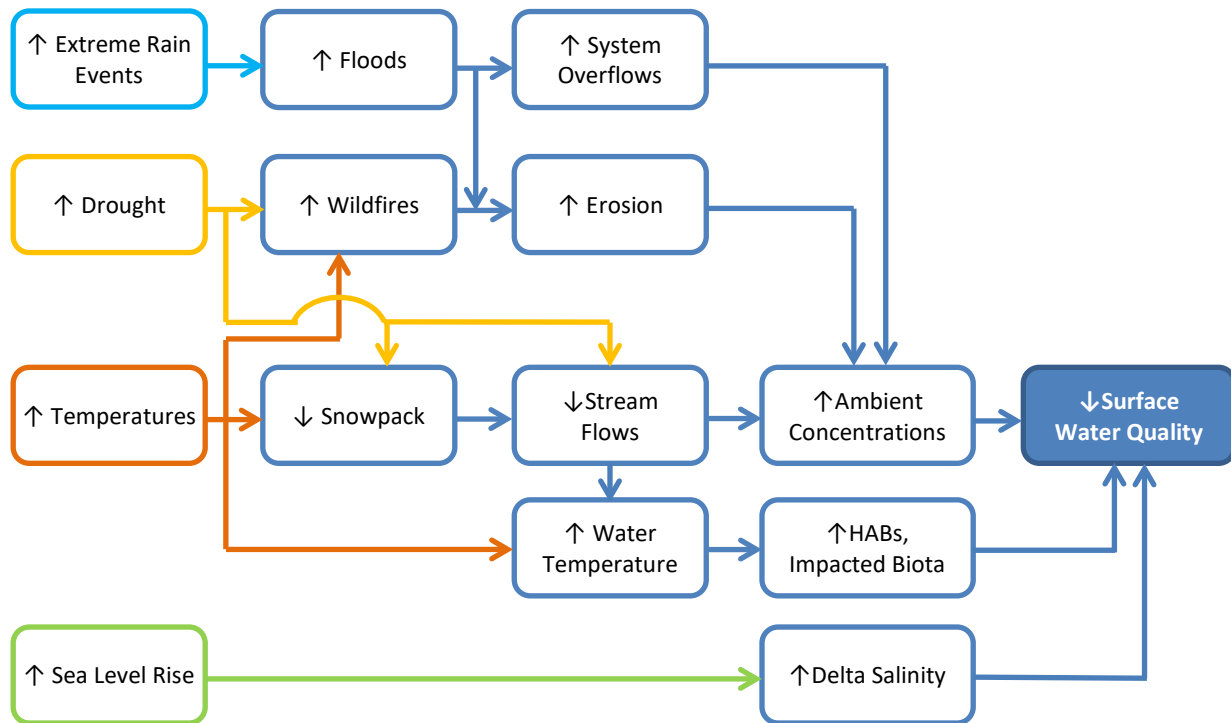


2.1.6 Water Quality

The possible consequences of climate change on California’s water quality are numerous, complex, and often interconnected. The potential impacts of climate change on the physical, chemical, and biological characteristics of surface waters include:

- Higher ambient air temperatures and a greater fraction of Sierra Nevada precipitation falling as rain may reduce stream flows, especially during summer months, which could result in more ephemeral/seasonal streams, warmer waters, greater ambient concentrations of some contaminants, and loss of aquatic habitats. Within the Central Valley, the projected change in water temperature ranges from 1.3 to 2.5 °F by 2025, and 2.9 to 4.9 °F by 2060 (DWR 2016).
- Increased wildfire and flash flood occurrences could amplify soil erosion processes and the transport of sediment and contaminants to surface waters, impacting drinking water supplies, fish spawning, aquatic habitat, and stream channel morphology.
- Heavy precipitation events could overload sewer systems and treatment plants, allowing wastewater to discharge into surface water bodies. Saturated soils could also limit infiltration both from percolation ponds and land application areas.
- Warmer surface waters would be conducive to the growth of cyanobacteria and algae, which could result in harmful algal blooms (HABs) that threaten water quality for recreation, drinking water, and aquatic life by reducing aesthetics, lowering dissolved oxygen levels, and producing toxins. Some cyanobacteria produce cyanotoxins that pose health concerns to humans and their pets and stock animals if present in drinking water supplies and recreational waters, as well as impacts to terrestrial and aquatic wildlife.
- The lower oxygen solubility of warmer waters coupled with the proliferation, and subsequent decomposition, of algae may lead to anoxic surface water conditions which would threaten aquatic species.
- Sea level rise may lead to a loss of freshwater aquatic habitat within the Delta, and a shift towards more salt-tolerant plant and animal communities.
- Increased water conservation leading to decreased dilution and a corresponding increase in the concentration of salts and other constituents.

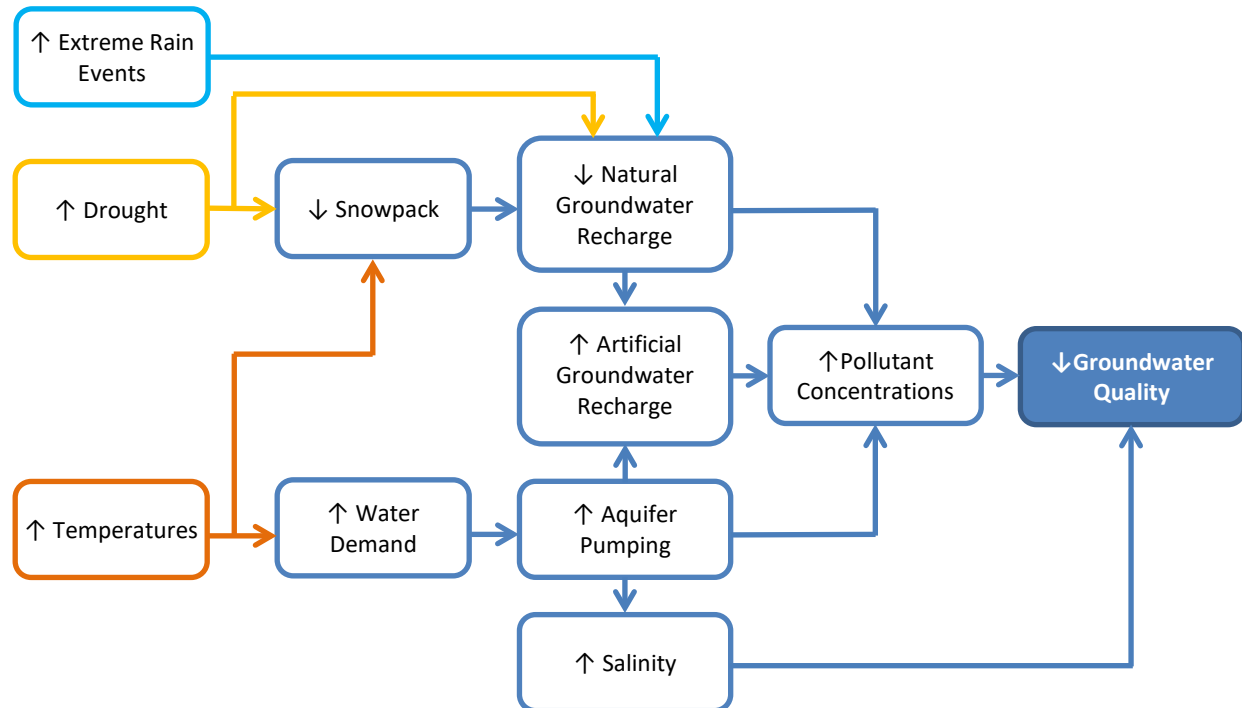
A simplified schematic summarizing some of the anticipated impacts of climate change on Central Valley surface water quality is presented below.



Climate change impacts on groundwater quality are not readily observed but no less prevalent than those on surface waters, and could include:

- The combination of higher temperatures, periods of low precipitation, and the potential higher reliance on groundwater supplies may cause a drop in groundwater tables and concentrating of groundwater contaminants. Higher intensity storm events may lead to more surface runoff and less infiltration and less groundwater recharge. Additionally, more precipitation falling as rain rather than snow could also mean more surface water runoff and less infiltration and recharge. Less recharge would lead to more concentration of contaminants and poorer groundwater quality.
- In an effort to recharge groundwater aquifers, increased application of storm water and/or treated wastewater injection may alter groundwater quality.

A simplified schematic summarizing some of the anticipated impacts of climate change on Central Valley groundwater quality is presented below.



2.2 Beneficial Uses Vulnerable to Climate Change Impacts

Beneficial uses of surface water and groundwater are defined in water quality control plans (i.e., Basin Plans). Each Regional Water Board is required to prepare and adopt a Basin Plan pursuant to California Water Code Section 13240 and supported by the federal Clean Water Act. The Central Valley Water Board has two Basin Plans, one for the Sacramento and San Joaquin River Basins, and one for the Tulare Lake Basin. The latest versions of these Basin Plans are:

- *The Water Quality Control Plan for the California Regional Water Quality Control Board Central Valley Region, The Sacramento River Basin and The San Joaquin River Basin – Fourth Edition (Sacramento/San Joaquin River Basin Plan; Central Valley Water Board 2016); and*
- *Water Quality Control Plan for the Tulare Lake Basin – Second Edition (Tulare Lake Basin Plan; Central Valley Water Board 2015).*

State law defines beneficial uses of California’s waters that may be protected against quality degradation to include (and not be limited to) “...domestic; municipal; agricultural and industrial supply; power generation; recreation; aesthetic enjoyment, navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves”. Protection and

enhancement of existing and potential beneficial uses are primary goals of water quality planning. Surface water and groundwater beneficial uses that may be vulnerable to climate change impacts are presented below. Beneficial use definitions are provided in Appendix A.

2.2.1 Surface Waters

Existing and potential beneficial uses of Sacramento River Basin and San Joaquin River Basin surface waters are presented in Figure II-1 and Table II-1 of the *Sacramento/San Joaquin River Basin Plan*. Similarly, Tulare Lake Basin surface water beneficial uses are identified in Table II-1 of the *Tulare Lake Basin Plan*. Anticipated climate change impacts and surface water beneficial uses threatened by these impacts are summarized in Table 1 and described below in greater detail. Along with the beneficial uses identified below, the MUN (Municipal and Domestic Supply) and AGR (Agricultural Supply) beneficial uses would be threatened by many climate change impacts, as these beneficial uses are sensitive to changes in both surface water supply and quality, and have been designated for surface waters throughout the Central Valley.

- The expected increase in surface water temperatures may endanger fish populations that thrive in cold waters, impacting the COLD (Cold Freshwater Habitat) designation.
- The combination of lower surface water flows and increasing reuse and recycling, increasing pollutant and sediment concentrations, and algae growth (which could bring a decrease in surface water dissolved oxygen levels and increase cyanotoxin levels) could potentially affect the hydrological and chemical quality of the region's streams, lakes and wetlands. These changes would impact several beneficial uses such as MUN, AGR, PRO (Industrial Process Supply), IND (Industrial Service Supply), COLD, WARM (Warm Freshwater Habitat), WILD (Wildlife Habitat), and SPWN (Spawning, Reproduction, and/or Early Development) throughout the Central Valley Region. In the Sacramento and San Joaquin River Basins, the BIOL (Preservation of Biological Habitats) and MIGR (Migration of Aquatic Organisms) beneficial uses would also be impacted.
- Increasing algae growth, potential harmful algal blooms, and decreased surface water flow could impact recreational beneficial uses such as REC-1 (Water Contact Recreational Use) and REC-2 (Non-contact Recreational Use).
- Decreasing surface water flows could result in an increase in ephemeral streams as well as water depths that no longer support NAV (Navigation) uses in the Sacramento and San Joaquin River Basins. Decreasing surface water flows and increases in sediment loadings would also influence reservoir water storage capacity management, which could impact the hydropower generation (POW) beneficial use throughout the Central Valley Region.
- Increasing surface water salinity, combined with lower stream flows limiting the amount of freshwater coming into Delta zones may cause conversions of habitat types (e.g.,

estuarine habitats to marine habitats) and/or loss of freshwater wetland habitats. These ecological changes could impact beneficial uses such as WILD and SPWN throughout the Central Valley Region, along with the BIOL and MIGR beneficial uses in the Sacramento and San Joaquin River Basins.

- In the Tulare Lake Basin, the RARE (Rare, Threatened, or Endangered Species) beneficial use is also expected to be impacted by the anticipated surface water and habitat impairments described above.
- In the Tulare Lake Basin, changes to water quality and supply are also expected to impair the GWR (Ground Water Recharge) and FRSH (Freshwater Replenishment) beneficial uses.

A summary of anticipated climate change impacts and surface water beneficial uses threatened by these impacts is presented in Table 1.

