

Appendix H: Climate Change Memorandum

Appendix H provides the MCG-approved Climate Change Memorandum which summarizes climate change work performed within the watershed and identifies how MokeWISE projects may mitigate potential climate change effects.

**MokeWISE Program:
*Climate Change***

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Climate Change Overview

The State of California, along with scientific organizations, including the International Panel on Climate Change (IPCC), have documented changes in both global and local climate over the past 100 years and anticipate even more changes in air temperature, precipitation, and mean sea levels in the coming decades. In California, warming temperatures are expected to raise the snowfall elevation, causing more winter precipitation in the Sierra Nevada to occur as rainfall. This will lead to larger and earlier runoff events. As a result of these