BENEFICIAL USES	Increased Temperature	Reduced Flow Rates	Increased Discharge Concentration	Increased Algae Growth	Increased Salinity
ENTIRE CENTRAL VALLEY					
MUN	X	X	X	X	X
AGR	X	X	X	X	X
IND		X	X	X	X
PRO		X	X	X	X
POW		X			
REC-1		X	X	X	
REC-2		X	X	X	
COLD	X	X	X	X	X
WARM		X	X	X	X
WILD	X	X	X	X	X
SPWN	X	X	X	X	X
SACRAMENTO AND SAN JOAQUIN RIVER BASIN ONLY					
BIOL	X	X	X	X	X
MIGR	X	X	X	X	X
NAV		X		X	
TULARE LAKE BASIN ONLY					
RARE	X	X	X	X	X
GWR		X	X	X	X
FRSH		X	X	X	X

Table 1. Summary of anticipated climate change impacts on surface water beneficial uses

2.2.2 Groundwater

Existing and potential beneficial uses of Sacramento River Basin and San Joaquin River Basin groundwater and Tulare Lake Basin groundwater are presented in Chapter II of their respective Basin Plans. Unless otherwise designated by the Regional Water Board, all groundwater in the three basins is considered suitable or potentially suitable, at a minimum, for the MUN, AGR, IND, and PRO beneficial uses. The REC-1, REC-2, and WILD beneficial uses have also been identified for groundwater within portions of the Tulare Lake Basin. Table II-2 of the Tulare Lake Basin Plan presents the beneficial uses of groundwater that existed as of 1993.

All of these beneficial uses are dependent on groundwater supply. In many climate change scenarios, drought conditions are expected to become more frequent, and diminishing surface water supplies are expected to result in increased groundwater pumping. These conditions would threaten groundwater supplies, and consequently, the MUN, AGRI, IND, and PRO beneficial uses. As discussed in Section 2.1.4, climate change impacts are also expected to influence groundwater quality by reducing groundwater recharge, and concentrating pollutants. The MUN, AGR, and PRO beneficial uses are dependent on water quality, and therefore would be impaired by these changes.

A summary of anticipated climate change impacts and groundwater beneficial uses threatened by these impacts is presented in Table 2.

	Declining Water Tables	Increased Salinity	Increased Artificial Recharge
ENTIRE CENTRAL VALLEY			
MUN	X	X	X
AGR	X	X	X
IND	X	X	X
PRO	X	X	X
TULARE LAKE BASIN			
REC-1	X	X	X
REC-2	X	X	X
WILD	X	X	X

Table 2. Summary of anticipated climate change impacts on groundwater beneficial uses

2.3 State-Wide Climate Change Response Measures

The State Water Board’s *Comprehensive Response – Climate Change (Resolution 2017-0012)* was adopted on March 7, 2017 to lay the foundation for a robust response to climate change that is integrated into all State Water Board actions. The planned climate change response includes actions aimed at reducing GHG emissions, improving ecosystem resilience, responding to climate change impacts, and ensuring that decisions are made using sound modeling and analyses. *Resolution 2017-0012* compels response actions from the State Water Board with support from the Regional Water Boards. These response actions include collaboration with, and support of, climate change response efforts being driven by other agencies including the United States Environmental Protection Agency (USEPA), California Air Resources Board (CARB), Department of Resources Recycling and Recovery (CalRecycle), and others. Ongoing climate change response initiatives are presented below.

2.3.1 Greenhouse Gas Reduction

Select state-wide initiatives aimed at mitigating the impacts of climate change by reducing GHG emissions are summarized below.

2.3.1.1 Assembly Bill 32 and Senate Bill 32

Assembly Bill 32 (AB 32), which was signed into law on September 27, 2006 and is also known as the California Global Warming Solutions Act of 2006, requires California to reduce its GHG emissions to the 1990 level by the year 2020. This emissions level would represent approximately a 30% reduction as compared to the GHG emission level under the “business as usual” scenario. Pursuant to AB 32, CARB adopted regulations to achieve the maximum technologically feasible and cost-effective GHG emission reductions. CARB’s strategy for reducing emissions is outlined in a scoping plan which is required to be updated at least every five years. The first scoping plan, titled *Climate Change Scoping Plan: A Framework for Change* (CARB 2008) was finalized in December 2008, and the first update was approved in May 2014. The scoping plan proposed to reduce GHG emissions through a combination of policies, planning, direct regulations, market approaches, incentives, and voluntary efforts.

Senate Bill 32 (SB 32), which was signed into law on September 8, 2016, a decade after AB 32, requires CARB to ensure that statewide GHG emissions are reduced to 40% below the 1990 level by 2030. SB 32 states that GHG reductions are critical for protection of all areas of the State, but especially for disadvantaged communities, which are often disproportionately impacted by climate change. Accordingly, SB 32 requires that the emissions goal be achieved “in a manner

that benefits the state’s most disadvantaged communities and is transparent and accountable to the public and the Legislature.”

2.3.1.2 Healthy Soils Incentive Program

In September 2016, the California Department of Food and Agriculture (CDFA) was appropriated \$7.5 million from the Greenhouse Gas Reduction Fund (GGRF) to develop and administer the Healthy Soils Incentive Program. The Healthy Soils Incentive Program will be designed to provide incentives to farmers and ranchers to build soil carbon and reduce GHG emissions from agricultural land. The program will provide growers with a list of practices that have quantifiable GHG reductions so growers can choose which practice to implement and obtain financial incentives for that implementation. GHG reduction quantification will be determined by a methodology developed by the California Air Resources Board.

In June 2017, CARB finalized the quantification methodology for the Healthy Soils Incentive Program. The program utilizes two tools for quantifying the benefits from various farm management practices in terms of carbon sequestered and GHG emissions reduced:

- *Comet-Planner*: This tool was developed by the United States Department of Agriculture (USDA) in collaboration with Colorado State University. Program applicants use Comet-Planner to quantify the benefits from various land management practices, including those that sequester carbon in above-ground biomass.
- *Compost-Planner*: This tool was created by CARB to allow program applicants to estimate the benefits of specific composting applications that are appropriate for California cropland and/or grassland.

Both of these tools rely on emission reduction coefficients using the DeNitrification-DeComposition Model, a biogeochemical model that was developed at the University of New Hampshire Institute for the Studies of Earth, Oceans, and Space.

2.3.1.3 Water - Energy Nexus

In the water sector, fossil fuel-based energy is often used for water and wastewater conveyance and treatment. GHG emissions can be reduced by replacing fossil fuels with renewable energy, improving system efficiency, and enhancing water conservation. Many water and wastewater agencies have already reduced their carbon footprint by utilizing renewable sources of energy and encouraging their users to be water efficient. The use of recycled water, increased system efficiency, and energy capture from wastewater streams have the potential to further reduce GHG emissions in the water sector.

Climate change has the potential to impact both the supply of, and demand for, energy in California. As discussed in Section 2, the Central Valley climate is expected to become warmer and have fewer “wet” years in the future. These changes may reduce the average stream flow entering reservoirs upstream of hydroelectric power stations, which in turn would reduce the long-term rate of power generation. Concurrently, a warmer climate may increase the demand for water and power, further intensifying our reliance on fossil fuels and other non-hydroelectric forms of energy. Water managers must consider the effect of climate change on stream flows and energy demands to optimize the operation of hydroelectric systems.

2.3.2 Adaptation

This *Work Plan* builds on several ongoing initiatives to adapt to the impacts of climate change and ensure protection of human health and the environment. Existing adaptation-focused initiatives are summarized in the following sections.

2.3.2.1 Safeguarding California

Executive Order S-13-08, which was issued in November 2008, directed the California Natural Resources Agency (CNRA) to develop a state climate adaptation strategy in coordination with local, regional, state, and federal public and private entities. In response to Executive Order S-13-08, the CNRA issued the *2009 California Climate Adaptation Strategy* (CNRA 2009), which established a proactive foundation for climate change adaptation and prioritized specific vulnerabilities and adaptation needs. In July 2014, the CNRA issued its first update of this report, titled *Safeguarding California: Reducing Climate Risk* (CNRA 2014). This report highlighted climate risks for nine sectors of California, including agriculture, public health, energy, and water. The report also discussed climate change impact mitigation progress to date, and proposed realistic sector-specific recommendations for future work. An update to this plan is currently being prepared. In addition to these documents, CNRA issued the 2016 *Safeguarding California: Implementation Action Plans* (CNRA 2016) which consisted of ten implementation plans to serve as a blueprints for executing the actions recommended in the 2014 *Safeguarding California: Reducing Climate Risk* report.

2.3.2.2 Cal-Adapt

Cal-Adapt is a web-based resource for visualizing local risks posed by the projected consequences of climate change, including extreme heat, sea level rise, snowpack, wildfire, and drought. The development of Cal-Adapt was a recommendation in the *2009 California Climate Adaptation Strategy* (CNRA 2009), which called for a “Web site that will synthesize existing California climate change scenarios and climate impact research and to encourage its use in a way that is beneficial

for local decision-makers.” Cal-Adapt was developed by the University of California at Berkeley’s Geospatial Innovation Facility with funding and advisory oversight by the California Energy Commission. The Cal-Adapt climate tools show projections for two possible climate futures, one in which GHG emissions peak around year 2040 and then decline, and another in which emissions continue to rise through the 21st century. Users can view potential future trends in temperature, extreme heat frequency, sea level rise, snowpack, and wildfire area under the two emissions scenarios for user-selected locations throughout California. The Cal-Adapt climate tools are supported by peer-reviewed research which has been downscaled to California’s geography to allow planners to identify potential climate impacts in their particular area, and assess local vulnerabilities to those impacts. Once those vulnerabilities are assessed, response strategies can be developed to more effectively respond to potential climate change impacts.

2.3.2.3 Vulnerability Assessments

The State Water Board Division of Drinking Water (DDW), Division of Financial Assistance (DFA), and Division of Water Quality (DWQ) are taking steps to identify and protect vulnerable communities and water systems. As outlined in *Resolution 2017-0012*, by 1 July 2018, DDW shall begin including climate change vulnerability assessments in community water system sanitary surveys, and shall encourage drinking water systems to use USEPA’s Climate Resilience Evaluation and Awareness Tool, or a comparable approach, to identify vulnerabilities to climate change impacts. DDW will work with DFA to provide technical assistance and financial support to protect drinking water systems that have been identified as being highly vulnerable to climate change impacts. DDW will also begin using climate change projections during the siting process for any new drinking water systems. Finally, DWQ is working with the Regional Water Boards to make recommendations regarding the need to modify permits and other regulatory requirements to reduce the vulnerability of water and wastewater infrastructure to flooding, storm surges, and sea level rise.

2.3.2.4 Risk Assessment and Adaptation Planning

The United States Department of the Interior, Bureau of Reclamation (USBR), has conducted several studies evaluating the potential impacts of climate change on the Central Valley environment, water supply, and socioeconomic conditions, along with potential adaptation/mitigation strategies. These studies include:

- *West-Wide Climate Risk Assessments: Bias-Corrected and Spatially Downscaled Surface Water Projections*. USBR 2011.
- *Summary Report: Central Valley Project Integrated Resource Plan*. USBR 2013.

- *West-Wide Climate Risk Assessments: Sacramento and San Joaquin Basins Climate Impact Assessment*. USBR 2014.
- *Sacramento and San Joaquin Rivers Basin Study*. USBR 2016.

As part of these studies, the USBR works with other federal agencies, states, tribes, non-governmental organizations, and local partners to identify strategies to adapt to, and mitigate, current and future water supply and demand imbalances. The 2016 *Sacramento and San Joaquin Rivers Basin Study* builds upon previous USBR studies by refining climate projection methods, improving modeling, and incorporating new climate projections from the Coupled Model Intercomparison Project Phase 5 into their assessment.

2.3.2.5 Sustainable Groundwater Management Act (SGMA)

In September 2014, Governor Edmund G. Brown signed the Sustainable Groundwater Management Act (SGMA) to establish a framework for sustainable local groundwater management and to provide authorities for local agencies to directly manage groundwater resources. SGMA requires local agencies in medium- to high-priority basins to adopt groundwater sustainability plans, which include measurable objectives for achieving basin sustainability goals within 20 years of plan implementation. Groundwater sustainability plans must account for population growth, climate change, and sea level rise over a 50-year planning and implementation period. In instances where local management efforts are unsuccessful, SGMA allows the State Water Board the authority to develop and adopt an interim plan to protect local groundwater resources. Upon passage of SGMA, DWR launched the Sustainable Groundwater Management Program to implement the law and provide ongoing support to local agencies around the state.

The Uncodified Findings section of SGMA states “When properly managed, groundwater resources will help protect communities, farms, and the environment against prolonged dry periods and climate change, preserving water supplies for existing and potential beneficial use.” As such, local agencies are encouraged to consider climate change impacts during groundwater management planning, and groundwater sustainability efforts are expected to function symbiotically with climate change mitigation initiatives.

2.3.2.6 Integrated Regional Water Management

Integrated Regional Water Management (IRWM) is a collaborative effort, led by regional water managers, to identify and implement water management solutions on a regional scale. These solutions aim to ensure reliable water supplies, improved water quality, environmental stewardship, efficient urban development, protection of agriculture, and a strong economy. The

fundamental principle of IRWM is that regional water managers, who are organized into regional water management groups, are best suited and best positioned to manage water resources to meet regional needs. DWR provides technical support to IRWM regional water management groups. IRWM was officially established in 2002 through the passage of the Integrated Regional Water Management Planning Act (Senate Bill 1672). Funding for IRWM comes from bond acts approved by California voters that have totaled approximately \$1.5 billion. To date, 49 IRWM regions have been established, which account for approximately 87% of the State's land area and 99% of its population.

3. Regional Water Board Considerations for Addressing Climate Change

This section presents current and proposed efforts that Central Valley Water Board programs are undertaking in response to climate change. Additional program information, including each program's goals, staffing, and performance targets may be found in the annual program fact sheets, which are available on the Central Valley Water Board website.

3.1 Planning

The planning program involves various activities that include: planning, data collection, and stakeholder engagement to ultimately support the development of surface water and groundwater regulatory standards, policies and guidance documents that protect and enhance existing and potential beneficial uses. Climate change adaptation and mitigation will be considered as part of future planning and guidance efforts.

3.1.1 Basin Planning

Basin Plans provide the foundation for all Central Valley Water Board regulatory actions by identifying surface water and groundwater beneficial uses, water quality objectives (WQOs), implementation actions to achieve WQOs, and monitoring programs to ensure that implementation actions are effective. The Central Valley Water Board has two Basin Plans, one for the Sacramento and San Joaquin River Basins, and one for the Tulare Lake Basin. The current versions of these Basin Plans are identified in Section 2.2.

The current Basin Plans do not contain policies that explicitly address climate change; however, since 2010 Basin Plan amendments must evaluate impacts of greenhouse gases and climate change as part of the environmental review process. Examples are recent amendments (Variance Policy and Salinity Control Program for the Lower San Joaquin River) that considered the impacts of drought and water conservation when setting and determining compliance with water quality objectives. It is also recognized that changing conditions will impact existing and potential beneficial uses (as noted in Section 2.2) and thereby alter the foundation of the Basin Plans.

The triennial review is a public review process that is conducted once every three years to identify and prioritize actions needed to address water quality concerns and maintain the effectiveness of the Basin Plan. The next triennial Basin Plan review, which is scheduled for 2018, will include proposed planning activities related to climate change. Examples of climate change-related concerns that may be considered for future action as part of the Basin Plan review process include:

- Develop a definition that will account for water quality changes from climate change in a manner consistent with state and federal law when developing basin plan amendments;
- Account for drought and water conservation impacts in setting of water quality objectives: determine if current regulatory measures are deterring conservation and whether the Basin Plan should be amended to remove or ease impediments to conservation (related to CV-SALTS);
- Evaluate temperature criteria to determine what surface water temperatures are achievable, in the face of climate change. This may lead to changes in basin plan requirements including development of temperature objectives;
 - Supported by two new contracts (2017) with the University of California Davis and University of California Santa Cruz;
- Re-designate/refine/define certain beneficial uses if climate change impacts permanently or seasonally alter the beneficial uses that can be supported in a given basin (e.g., limited MUN and/or AGR uses; removal of COLD);
- Prioritize areas to protect certain beneficial uses that are especially climate-sensitive, such as COLD; this would involve coordination with other agencies that control water rights and flow, along with the development of numeric temperature water quality objectives;
- Develop a wetland/floodplain protection and restoration policy that balances water quality and buffering improvements with management to reduce potential methyl-mercury production related to disturbances in wetland sediments;
- Develop policy to protect headwaters and riparian areas to limit future sedimentation; and
- Streamline the permitting and review process for groundwater recharge projects (linked to CV-SALTS).

3.1.2 Total Maximum Daily Loads (TMDLs)

The Total Maximum Daily Loads (TMDL) program establishes maximum allowable pollutant loading rates (i.e., TMDLs) for impaired water bodies to ensure that WQOs are achieved and beneficial uses are protected. The program identifies background loading rates and allocates the remaining allowable pollutant load among dischargers to the water body.

As discussed in Section 2, average surface water flows may decrease in the future, reducing available dilution and assimilative capacity and thereby altering the allowable pollutant load. There will also, likely, be more frequent occurrences of periodic high flows. Changes to surface water temperature, dissolved oxygen, and turbidity are also possible. Observed changes in surface water characteristics may require TMDL program staff to:

1. Re-open and update existing TMDLs and control programs to account for changing conditions;
2. Update the definition of “background conditions” based on observed changes in ambient surface water characteristics; or
3. Expand the list of water bodies classified as “impaired” based on current program guidelines.

If changes to surface water body conditions are observed over time, updates to TMDL values may be needed to maintain WQOs, or site specific objectives would need to be considered to improve program responsiveness to changing environmental conditions. For flexibility, most major control programs include set review periods and “re-opener clauses” to allow adjustments. Planning assessment periods have been lengthened so that observed environmental variability can be better understood and incorporated into TMDL planning. Each Triennial Review identifies current, upcoming and long-term Control Program evaluations commitments identified in each Basin Plan.

A continuing need for the TMDL and all planning programs is a comprehensive, reliable and accessible water quality database developed in collaboration with the Surface Water Ambient Monitoring Program (SWAMP) to ensure that the appropriate monitoring is conducted to fully understand changes to ambient surface water body conditions.

3.1.3 Delta Program

Central Valley Water Board Delta Program staff work with staffs of the San Francisco Bay Regional Water Quality Control Board (San Francisco Bay Water Board) and State Water Board to develop strategies for addressing impacts to beneficial uses in the Delta. In 2008, the State Water Board, San Francisco Bay Water Board, and Central Valley Water Board jointly adopted the *Strategic Workplan for Activities in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (State Water Board 2008), which described the actions the Water Boards would complete to protect beneficial uses of water in the San Francisco Bay/Sacramento-San Joaquin Delta, and provided timelines and resource needs for implementation. In 2014, the Central Valley Water Board prepared the *2014 Delta Strategic Work Plan* (Central Valley Water Board 2014) to provide updates on work proposed in 2008, and to present new projects recommended by the Central Valley Water Board and Delta Stewardship Council. Implementing the 2014 Delta Strategic Plan was identified as one of the highest priorities during the most recent Triennial reviews. Two of the nine projects identified have a direct nexus to impacts from climate change: developing the Delta Nutrient Research Plan; and developing and implementing a sustainable Regional Monitoring Program.

The Delta Nutrient Research Plan is currently being developed by the San Francisco Bay Water Board staff, stakeholders that include university scientists, and Central Valley Water Board staff. The Plan is a study to determine whether nutrient objectives are needed to protect beneficial uses in the freshwater Delta. It specifically focuses on drivers that are influencing increased production of blue-green algae and macrophytes, shifts in algal species composition to those less nutritious for aquatic herbivores and decreased oxygen concentrations in back sloughs in the eastern Delta. The Plan has focused extensively on the drivers of harmful/toxic algal blooms so that their occurrences can be better predicted and mitigated. An over-arching research recommendation is the development of mathematical models that will assist in further testing relative impacts of various drivers, including of climate change scenarios and possible management strategies. During 2017, discretionary funding was secured to begin linking various modeling efforts between San Francisco Bay and the Delta to determine the role of nutrients in the changing environment.

The Delta Regional Monitoring Program (RMP) initiated its third year of sampling in 2017 and is developing a nutrient monitoring program to help support the Delta Nutrient Research Plan. In addition, the RMP provides baseline information for general chemistry, mercury, pesticides, toxicity and other constituents. The RMP effort is critical to provide trend information over time as a self-sustaining entity that coordinates monitoring in the Delta so that water quality conditions can be efficiently assessed and regularly reported. The information will support modeling efforts and track changing conditions.

Anticipated climate change impacts to Delta surface water include changes in water temperature, dissolved oxygen, and algae growth (Section 2.2.1). Sea level rise will inundate new areas and influence salinity gradients. Sea level rise coupled with more extreme coastal storms will result in increased flooding in the Delta. Changes in precipitation patterns will influence the timing and flow rates of freshwater inputs to the Delta. In response to these changes, wetland restoration projects to protect areas serving as wetland habitat and GHG sinks as well as tidal wetlands to ameliorate rising sea level are being promoted. Rising sea levels and changes in precipitation patterns and flooding will alter the characteristics, locations, and seasonality of wetlands. These environments are also known to increase production of methyl-mercury, which accumulates in the food web, thus making top trophic level fish unsafe for human and wildlife consumption. Additional wetland habitats could increase methylmercury concentrations in Delta and other fish. Currently there are several fish consumption advisories informing subsistence and recreational fishers about safe fish consumption rates of locally caught fish. In addition there is an extensive Mercury Exposure Reduction Program (MERP), as part of the Delta Mercury Control Program, to educate Delta fish consumers about safer species to eat and which fish to avoid. Central Valley Water Board staff is coordinating with fisheries agencies, California Department of

Water Resources and US Bureau of Land Management to identify management practices for various wetland and tidal environments to reduce methyl-mercury production. Results from the management practices review will be linked to mitigation measures as part of the water quality certification program for the development of new habitat. However, there have not been a sufficient management practices developed to date to address the multiple types of wetlands and their specific habitat requirements. Therefore, more research is needed to develop additional feasible and implementable methylmercury management practices to reduce methylmercury discharges from wetlands. As described in Section 3.1.1, there may also be a need to work through the Basin Planning process on wetland protection and restoration issues.

3.1.4 Surface Water Ambient Monitoring Program (SWAMP)

SWAMP was created to fulfill the legislative mandate for a unifying program that would coordinate all surface water quality monitoring conducted by the State Water Board and Regional Water Boards. SWAMP conducts water quality monitoring directly and through collaborative partnerships. Surface water monitoring data collected by SWAMP will be a critical component in monitoring climate change impacts on surface water conditions. In 2016, SWAMP staff was trained in identifying and sampling toxic algae such as cyanobacteria. SWAMP staff will work with the State Water Board to conduct initial algal bloom response monitoring, as needed, in the future. During the 2017/2018 fiscal year, Central Valley Water Board SWAMP staff will develop a discretionary funds contract to establish sentinel non-perennial stream monitoring sites in the Sierra Nevada foothills to monitor reference conditions. Monitoring non-perennial streams will allow for evaluation of how varying flow conditions affect biology and water quality, an important consideration for climate change. Data collected will include bioassessment, physical habitat and wetland condition, basic chemistry, continuous temperature, and targeted flow information. This project will build on work done at USEPA Region 9 to validate that SWAMP bioassessment tools can be used in non-perennial streams and will augment the statewide Reference Condition Management Program. Information from this project will support the objectives of this *Work Plan*, as well as development of a State-wide biological integrity assessment implementation plan and SWAMP's assessments of ecological condition. In coordination with this effort, SWAMP is also planning to deploy continuous temperature loggers in several headwater streams to monitor temperature trends and evaluate whether the streams are protective of cold water habitat.

Since climate change is expected to have an impact on reference and background conditions of surface waters, SWAMP's monitoring approach will need to be adjusted in the future to ensure that any changes in key climate change indicators (e.g., temperature, flow rate, salinity, dissolved oxygen, etc.) are captured in their dataset. This data will help planners better quantify how background conditions are evolving and what impact these changes might have on beneficial

uses. In the future, SWAMP may need to expand available laboratory resources so that chemical and biological surface water changes can be examined more thoroughly.

3.1.5 Central Valley Salinity Alternatives for Long-Term Sustainability Program (CV-SALTS)

The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) initiative is a stakeholder-driven effort that was initiated in 2006 to develop a sustainable Salt and Nitrate Management Plan (SNMP) for surface and groundwater throughout the entire Central Valley. The SNMP addresses the legacy of salt and nitrate accumulation in soil, groundwater, and surface water in the region. The SNMP was submitted to the Central Valley Water Board in December 2016, and appropriate recommendations will ultimately be incorporated into the Basin Plans as an amendment. The SNMP has three primary goals:

1. Ensure a safe drinking water supply;
2. Achieve balanced salt and nitrate loading; and
3. Implement managed aquifer restoration.

Salt and nutrient management is a critical issue now with impacts to drinking water supplies and agricultural land going out of production and will become especially critical in the future if decreases in water supply continue to be observed. As a long term program, CV-SALTS is considering climate change as part of its planning process. The strategies for managing salt and nitrate prioritize shorter term actions to ensure safe drinking water including short and long-term alternative supplies, with a recognition that achieving balance and restoring impacted water ways will require long-term commitments. The strategy allows resources to focus on public health concerns first as the longer term solutions are developed.

Climate change impacts influenced CV-SALTS planning including potential increased drought frequency and reduced freshwater flows, which in turn lead to expanding reuse and conservation. In response to these conditions, CV-SALTS prepared a Conservation and Drought Policy to guide salt and nitrate management during extended dry periods. The recommended policy provides the Board flexibility to evaluate water quality conditions over a longer time period to balance erratic water year types and balance the need for conservation with short-term compliance. Revisions to the Variance and Exceptions policies are also being recommended to support the flexibility as long as the discharger is actively engaged through CV-SALTS in developing the long-term solutions.

Receipt of the recommended strategies and policies was formally acknowledged by the Board in March 2017, and staff was directed to develop basin plan amendments to incorporate appropriate elements into both Basin Plans. The development is ongoing with consideration of amendments by the Board anticipated in 2018. Some key recommendations include:

- Nitrate Management Strategy (Groundwater)
 - Prioritization of groundwater basins exceeding drinking water standards
 - Ability to address issues at a management zone scale rather than permit by permit
 - Early Action Plans to provide short-term safe drinking water supplies as long-term solutions/supplies are developed
- Salt Management Strategy (Surface and Groundwater)
 - Compliance flexibility if dischargers participating in Prioritization/Optimization Study for long-term solutions
 - Requires continued implementation of salinity minimization plans
 - Includes identification of salt management areas; feasibility study of a regulated brine line; and alternatives for areas that could not be reasonably served by a regulated brine line
- Development of salinity/nitrate monitoring network (Surface and Groundwater)
- Coordination with SGMA Groundwater Management entities (Groundwater)

3.2 Surface Water Regulation

As discussed in Section 2, the potential impacts of climate change on surface water bodies are varied and interconnected. Across surface water programs, there may be tension between state and federal interpretations of if and how to account for climate change. The following sections discuss how climate change is impacting surface water regulatory programs, how the programs are adapting to these impacts, and steps that may be taken to enhance program response.

3.2.1 National Pollutant Discharge Elimination System (NPDES)

The National Pollutant Discharge Elimination System (NPDES) program is a federal program that has been delegated to the State for implementation by the State Water Board and the Regional Boards. The NPDES program regulates point sources that may discharge pollutants to surface waters of the United States. Discharges are regulated via individual and general permits, which include requirements related to discharge flow rate, pollutant concentrations, and discharge monitoring.

Climate change impacts are expected to influence the flow rate, temperature, turbidity, salinity and other characteristics of Central Valley surface waters. This will impact the environment and

potentially humans who rely upon the water for potable uses, boosting the importance of the data collected by the Delta Regional Monitoring Program. Additionally, permits for facilities in and upstream of the Delta may need to be updated based on the findings from the Delta Nutrient Research Plan. These impacts may include shifts in precipitation patterns reducing surface water flows, especially during summer months when Sierra Nevada snowpack has been depleted. At the same time, increased focus on water conservation and recycling may result in lower flow rate, higher concentration discharges to surface waters impacting the environment and the water quality of potable water supplies. Permit requirements will need to be updated in response to these trends. Future permits would need to incorporate a higher degree of adaptability, such as a weather-dependent component whereby the discharge requirements vary based on surface water flow characteristics. Contingencies may also be written into permits to modify discharge requirements during extreme weather events. In the future, dischargers will also be required to prepare climate change action plans outlining their efforts towards reducing GHG emissions, improving operational efficiency, and preparing their facility for extreme weather events. In the short-term, voluntary action plans will be requested. Climate actions plans may be any plan or part of a plan that addresses responses to potential and expected impacts of climate change (e.g. more frequent and more intense rainfall events). In many cases, these plans may be excerpted from broader city, county or regional climate change plans. As such, it will be important to understand how a specific facility's plans fit into the larger holistic context of a community's climate change response. Central Valley Water Board staff will review voluntary action plans, climate plans prepared by other agencies, and the latest climate projection data from DWR to inform any future decision-making and identification of appropriate requirements for mandatory climate change action plans.

Dischargers will need to re-evaluate flood hazards and their potential impacts on facility operations. Additionally, there will be a need to reconsider previously granted dilution credits in order to account for increased stream flow variability. There will be more NPDES facilities that will reduce or eliminate surface water discharges as recycled water use becomes more prevalent, this could lead to reduced surface water flows and consequent impacts on both water quality and water rights. Changes in background concentrations coupled with changes in aquatic species present in surface water may necessitate changes in testing criteria related to toxicity.

3.2.2 Storm Water

The Storm Water Program regulates storm water discharges from industrial facilities, construction sites, and municipal systems through the NPDES permitting program. As discussed in Section 2, the frequency of large storms, including atmospheric rivers, may increase in the future, potentially resulting in increased rates of erosion and sediment discharge. Storm water is

also a water supply resource that is used to help mitigate drought conditions. The urgent need to protect water quality from storm water impairment, compounded by the severe impacts of drought and climate change, compels immediate action to preserve California’s water resources. The California Water Action Plan, released in January 2014, called for multiple benefit storm water management solutions and more efficient permitting programs. In April 2014, the State Water Board formed a team of State Water Board and Regional Water Board staff (Initiative Team) to develop a Storm Water Strategic Initiative to guide the Storm Water Program for at least the following ten years. From this initial effort evolved the Storm Water Strategy Team in September 2015, composed of State Water Board staff in the Storm Water Planning Unit, along with Regional Board staff and Executive Management sponsors. This effort captures a number of State Water Board and Regional Water Board climate change adaptation efforts. The State Water Board and Regional Water Boards are advancing the perspective that storm water has value, supporting policies for collaborative watershed-level storm water management, addressing obstacles, developing resources, and integrating regulatory and non-regulatory interests. These efforts include participation and support by the public, stakeholders, and communities where storm water management remains a challenge.

Storm water permitting changes are also being evaluated to ensure that storm water is effectively managed in the future. Facility best management practices (BMPs) will need to become more robust, including more frequent use of engineered products and “Low Impact Development” (LID) techniques. Low Impact Development refers to systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of storm water in order to protect water quality and associated aquatic habitat (USEPA 2017). In the Municipal Separate Storm Sewer System (MS4) program, more permits will require the use of LID. Additional research and regulatory development is needed for “Low Impact Development” applications such as the use of permeable pavements or dry wells to enhance groundwater recharge. With an increase in precipitation falling as rain, there will also be the need for more robust BMPs both permanent, such as at industrial facilities, and temporary, such as at construction sites. In order to prepare for more precipitation falling as rain and more extreme rain events, sites may need to construct larger storm water detention systems. There may also need to be more options for practices which appropriately increase recharge of groundwater. Given the large changes expected in rainfall frequency and severity, program requirements will need to change in order to appropriately protect beneficial uses.

3.2.3 Water Quality Certification

The Water Quality Certification Program regulates the removal or placement of materials (e.g., dredging, levee construction, etc.) in wetlands and waterways of the State. These projects

generally require a Clean Water Act Section 404 permit from the U.S. Army Corps of Engineers. The State's Water Quality Certification is issued pursuant to Section 401 of the Clean Water Act to certify that the project approved by the Corps will also meet State water quality requirements. The Federal and State governments have policies requiring that projects cumulatively do not cause a net loss of wetland resources. As part of the 404 and 401 permitting process, impact avoidance, minimization, and mitigation is required for projects that impact wetland resources.

Climate change is expected to impact the Water Quality Certification Program in a similar fashion to how it may impact the Storm Water Program. With the potential for more frequent and greater intensity storms in the future, vigorous BMPs and the use of engineered products may be needed to control erosion during dredging and material placement projects. The number of Water Quality Certifications may also increase in the future if more flood control structures and storage reservoirs are constructed in response to changing storm patterns and shrinking snowpack volumes. Sea level rise may also prompt new projects related to bridge piers, docks, and shoreline infrastructure, many of which may also require Water Quality Certifications. Damage caused by intense storms and flooding will increase the number of infrastructure restoration and repair projects. Wetlands provide attenuation of the flooding and stream flows associated with intense storm activity, and lead to more resilient and natural environments. Climate change impacts will lead to increased focus and value being placed on wetlands, which are regulated by the 401 Water Quality Certification Program, as ecological habitat and carbon sinks. This will result in the need for more wetlands and reduction in the loss of wetlands-associated 401 projects. Any creation of new wetlands as mitigation measures will need to be balanced with active management to reduce potential of methyl-mercury production. Through the Water Quality Certification Program, the Regional Water Boards have the ability to encourage multi-benefit restoration, and mitigation projects. Coordination of these projects is accomplished in a number of ways including the use of mitigation banks, in-lieu fee programs, and habitat conservation plans.

3.2.4 Forest Activities Program

The Forest Activities Program addresses storm water discharges from land disturbing activities including timber harvesting and fuels management projects on forested lands in the Central Valley Region. Climate change is expected to continue negatively impact forest resiliency, resulting in tree species shifts, and more frequent and intense forest fires. Severe storm events are expected to increase erosion and challenge the capacity of the existing legacy road infrastructure traversing our forests. The warmer climate and reduced snowpack may result in a shift in what is considered a commercially valuable tree species and allow for forest growth at higher elevations than are currently observed. Further, increased concern regarding fuels loading

in our forested lands has the potential to lead to increased management and land disturbing activity that may come in the form of more fuels reduction projects, prescribed fire use, operational changes and rule changes that allow the cutting and removal of more trees faster, and decisions to allow wild fires to burn with minimal suppression or treatment.

With an expectation of continued increases in incidence and severity of wild fires comes a greater need for staff participation in post-fire assessment and response activities. Increased wild fire occurrences in recent years has led to a greater focus on environmental review (California Environmental Quality Act and National Environmental Policy Act) requirements in the 2017 General Order on Emergency and Exemption plans for post-fire salvage logging activities. The next five to ten years will see a close evaluation of the requirements placed on post-fire salvage operations to determine effectiveness in achieving water quality protection.

The Forest Activities Program will need to change as other regulations related to AB 32 evolve, including potential links to forestry offset protocols and GHG analysis. This work will be coordinated with the Air Resources Board, California Department of Forestry and Fire Protection (CAL FIRE) and the California Board of Forestry and Fire Protection. The program will continue to engage SWAMP and other state and federal partners to enhance surface water monitoring in forested lands. Program staff has been and will continue to be involved in multi-disciplinary, multi-agency and non-governmental organization work groups focused on best management practice effectiveness evaluation and adaptive management efforts.

These efforts are aimed, in part, at refining management measures in response to the risk of more frequent and intense land management, fires, and precipitation events. The Central Valley Water Board's recently adopted 2017 General Order for Timberland Management Activities (Order No. R5-2017-0061) and the planned permit for nonpoint source discharges from lands managed by the U.S. Forest Service and Bureau of Land Management will allow for greater flexibility in the future through updates made in response to new research or BMPs. The permit for nonpoint source discharge on lands managed by the U.S. Forest Service and Bureau of Land Management currently in development contemplates inclusion of cattle grazing activities on those lands. Higher ambient air temperatures and lower water quantity could result in increased concentrations of animals grazing near surface waters resulting in the need to address potential impacts via adaptive management and updated BMPs.

While the program primarily focuses on surface water impacts, timberland management activities usually require stabilization of native road surfaces, and this is usually achieved by applying water. Less readily available surface water could lead to increases in well-drilling to access shallow aquifers.

Currently, the Forest Activities Program is assessing the use of a Watershed-Based Plan in Battle Creek (located in Shasta and Tehama counties) to determine whether it provides a more proactive, holistic approach to watershed management. Further, the Watershed-Based Plan is expected to act as a tool for accelerating appropriate management actions in a pre-fire or post-fire scenario that will be protective of water quality. This type of approach may be beneficial in addressing climate change impacts as it focuses on forethought and planning at the watershed scale. Implementation of these activities may be expanded in the future to further mitigate wildfire risk, especially if public acceptance of climate change enhances the perceived value of forests as GHG sinks and supports decisions to treat those landscapes.

3.2.5 Mining

The mission of the Mining Program is to protect water quality at mining sites pursuant to California Code of Regulations Title 27. The Mining Program oversees the discharge of mining waste to land for approximately 95 mine sites with known or potential water quality impacts in the Central Valley Region. Discharges are regulated through WDRs that address all surface impoundments, tailing ponds, rock waste piles, and pits. Mining Program staff prepares WDRs, conduct inspections, review compliance reports, and identify potential responsible parties for mines that have been abandoned. Program objectives are achieved through collaboration with the Land Disposal Program, NPDES Program, Site Cleanup Program, and others.

Potential climate change impacts that could affect the Mining Program include the increased frequency and magnitude of storm events, extreme wet seasons, and alternatively, potentially more frequent periods of drought. Increased storm frequency and wet weather periods could impact mine activities in the following ways:

- Surface impoundments may need to be upgraded and expanded to accommodate the increased rate of runoff;
- BMP updates and repair of erosion control infrastructure may be needed to effectively control erosion and the transport of metals and other constituents of concern offsite and towards potential sensitive receptors;
- Reinforcement and/or more proactive maintenance of access roads may be needed to prevent washout;
- Additional NPDES and WDR permits may be needed to manage discharges; and
- Enhanced monitoring of bulkheads and similar mine features may be needed to safely regulate the potential increase in water volume behind these features. Some mine features may need to be retrofitted to withstand higher frequency events.

Alternatively, periods of drought and higher air temperatures could impact mine activities through:

- Reductions in groundwater levels could cause monitoring well networks to become dry, necessitating the installation of deeper wells; and
- Increased frequency of wildfires may limit access and infrastructure and amplify erosion processes at mine sites.

These climate change impacts may necessitate Central Valley Water Board staff to conduct additional inspections and emergency meetings, or review additional water management proposals, discharge reports, permit applications, or other time-sensitive deliverables. Additional research is needed to identify potential contingency plans for extended droughts and extreme rainfall events. A discharger may be asked to develop both short- and long-term contingency measures to address these more extreme climatic uncertainties. Mining staff will also coordinate with TMDL program staff to identify potential changes to existing TMDLs to address potential increased mass transport from mine sites (i.e. mercury TMDL).

3.2.6 Cannabis Cultivation Waste Discharge

The Cannabis Cultivation Waste Discharge Program was recently created to address and reduce the environmental damage caused by cannabis cultivation. Program resources are focused on improving process efficiency, pursuing enforcement actions, and enrolling cultivators in the Regional Water Board's General Order for Discharges of Waste Associated with Medicinal Cannabis Cultivation Activities and the State Water Board's General Waste Discharge Requirements and Waiver of Waste Discharge Requirements for Discharges of Waste Associated with Cannabis Cultivation Activities. The primary concerns of cannabis cultivation include illicit grading activity, illegal water diversion, and chemical/nutrient discharges to waters of the State.

Similar to other crops, cannabis grows best within a specific range of environmental conditions. Changes in temperature and/or precipitation patterns will impact cannabis watering and nutrient needs. There will likely be changes in locations where cannabis is cultivated. During times of extended drought, the limited water resources of the State are at increased threat of pollution and potential over-use. In an extreme drought scenario, growers may move their operations to locations that are more conducive to cannabis growth (e.g., from northern counties to the Central Valley floor). The Cannabis Cultivation Waste Discharge Program will encourage or require water conservation/recycling at cannabis operations if drought conditions persist for an extended period. Growers may also proactively implement water conservation/recycling measures into their operations to mitigate the impact of drought conditions on regional water supplies. Similar to other regulated discharges, water conservation/recycling applications at cannabis operations

may concentrate pollutant discharges, which may have unintended consequences on receiving waters.

Since the California cannabis industry and associated regulatory framework are still in the early stages, it is difficult to predict how water quality protection measures will evolve in the coming years. As with other programs with BMP requirements, the Cannabis Cultivation Waste Discharge Program continually examines common practices employed at cultivation sites and ensures that adequate best management practices are being employed to prevent pollution to receiving waters. Through the development of new technologies and GIS programs, Cannabis Cultivation Waste Discharge Program staff will be able to track the movement of cultivation activities, model threats to water resources, and transition towards watershed-scale analysis. Leveraging these newly developed technologies with existing staff resources will allow the Cannabis Cultivation Waste Discharge Program to better adapt to threats created by climate change, and mitigate potential negative impacts on receiving waters.

3.2.7 Irrigated Lands

The Irrigated Lands Regulatory Program (ILRP) was initiated in 2003 to regulate the discharge to surface water of irrigated land wastes including pesticides, fertilizers, salts, pathogens, and sediment (section 3.3.6 addresses the ILRP groundwater program). The ILRP regulates discharges using General Orders for agricultural growers that are part of third-party groups (coalitions). Currently there are 14 coalitions helping growers comply with the General Orders. The goal of the ILRP is to prevent irrigated lands discharges from causing or contributing to exceedances of water quality objectives.

Future changes in temperature and/or precipitation patterns may impact the use of water, fertilizer, pesticides, and other amendments at agricultural operations. An increase in the use of these amendments may have a corresponding increase in amendment loading to surface water and groundwater. The impact on surface water quality could be amplified if other climate change-related trends (e.g., increased erosion or reduce streamflow) were also observed. Current ILRP General Orders include requirements related to sediment control, pesticide use, and surface water monitoring. While the recently approved ILRP pesticide evaluation protocol accounts for use patterns in evaluating pesticides to be monitored, other requirements may need to be updated if a greater degree of surface water impairment is observed.

Climate change and unreliable water supplies could result in the push for greater irrigation efficiency. This might lead to increased concentrations of nitrogen below the root zone because of decreased flows. However, it could also result in decreased loads because irrigation efficiency

promotes fertilizer application efficiency. Also, irrigation is not the only source of groundwater recharge; aquifers are recharged by storm events, waterways and surface water impoundments. There will be an increasing push for opportunities to enhance groundwater recharge in agricultural settings. As related policies develop, it may be necessary to update the requirements of the ILRP permits.

To more proactively address potential climate change impacts, the ILRP staff will collaborate with planning programs to anticipate future changes in background surface and groundwater quality, and modify the General Orders accordingly. There will need to be changes in Management Practices Evaluation Programs to address the need for robust BMPs in light of climate change. Increased rainfall intensity and severe weather occurrences will necessitate more robust storm water management practices. The ILRP will work with the CDFA to promote the Healthy Soils Incentive Program (Section 2.3.1.2), part of California's interagency Healthy Soils Initiative, to encourage growers to build soil carbon and consequently reduce GHG emissions and erosion. In an effort to promote the use of compost as an alternative to fertilizers, the Central Valley ILRP staff, along with State Water Board staff, is managing a grant to fund research related to the nitrogen content of various forms of compost and development of tools to help growers fill out the organic amendment portion of their nitrogen management plans.

3.2.8 Nonpoint Sources

The goal of the Nonpoint Source Program is to restore waters impacted by nonpoint source pollution and to protect unimpaired water bodies by assessing nonpoint source pollution problems and implementing management programs. The Nonpoint Source Program implements the State-wide *California Nonpoint Program Implementation Plan for 2014-2020* (State Water Board 2015), which focuses on improving the State's ability to effectively manage nonpoint source pollution and conform to the requirements of the federal Clean Water Act and the federal Coastal Zone Act Reauthorization Amendments of 1990.

Sources of nonpoint pollution in the Central Valley include timber harvests, legacy roads, abandoned mines, agricultural areas, and development projects outside of areas regulated by the NPDES Program. The Nonpoint Source Program encompasses several different surface water regulatory programs that address specific source types. In addition, the Nonpoint Source Program includes activities to protect threatened and high quality waters not already addressed by these source-specific programs. Similar to other programs, the Nonpoint Source Program and associated Clean Water Act section 319(h) grant projects would be directly impacted by increases in precipitation falling as rain (as opposed to snow) and increases in the frequency and intensity of rain events and floods. These changes will necessitate updates to existing erosion control BMPs to accommodate increases in flows and sediment loading, and increase the need for new

BMPs in instances where currently none are required, to prevent new and increased impacts to drinking water supplies, fish spawning, and aquatic habitat, particularly for salmon. Additional time and funding may also be needed to optimize BMPs to ensure that TMDLs and other Basin Plan requirements are consistently achieved under new conditions.

Further, under a future drought scenario, it may be more difficult to assess erosion control BMP performance due to the more variable nature of storm frequency. There will be a need to develop criteria and other 319(h) grant program adjustments to deal with increased uncertainty in monitoring events used for effectiveness assessments. Drought conditions may also increase the risk of wildfire and vegetation loss, which would amplify the risk of sediment and pollutant runoff. There will be an increased need for projects with vegetative cover to reduce erosion risks.

In addition, higher surface water temperatures and increased erosion and sediment/nutrient transport may increase the frequency and extent of harmful algal blooms. This could prompt changes in TMDLs and necessitate new and more robust BMPs to mitigate impacts to drinking water supplies, recreational uses, and aquatic habitat. Additional research is needed on the site-specific causes of harmful algal blooms and optimal BMPs to reduce nutrient inputs and other bloom drivers.

To address these concerns for section 319(h) grant projects, the Nonpoint Source Program will require future section 319(h) grant project proponents to account for predicted increases in frequency and magnitude of extreme rain events in project designs. In addition, the Nonpoint Source Program will encourage the USEPA's Clean Water Act section 319(h) grant program manager to consider:

- Lengthening the grant period, which currently allows three years for characterization of baseline conditions and BMP effectiveness, in response to the potential for prolonged periods of drought conditions; and
- Developing criteria and adapting statistical methods to address the increased uncertainty in monitoring events used for effectiveness assessments during drought periods.

As more information is learned about the drivers of harmful algae blooms in the Delta and other Central Valley waters, the Nonpoint Source Program will collaborate with the planning and other surface water regulatory programs to address those drivers to protect recreation, drinking water, aquatic life and other beneficial uses of Central Valley waters to the extent possible.

Overall, there will be increasing demand for USEPA Clean Water Act section 319(h) grant program funding for erosion control, fuel management, streambed restoration and other types of projects to address nonpoint pollution concerns in the Central Valley. Nonpoint Source Program staff will

continue efforts to convey information about section 319(h) and other potential funding sources to section 319(h) project proponents and other stakeholders who desire to implement water quality improvement projects.

3.3 Groundwater Regulation

As discussed in Section 2, the higher temperatures and shifting precipitation patterns associated with climate change are expected to negatively impact the quantity and quality of available groundwater resources. At the same time, increased groundwater pumping could further impair groundwater quality by concentrating pollutants resulting in recharge with poorer quality water. Within all groundwater/land disposal programs, there will be a need to evaluate potential impacts of climate change. The following sections discuss how climate change is impacting groundwater regulatory programs, how the programs are adapting to these impacts, and what additional steps may be undertaken to enhance program response.

3.3.1 Title 27 – Non-Hazardous Waste Land Disposal

The Title 27 Program protects water quality by regulating non-hazardous waste discharge to land for treatment, storage and disposal in waste management units, pursuant to Title 27 of the California Code of Regulations. Wastes regulated by this program include municipal solid wastes, designated wastes such as petroleum impacted soils and auto shredder waste, and inert solid wastes. Typical discharge sites include landfills, industrial surface impoundments, and waste piles.

Future design and operation of landfills will be influenced by the observed impacts of climate change. Landfill covers could be more susceptible to erosion during extreme weather events. Extended periods of drought will negatively impact the performance of vegetative covers, leading to increased maintenance. These trends will prompt new regulations and/or BMPs to maintain landfill cover performance. Future waste discharge requirements will require dischargers to design landfill covers for higher intensity and longer duration storm events to the extent those changes are required by Title 27 of the California Code of Regulations. In addition, the WDRs will require that the vegetative cover can withstand increased temperatures and higher intensity rainfall events. Changes in groundwater levels will mean that some sites would no longer be able to meet siting criteria and existing landfills may not be allowed to expand or will be required to install groundwater barriers. Some groundwater monitoring wells will need to be relocated or screened different as water table elevations change. More extreme rainfall events will necessitate larger surface impoundments and potential changes in storm water management systems. Future WDRs will require that surface impoundments and storm water management systems are designed to store larger flows and, possibly, require greater freeboard to the extent

allowed by the regulations. There will also be flood related issues associated with closed landfills in flood plains and adjacent to rivers. The WDRs will require the submittal of flood management plans and contingency plans to address increased threats caused by larger floods. More robust surface water modeling will be an important tool to predict higher intensity and duration events.

Landfills also present opportunities for climate change mitigation. The Title 27 Program currently requires landfill gas capture only at locations where a gas leak has been confirmed. The program may encourage the use of fully enclosed digesters, bioreactors, and treatment cells, as opposed to “dry tomb” containment cells, to further promote the capture of methane gas. Anaerobic digester requirements are currently being incorporated into some WDRs, and the Title 27 Program is collaborating with CARB and local air districts to increase the collection and treatment of landfill gases. Additional collaboration is planned with CARB and Cal Recycle to encourage the application of landfill digesters and use of landfill gas as an energy source. Future Monitoring and Reporting Programs will require more robust gas monitoring programs and calculations of the mass of volatile organic constituents and methane that are captured by landfill gas collection systems and prevented from going into the atmosphere. The WDRs will require, to the extent allowed by the regulations, active gas extraction and treatment systems instead of passive venting systems which release untreated gases to the atmosphere.

Future WDRs will also require Dischargers to monitor and report changes in groundwater and surface water temperatures over time. Potential future research that could be conducted in concert with other regulatory agencies include directly evaluating the mass flux of methane and other gases from landfills to the atmosphere and to underlying groundwater. The research could lead to improvements to further reduce greenhouse gas fluxes to the atmosphere and gas-related impacts to groundwater quality.

3.3.2 Waste Discharge Requirements (Non-15)

The WDRs, or Non-15, Program regulates point discharges to land that are exempt from Title 27 of the California Code of Regulations, pursuant to Subsection 20090 of Title 27. The WDRs Program primarily regulates wastewater treatment plants (WWTPs), wastewater recycling operations, food processing industries, and other industries that discharge non-hazardous wastes.

Demand for water recycling will increase in the future in response to water supply changes (Section 2.1.5). Many wastewater agencies are already recycling wastewater by collaborating with other agencies to apply a portion of treated wastewater to landscaping, agricultural fields, or groundwater aquifers. This trend is expected to become more common in the future, which may prompt more use of the State-wide water recycling General Order. The use of recycled water

will reduce the overdraft of groundwater aquifers and help ensure drinking water supplies for future generations.

Anaerobic digesters, which are currently employed at a subset of WWTPs, are also expected to become more common as a means of renewable energy generation. Anaerobic digestion of organic waste produces methane gas, which can be captured and used as an energy source while also preventing its release to the atmosphere. As digester feedstocks expand beyond biosolids to other co-digestates, permit requirement may need to be amended. To further accelerate the adoption of anaerobic digester technology, incentive programs administering grants and/or low-interest loans may be considered. Additional General Orders may also be adopted for non-dairy industries (e.g., food processors and wineries) that may benefit from anaerobic digester technology.

As with many programs, Non-15 facilities may require additional measures to account for flooding and extreme weather events, depending on their locations. Municipal waste water systems will also have to deal with increased inflow and infiltration (I&I) into their systems due to increasingly saturated soils accompanying increases in rainfall. This may necessitate recalculation of water balances and potential design changes for treatment systems. Changes in underlying groundwater quality related to increasing salt concentrations will result in changes to permit requirements. As a result, dischargers could face issues if regulators set lower effluent limits for salt and biochemical oxygen demand (BOD), since the added treatment is would be energy-intensive, which, in turn, could increase GHG emissions. The WDRs Program will also need to assess how to work with facilities that may be at greater risk of flood water inundation. As with the NPDES program, facilities will be asked to prepare climate change action plans. Climate action plans may be any plan or part of a plan that addresses responses to potential and expected impacts of climate change (e.g. more frequent and more intense rainfall events). In many cases, these plans may be excerpted from broader city, county or regional climate change plans. As such, it may be important to understand how a specific facility's plans fit into the larger holistic context of a community's climate change response. Central Valley Water Board staff will review voluntary action plans, climate plans prepared by other agencies, and the latest climate projection data to inform decision-making when identifying appropriate requirements for mandatory climate change action plans. Data collection needs for the WDRs Program include a better method of quantifying the quantity of recycled water used in place of extracted groundwater.

3.3.3 Site Cleanup and Underground Storage Tanks (USTs)

The Site Cleanup Program and Underground Storage Tank (UST) Program regulate and oversee the investigation and cleanup of contaminated sites that are polluting, or threaten to pollute, surface water and/or groundwater. Site Cleanup Program sites include military bases, railyards, oil refineries, and smaller facilities such as dry cleaners and plating shops. UST Program sites include fuel hydrocarbon releases from UST systems. The two main components of the UST program are the permitting of operating USTs, which is run by local Certified Unified Program Agencies (CUPAs), and cleanup of UST releases, which is shared by select CUPAs and the nine Regional Water Boards.

Climate change is expected to impact the Site Cleanup Program and UST Program primarily through potential decreases in groundwater table elevation and greater emphasis on the use of “green” remediation technologies. Drought may lead to decreases in groundwater table elevations, causing wells to become dry, and the effectiveness of existing remedial technologies to potentially be reduced. . Additionally, potential climate change-related shifts in the transportation industry may lead to changes in fuel composition, the use of smaller USTs, and possibly a reduction in the total number of services stations with petroleum fuels. These changes would all have subtle impacts on the UST Program’s approach towards regulation and cleanup. On the other side of things, issues related to disposal of batteries from an increasing number of electric cars, for example, could put pressure on other programs, such as Title 27.

As with other programs, concerns related to increased flood events and increasing soil saturation, could affect site cleanup and UST facilities. Along with these concerns are issues related to changes in concentrations, locations and transport of soil and groundwater contaminants.

The Site Cleanup Program and UST Program encourages the use of “green” remediation technologies such as passive systems (e.g., permeable reactive barriers), biological approaches, in-situ remedies, and remedies utilizing renewable energy sources such as solar panels. On 6 February 2015, the Central Valley Water Board adopted *Order No. R5-2015-0012: Waste Discharge Requirements General Order for In-Situ Groundwater Remediation and Discharge of Treated Groundwater to Land* to expedite the approval of in-situ remedy proposals and provide more consistent regulation of their implementation. The Site Cleanup Program, statewide, could also pursue an incentive program to encourage the use of renewable energy sources at cleanup sites. Greenhouse gas reduction strategies will result in increasing incentives for infill and brownfield development and the need to expedite putting properties back into productive use. This will put pressure on the Site Cleanup Program and will likely result in more requests for “low threat” closures and the like. The need for more low impact development and storm water management may also impact urban areas with contaminated groundwater and potentially affect groundwater cleanups.

3.3.4 Confined Animal Facilities

Confined animal facilities are characterized by farms or ranches where livestock are held for a significant period of time and provided with food. Most confined animal facilities in the Central Valley are dairies; however, there are also many feedlots and poultry facilities. The primary objective of Confined Animal Facilities Program is to prevent impairment of surface water and groundwater by controlling the discharge of manure, wastewater, and storm water runoff.

Climate change is expected to impact confined animal facilities primarily through an increased focus on water conservation and recycling. Water conservation efforts could result in more concentrated waste streams which may be more harmful to surface water and groundwater if waste applications rates are not reduced, especially during low flow periods. If strict limits are placed on water use, facility managers may choose to change cropping patterns or import feed. A switch to imported feed could result in a reduction in cropland available for land application of manure, leading to higher localized salt and nutrient loading. Additionally, increases in extreme weather events, especially heat events, may result in animal mortalities. In the past, animals deaths associated with extreme heat have necessitated temporary contingency plans for disposal of dead animals. More extreme heat, associated with climate change could make this a more common occurrence.

Recently, a number of dairies located near surface waters have had issues related to flooding whereby corrals, manure storage areas, and ponds have been inundated. High surface water flow rates and flooding may be experienced in the future as a function of higher intensity storms and increased snowmelt rates. It will be necessary to identify methods to mitigate these risks. Existing and future general orders will need to account for changes in flooding risk, land available for manure application, water availability, and implications for fodder crops. Monitoring data will continue to track the overall amount of waste being generated versus available land application acreage.

There is potential for funding to address some of the issues that have a nexus to reduction in short lived climate pollutants, through greenhouse gas reduction funds. The Central Valley Water Board adopted Order No. R5-2011-0039, *General Order for Centralized Dairy Manure Anaerobic Digester or Centralized Dairy Manure Co-Digester Facilities* in 2011 to streamline the permitting process for centralized dairy manure digester and co-digester facilities. Anaerobic digester use may become more common in the future as a means of treating manure waste and generating methane gas for use as an energy source. Research is ongoing to optimize manure digester gas production and produce an easily transportable solid fertilizer as a digester end product. Increased use of anaerobic digester technology could benefit water quality by relieving the

pressure to apply manure to dairy cropland by incentivizing the sale and use of compost at more agronomic rates on non-dairy cropland. Future general orders may require a higher level of scrutiny for flood protection measures around dairies. Future orders may also allow for more dynamic flood protection measures, including adaptive requirements based on observed and predicted flood frequencies and magnitudes. In addition to digesters, Board staff will be working with, stakeholders, and the State Board and other agencies to address issues related to on-farm composting of manure.

3.3.5 Irrigated Lands

As discussed in Section 3.2.8, the ILRP was initiated in 2003 to regulate waste discharges from irrigated lands using General Orders. Groundwater protection requirements were added to the ILRP in 2012, and continue to be developed. Growers in areas where groundwater is vulnerable to contamination or is known to be impacted by nitrate or other agriculture constituents are required to have a certified nitrogen management plan and provide nitrogen summary reports to their coalitions. Agricultural coalitions are also required to conduct groundwater quality trend monitoring in accordance with the appropriate General Order.

To ensure protection of groundwater quality, the ILRP requires development of Management Practice Evaluation Programs to identify appropriate management practices. This initiative is currently underway to protect groundwater from nitrate leaching, which could become increasingly harmful to groundwater under drought and/or limited groundwater recharge conditions in the future. Agricultural coalitions in the Tulare Lake Basin were awarded a \$2,000,000 United States Department of Agriculture grant to implement an innovative program to quantify and minimize nitrate leaching from farming operations. The project is producer-led, but involves a broad range of technical partnerships and collaborators, including local universities and the CDFA. Similar to other programs involved in monitoring groundwater, monitoring wells used for ILRP reporting may become dry under future climate conditions, necessitating the installation of deeper wells. Climate change will lead to changes in irrigation practices, especially if obtaining water becomes more difficult. These changes will affect contaminant concentrations and contaminant transport in soils. Changing temperature regimes will also lead to changes in pest prevalence which could lead to changes in the use of pesticides and herbicides. These potential impacts of climate change will need to be addressed in management plans and evaluation of management practices. Efforts related to enhanced compost use and CDFA's Healthy Soils Initiative may necessitate changes in how nutrients are managed. Regulations will need to evolve to address increased use of recycled water and potential groundwater recharge efforts on farms. The program will also be working with CV-SALTS to tackle issues related to increasing salt concentrations.

3.3.6 Oil Fields

The purpose of the Oil Field Program is to properly regulate oil field discharges and oversee monitoring activities to ensure the protection of surface water, groundwater, and human health. The Oil Field Program regulates four primary activities related to oil production:

- Generation of drilling muds during well development;
- Discharge and reuse of wastewater produced during oil production;
- Disposal well practices; and
- Well stimulation practices under Senate Bill 4.

Extreme precipitation and flood events will negatively impact operations at oil fields. Wastewater facilities, including ponds and storm water conveyance systems, may require re-evaluation and/or upgrades to effectively handle wet-weather flows and ensure that constituents of concern are properly handled. Central Valley Water Board staff will review wastewater facility operational data during inspections and review of permit applications to ensure they procedures are adequate to protect surface water and groundwater quality.

Oil field activities within the region are generally concentrated in the southern portion of the Central Valley. Oil field operators are adapting to region-wide reductions in surface and groundwater availability. Oil field dischargers are currently pursuing water conservation and recycling applications in response to reductions in freshwater supplies. Water districts are also pursuing applications to use recycled oil field wastewater to supplement irrigation supplies. Wastewater treatment research aimed at increasing the fraction of oil field wastewater that can be recovered is also ongoing. The Oil Field Program will encourage or require water efficiency and/or recycling applications in the future. WDRs will need to be updated to ensure that allowable discharges continue to be protective of surface water and groundwater. Depending on the outcome of the region's Food Safety Panel efforts, there may be more permitting related to the use of recycled water from oil fields and associated advanced treatment systems. Given the nature of produced wastewater, more extensive monitoring will be necessary to ensure that the increase in the number of discharges and expansion of uses will be protective of water quality and public health.

3.4 Overarching Considerations

Several common themes are evident throughout the Central Valley Water Board program climate change considerations presented in the previous sections, including:

- Potential changes to the characterization of “background conditions” will be needed over time as new data is obtained and long-term environmental trends are better understood;
- Re-evaluation of appropriate designation of beneficial uses and level of protection (e.g. changing from COLD to WARM and/or refining to “limited” uses) which in turn will change regulatory requirements.
- Meeting regulatory requirements will become more difficult, and result in the need for flexible, adaptable regulatory mechanisms;
- BMPs and surface water management infrastructure design will need to be reevaluated in response to potential changes in extreme weather patterns;
- Expanded use of water conservation and recycling will result in lower flow rates, more concentrated discharges;
- There will be increased sensitivity of surface water bodies to pollutant loadings due to lower stream flows and higher water temperatures; and
- There will be more incentives to implement environmentally friendly solutions, including “green” groundwater remedies, “low impact development” storm water systems, and anaerobic digestion applications to exploit organic waste resources.

Since these themes affect multiple programs, collaboration and knowledge-sharing between programs will be critical for ensuring that program policies and procedures adapt to changing conditions. Inter-program collaboration, especially with planning program staff, will prepare staff to better handle these changes and enable them to more proactively and effectively implement new policies.

4. Work Plan for Addressing Climate Change and Water Quality in the Central Valley

This section presents an approximate timeline for the implementation of major Central Valley Water Board initiatives discussed in Section 3. The section has been organized by the projected timeframe for initiative implementation, as follows:

- Short-Term: 0 to 4 years;
- Medium-Term: 3 to 7 years; and
- Long-Term: greater than 7 years.

In many cases, the timing of these initiatives is dependent upon funding availability, agency approvals, and other factors that cannot be readily and easily predicted. In these instances, the steps needed to commence initiative activities are briefly discussed. Program managers will assess the level of effort needed for each initiative and ensure that their work plans account for this, so that initiatives can be completed within the prescribed timeframes. The priority projects outlined below represent work commitments for Board staff. As more data is collected and knowledge is gained, these priorities will be revisited and modifications or additions will be made as appropriate. As such, one of the lynchpins of future efforts to address climate change will be robust data collection coupled with predictive modeling of water quality under future climate change scenarios.

4.1 Short-Term

Central Valley Water Board initiatives that will be conducted within the next four years are summarized in Table 3 and discussed further in the following sections.

4.1.1 Waste Discharge Requirements

The Waste Discharge to Land Program (non-15) will begin the process of updating Waste Discharge Requirements (WDRs) which are older than 15 years old. These updates will account for new knowledge based on recent drought and heavy precipitation years. Information will be gathered by working with dischargers and utilizing Water Code Section 13267 Orders for technical reports, when necessary. Data collected from the winter of 2016-17 coupled with ongoing work with dischargers has pointed out the potential need for updated water balances in a number of older WDRs. The non-15 program has begun to incorporate revisions to these work plans in its yearly permitting workload.

SHORT-TERM INITIATIVES (0 TO 4 YEARS)		
Section	Initiative	Summary
4.1.1	Waste Discharge Requirements	Update WDRs older than 15 years to account for new knowledge obtained from recent drought and heavy precipitation years.
4.1.2	Voluntary Climate Change Action Plans	Request voluntary action plans summarizing planned responses to potential and expected climate change impacts.
4.1.3	Data Collection	Expand surface water monitoring capabilities and focus data collection efforts on climate change-related parameters.
4.1.4	Delta Nutrient Research Plan	Coordinate Bay-Delta modeling efforts to better evaluate drivers influencing nutrient impacts on water quality.
4.1.5	Central Valley Salinity Alternatives for Long-Term Sustainability Program (CV-SALTS)	Develop Early Action Plans, permit updates, and Basin Plan amendments based on salt and nitrate management strategies.
4.1.6	Basin Planning: Triennial Review	Include planning priorities focused on climate change adaptation.
4.1.7	Basin Planning: Temperature Criteria Evaluation	Evaluate temperature criteria to determine achievable conditions leading to changes in basin plan requirements.

Table 3. Summary of short-term initiatives

4.1.2 Voluntary Climate Change Action Plans

Both the NPDES and Waste Discharge to Land (non-15) programs will ask dischargers to provide climate action plans on a voluntary basis, as permits are renewed. Climate actions plans in this context may be any plan or part of a plan that addresses responses to potential and expected impacts of climate change (e.g. more frequent and more intense rainfall events). In many cases these plans may be excerpted from broader city, county or regional climate change plans. As such, it may be important to understand how a specific facility’s plans fit into the larger holistic context of a community’s climate change response.

4.1.3 Data Collection

SWAMP surface water data collection and collaborative partnerships will become increasingly focused on climate change-related parameters over the next four years. During 2017 and 2018, SWAMP will develop a discretionary funds contract to establish sentinel non-perennial stream monitoring sites in the Sierra Nevada foothills to monitor reference conditions. Monitoring non-perennial streams will allow for evaluation of how varying flow conditions affect biology and water quality, an important consideration for climate change. The Sierra Nevada has many high quality watersheds, but those watersheds are at risk due to climate change, development, increasing water demands, and catastrophic wildfires. Documenting reference conditions is also

an essential first step towards evaluating ecological conditions in non-perennial streams across the state.

In coordination with the non-perennial stream monitoring effort, SWAMP is planning to deploy continuous temperature loggers in several headwater streams to evaluate temperature trends and determine whether streams are protective of cold water habitat. SWAMP staff was recently trained in identifying and sampling toxic algae. Staff will work with the State Water Board to conduct initial algal bloom response monitoring in the coming years. Subsequent monitoring may be completed to evaluate algal bloom trends, and collaborate with other programs on appropriate mitigation measures. Collaboration with the Department of Water Resources and other agencies on data collection will provide benefits for water quality monitoring.

SWAMP's monitoring approach will need to be adjusted in the future to ensure that any changes in key climate change indicators (e.g., temperature, flow rate, salinity, dissolved oxygen, etc.) will be tracked in order to understand both baselines and future trends. For example, SWAMP will be deploying water temperature data loggers at key reference sites to assess changes in temperature over time. In addition, SWAMP staff will be incorporating data from other monitoring efforts, such as flow and electrical conductivity data from the continuous monitoring stations operated by the Department of Water Resources, into their evaluations. Conducting trend evaluations and designing monitoring studies related to climate change considerations will be done in coordination with the TMDL and Basin Planning Programs in order to better understand changes to ambient surface water body conditions.

4.1.4 Delta Nutrient Research Plan and Regional Monitoring Program

Two programs, the Delta Nutrient Research Plan and the Delta Regional Monitoring Program, will collect information on the evidence and effects of climate change. The purpose of the Delta Nutrient Research Plan is to identify research and modeling to determine whether water quality objectives for nutrients can address problems of harmful algal blooms, limited food supplies for native fish, invasive aquatic plants, and low dissolved oxygen in the Delta. Multiple factors interact with nutrients to cause these problems. Among them are physical factors of water volume, flow rates, water residence time, temperature, and timing and magnitude of major weather events, all of which respond to climate change. Data collection and analysis under the Delta Nutrient Research Plan will therefore include tracking and modeling changes to climate-driven factors, in order to understand and predict outcomes for water quality and nutrient management. The Delta Nutrient Research Plan is being developed and implemented by the Central Valley Water Board and a stakeholder and technical advisory group. Modeling and other activities are coordinated with the San Francisco Bay Nutrient Management Strategy and the Delta Regional Monitoring Program.

The Delta Regional Monitoring Program (RMP) is a stakeholder-directed project whose goal is to coordinate, design, and conduct water quality monitoring in and around the Delta. In 2017, the RMP is engaged in its third year of monitoring. The RMP is gathering and evaluating water quality data for priority constituents, namely mercury, current use pesticides, aquatic toxicity, nutrients, and pathogens. Key outcomes of the RMP's current work are assessments of status and trends of these constituents. Additional efforts under the RMP's Monitoring Design include continuation of monitoring and assessment of sources and environmental processes that control the water quality conditions of interest. Data collected through the RMP and the Nutrient Research Plan will provide useful information that can be directly related to understanding and predicting impacts of climate change in the Delta.

4.1.5 Central Valley Salinity Alternatives for Long-Term Sustainability Program (CV-SALTS)

CV-SALTS has a 50-year planning horizon. As such, its future regulatory requirements, basin plan amendments and policy directions will necessarily take climate change into account. Climate change impacts will be considered as part of California Environmental Quality Act (CEQA) analysis conducted for the regulatory processes. Additionally, CV-SALTS will be coordinating with Sustainable Groundwater Management Act (SGMA) programs to ensure the long term viability of groundwater resources. This will be increasingly important as surface water supplies become less reliable in the face of climate change. A big part of the short term efforts in CV-SALTS will concentrate on planning for drought, water conservation and the impacts of nitrate on groundwater. The following specific near term activities for CV-SALTS assumes that the preferred recommendations developed by the stakeholder led CV-SALTS initiative are adopted as proposed into the Basin Plans by the end of FY17/18.

- FY17/18
 - Develop for Board consideration, basin plan amendments on the salt and nitrate management strategies including use of management zones; updated variance and exception policies; and drought and conservation policy
- FY18/19
 - Initiate development of management zones and Early Action Plans in Priority 1 groundwater basins to insure safe drinking water in nitrate contaminated areas
 - Initiate Salinity Prioritization and Optimization (P&O) Studies
 - Incorporate P&O commitments into permits
 - Initiate groundwater salt and nitrate monitoring network
- FY19/20
 - Begin implementing Early Action Plans

- Identify long-term nitrate solutions for priority 1 areas
- Incorporate management plan commitments into respective permits

4.1.6 Basin Planning: Triennial Review

During FY17/18, the Central Valley Triennial Review will be conducted. As part of the process, the Board will determine planning priorities balanced against available resources. The decision will result in a three-year work plan and identify planning efforts specifically focused on climate change. During FY19/20, results of the temperature studies should be available to determine whether a methodology could be incorporated into the Basin Plans for determining changing conditions, temperature range achievability, and need for temperature criteria and prioritization of water bodies needing focused COLD protection in water bodies below dams.

4.1.7 Basin Planning: Temperature Criteria Evaluation

The Central Valley Water Board is managing contracts to develop a methodology for deriving temperature criteria ranges that are protective of Central Valley anadromous salmonids. The methodology will take into consideration time of year and stream location based on life stages that are expected to be present. The methodology will also take into consideration the type of water year and possibly air temperature, food availability, stream geometry, refugia, and the presence of other Threatened and Endangered species. Before staff can propose water quality objectives, additional studies will be needed on the environmental conditions that are available, water quality conditions that could reasonably be achieved, and other factors that the Board must consider when establishing water quality objectives.

4.2 Medium-Term

Central Valley Water Board initiatives that are planned for approximately the next three to seven years are summarized in Table 4 and discussed further in the following sections.

MEDIUM-TERM INITIATIVES (3 TO 7 YEARS)		
Section	Initiative	Summary
4.2.1	Waste Discharge Requirements	Continue updating WDRs older than 15 years to account for knowledge obtained from recent climate data.
4.2.2	Central Valley Salinity Alternatives for Long-Term Sustainability Program (CV-SALTS)	Evaluate potential changes to salt concentration limits in the face of increased water conservation and recycling.
4.2.3	Develop Background Conditions Definition	Develop a background conditions definition that incorporates climate change impacts in a manner consistent with existing laws.
4.2.4	Basin Planning: Triennial Review	Continue to include planning priorities focused on climate change adaptation.
4.2.5	Modelling and Data Collection	Develop climate change-related modelling, analysis, and data collection initiatives in collaboration with other agencies.
4.2.6	Wetland Mitigation Requirements	Update 401 Certification requirements to improve wetland climate change resiliency and manage methylmercury production.
4.2.7	Watershed Based Planning	Utilize watershed planning framework to address water quality issues in forested landscapes

Table 4. Summary of medium-term initiatives

4.2.1 Waste Discharge Requirements

The Waste Discharge to Land Program (Non-15) will continue updating Waste Discharge Requirements (WDRs) which are older than 15 years old. These updates will account for new knowledge based on recent drought and heavy precipitation years. Information will be gathered by working with dischargers and utilizing Water Code Section 13267 Orders for technical reports, when necessary. This workload will be incorporated into the yearly planning for the non-15 program.

4.2.2 Central Valley Salinity Alternatives for Long-Term Sustainability Program (CV-SALTS)

CV-SALTS has a 50-year planning horizon. As such its future regulatory requirements, basin plan amendments and policy directions will necessarily take climate change into account. Climate change impacts will be considered as part of CEQA analysis conducted for the regulatory processes. Additionally, CV-SALTS will be coordinating with Sustainable Groundwater Management Act (SGMA) programs to ensure the long term viability of groundwater resources. This will be increasingly important as surface water supplies become less reliable in the face of climate change. One focus of the medium term efforts under CV-SALTS will be the determination

of and definition of background conditions. Additionally the program will look at potential ways in which concentration based limits for salts may need to be altered in the face of increased water conservation and recycling. The following CV-SALTS initiatives are planned for the next three to seven years.

- FY20/21
 - Initiate nitrate management in Priority 2 groundwater basins
 - Management Zone and Early Action Plan Development
- FY21/22
 - Begin implementing Early Action Plans
 - Identify long-term nitrate solutions for Priority 2 areas
 - Incorporate management plan commitments into respective permits

4.2.3 Develop Background Conditions Definition

The Basin Planning Program will develop a background conditions definition that will incorporate the changes from climate change in a manner consistent with state and federal law. This definition will be use in future development of basin plan amendments. This work will account for the impacts of drought and water conservation in setting of objectives. The program will also determine if any current regulatory measures are deterring conservation and whether the Basin Plan would need to be amended to remove impediments to this latter issue is related to CV-SALTS work on revising concentration based limits for salts.

4.2.4 Basin Planning: Triennial Review

During FY20/21, the Board will proceed with a Triennial Review of actions needed to improve and maintain effectiveness of the Basin Plans. During the review, planning activities related to climate change will be reviewed and additional activities may be prioritized by the Board.

4.2.5 Modelling and Data Collection

The Central Valley Water Board plans to support climate change-related data collection, and modelling and analysis initiatives being conducted by State and federal agencies. Collaboration on these efforts will allow for better coordination between the Central Valley Water Board and other agencies on climate change-related issues in the future. Additionally, these tools will also enhance the ability of technical staff to forecast climate change impacts and their effect on water resources. Modelling initiatives that Central Valley Water Board plan to support include:

- California Department of Fish and Wildlife temperature modeling for the Sacramento River;
- CNRA water security and agricultural resilience modelling being conducted as part of the Fourth California Climate Change Assessment;
- USEPA Better Assessment Science Integrating Point and Non-Point Sources (BASINS) environmental analysis system for watershed- and water quality-based studies;
- USEPA’s WEPPCAT tool for assessing the potential impacts of climate change on sediment loading to streams; and
- USEPA’s Water Quality Analysis Simulation Program (WASP) model for predicting water quality responses to natural phenomena and manmade pollution.

The Central Valley Water Board will work with the State Water Board on contracts and other collaborative efforts for modeling the impacts of climate change on water quality.

Additionally, numerous programs will work on collaborations to foster data collection related to climate change. Almost of the Board’s programs will participate in this effort to some extent. The SWAMP program will continue to have the lead on surface water monitoring and will coordinate with the surface water regulatory programs. Groundwater research will largely be centered in each program, but it will be done in concert with the Sustainable Groundwater Management Program. Collaborations will include working with the State Water Board, CDFA, CalRecycle, CNRA, the Board of Forestry and other state agencies. Research work will also be coordinated with federal and local agencies wherever appropriate. Data needs include but are not limited to surface water temperature, sediment transport, links between surface water flow and water quality, groundwater quality trends for nitrates and salts, as well as the impacts of Best Management Practices coupled with climate change.

4.2.6 Wetland Mitigation Requirements

Water Quality Certification program staff will update wetland mitigation requirements in 401 Certifications to better link them with efforts to enhance carbon sequestration and adapt to anticipated climate change impacts on wetland environments. For projects that reduce wetland area or function, program staff will require applicants to propose an equivalent carbon sequestration replacement at an appropriate ratio, likely higher than 1 to 1. For proposals that reduce wetland area or function in an urbanized area with a problematic heat-island effect, applicants would be required to propose an equivalent benefit to the lost wetland cooling function at likely at a 1 to 1 ratio.

Water Quality Certification program staff will also update wetland mitigation requirements to better manage wetland methylmercury production. For projects that create new wetlands or

modify wetlands that discharge to a waterbody impaired by methylmercury, the applicant will be required to assess methylmercury discharge and, if needed, propose a methylmercury control plan.

4.2.7 Watershed Based Planning

Forest Activities program staff will utilize USEPA’s 9-element watershed planning framework to address existing and potential water quality issues in forested landscapes. Water quality improvement and protection can be achieved by identifying strategies and implementing projects that improve overall forest health and fire resilience in both burned and unburned areas. The focus of these efforts will be in watersheds where existing or potential water quality and beneficial use value are high, where poor forest management and/or changing climate have led to unhealthy forest conditions, and where the risk of high intensity wildfire and subsequent, post-fire erosion issues are greatest. With a higher rate of forest fires expected in the future, greater emphasis will be placed on pre-fire management activities aimed at mitigating the spread of forest fires and their impact on nearby surface water bodies.

4.3 Long-Term

Central Valley Water Board initiatives that are expected to begin more than seven years from now are summarized in Table 5 and discussed further in the following sections.

LONG-TERM INITIATIVES (GREATER THAN 7 YEARS)		
Section	Initiative	Summary
4.3.1	Basin Planning	Begin to develop basin plan amendments that account directly for climate change.
4.3.2	Central Valley Salinity Alternatives for Long-Term Sustainability Program (CV-SALTS)	Continue developing policies and regulatory solutions to address salt and nitrate issues within the region.
4.3.3	Mandatory Climate Action Plans	Require dischargers to prepare plans summarizing their planned responses to potential and expected impacts of climate change.
4.3.4	National Pollutant Discharge Elimination System (NPDES) Permits	Update permits requirements to include extreme weather contingency planning and other climate change-related elements.
4.3.5	Best Management Practice (BMP) Requirements	Update BMP requirements to more effectively address anticipated weather extremes.
4.3.6	Landfill Regulations (Title 27)	Title 27 permitting/regulatory changes.

Table 5. Summary of long-term initiatives

4.3.1 Basin Planning

Climate change impacts will be considered during the next Basin Plan triennial review, which is scheduled for 2018. The triennial review is a public review process that is conducted once every three years to identify and prioritize actions needed to address water quality concerns and maintain the effectiveness of the Basin Plan. After public input is received, the Central Valley Water Board develops and adopts by resolution a priority list of potential issues that may result in basin plan amendments.

The priority list guides development of a work plan for each Basin Plan which describes the actions the Central Valley Water Board may take to investigate and respond to issues. Many of the issues have not been investigated by staff, and detailed information was not provided in comments. These issues are described in broad conceptual terms. Before an issue can result in a basin plan amendment, staff must investigate the issue to identify the scope of potential basin plan amendment in conformance with applicable federal and state laws and regulations. After determining that a basin plan amendment is the appropriate means to address the issue, information, including the development of scientific justification, is prepared to support the amendment. Then the potential amendment undergoes a structured public participation process before it can be presented to the Central Valley Water Board for its consideration.

The Issue List and Work Plan for the 2014 Triennial Review of the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (2014 Triennial Review Work Plan; Central Valley Water Board 2015) was adopted on 16 April 2015. The 2014 Triennial Review Work Plan identified 14 issues that could potentially be developed into Basin Plan amendments. For each issue, the work plan presented ongoing actions and resources, along with longer-term actions and resources to needed to adequately address the issue. It is anticipated that the next triennial review work plan will be finalized in 2018, and will address the Central Valley Water Board's response to climate change-related issues. Climate change response actions may be formalized as basin plan amendments to outline the Central Valley Water Board's plan for achieving WQOs and protecting beneficial uses under changing environmental conditions.

4.3.2 Central Valley Salinity Alternatives for Long-Term Sustainability Program (CV-SALTS)

The long term nature of CV SALTS means that work will be continuing on policy and regulatory development. Although the exact deliverables for CV SALTS beyond the 2022 time frame mentioned above are not fully developed at this time, CV SALTS will continue its work on

comprehensive solutions to salt and nitrate issues in the Region. Climate change issues, especially as they relate to groundwater use and availability, will be critical to consider in this process

The Central Valley Water Board recently adopted a basin plan amendment to recognize Extended Dry Period conditions in the lower San Joaquin River with electrical conductivity water quality objectives that are different than the electrical conductivity water quality objectives when there is not an Extended Dry Period. The Salt and Nitrate Management Basin Plan Amendments are expected to also include consideration of dry periods that would provide different permit requirements during dry conditions. These amendments address salinity discharges and will occupy the Board in the short term. For the mid-term, the Board may want to evaluate the need for varying the water quality objectives for other constituents during drought or flood conditions. Basin plan amendments for other constituents would most likely be in the long-term.

4.3.3 Mandatory Climate Action Plans

Over the longer term, it will be necessary to ensure that NPDES and WDR facilities are appropriately prepared for the impacts of climate change. As such, both the NPDES and Waste Discharge to Land (non-15) programs will begin to require climate action plans as a condition of permit renewal. As with the voluntary plans described above, climate action plans in this context may be any plan or part of a plan that addresses responses to potential and expected impacts of climate change (e.g. more frequent and more intense rainfall events). In many cases these plans may be excerpted from broader city, county or regional climate change plans. As such, it may be important to understand how a specific facility's plans fit into the larger holistic context of a community's climate change response.

4.3.4 National Pollutant Discharge Elimination System (NPDES) Permits

Future permits will need to include contingency plans in the event of extreme weather events. The contingency plans would ensure wastewater treatment units are protected and impacts to surface waters are minimized during extreme weather events. This could result in the need for additional storage facilities to equalize high peak flows. Furthermore, results of data collection and trend analysis will be used to determine any permit requirements that may need to be updated. For example, permit requirements that may need to be updated in response to these trends could include revised dilution credits, additional water quality-based effluent limits, and salinity controls. Trend analyses will also be used to identify potential trigger point values (e.g., observed flow rates or temperatures) that would prompt changes in discharge permit requirements. For example, more restrictive limits on nutrient discharges may

be established if a specified surface water temperature value is recorded at a specified frequency.

In the future, staff will consider modelled weather extremes, in addition to observed environmental data, when determining permit requirements. This shift will necessitate a greater degree of collaboration between the NPDES program and other State and federal agencies involved in ongoing modelling efforts (Section 4.2.5). Future permits would also need to incorporate a higher degree of adaptability, such as a weather-dependent component whereby the discharge requirements vary based on surface water flow characteristics or extreme drought conditions. Examples of variable requirements include dilution credits that would vary based on surface water flows and salinity effluent limits that change considering extreme drought conditions. Future permits may allow for dischargers to conduct pilot projects whereby new techniques or processes are tested on an interim basis to evaluate their potential benefit towards helping dischargers achieve permit requirements.

4.3.5 Best Management Practice (BMP) Requirements

Regulatory program staff will review permittee BMP requirements to evaluate whether existing BMPs are protective of surface water and groundwater under future extreme weather scenarios. Surface water programs which routinely review permittee BMPs include Storm Water, Water Quality Certification, Forest Activities, Irrigated Lands, and Nonpoint sources. BMP requirements may be modified to more effectively address the higher temperatures, more intense storms, and greater fraction of precipitation falling as rain (versus snow) in the future. Erosion control and storm water management will be a major focus in future BMPs. In addition, the Title 27 groundwater regulatory program will evaluate landfill cover BMP requirements to ensure that BMPs demand covers which can withstand both long-term drought and also intense storm conditions under future climate scenarios.

4.3.6 Landfill Regulations (Title 27)

Title 27 program staff will participate in the State-wide Title 27 roundtable on regulatory changes related to landfill gas capture requirements associated with greenhouse gas reduction efforts, and storm water management requirements associated with anticipated changes in storm intensities. Staff will coordinate with CalRecycle on proposed permitting and regulatory changes to encourage the use of enhanced landfill gas capture and treatment technologies to reduce greenhouse gas emissions from landfills. Program staff will also evaluate whether changes to landfill cover requirements are needed to ensure covers appropriately designed to withstand the higher temperatures and storm intensities that are anticipated under future

climate conditions. Additional regulatory changes may also be needed based on the outcomes of the Title 27 roundtable.

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APPENDIX A

Beneficial Use Definitions

AGR - Agricultural Supply

Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

BIOL - Preservation of Biological Habitats

Uses of water that support designated areas or habitats, such as Areas of Special Biological Significance, established refuges, parks, sanctuaries, ecological reserves, or other areas where the preservation or enhancement of natural resources requires special protection.

COLD - Cold Freshwater Habitat

Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

GWR - Ground Water Recharge

Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

IND - Industrial Service Supply

Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization.

MIGR - Migration of Aquatic Organisms

Uses of water that support habitats necessary for migration, acclimatization between fresh and saltwater, or other temporary activities by aquatic organisms, such as anadromous fish.

MUN - Municipal and Domestic Supply

Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

NAV - Navigation

Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels.

POW - Hydropower Generation

Uses of water for hydropower generation.

PRO - Industrial Process Supply

Uses of water for industrial activities that depend primarily on water quality.

RARE – Rare, Threatened, or Endangered Species

Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.

REC-1 - Water Contact Recreation

Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

REC-2 - Non-Contact Water Recreation

Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tide pool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

SPWN - Spawning, Reproduction, and/or Early Development

Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

WARM - Warm Freshwater Habitat

Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

WILD - Wildlife Habitat

Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.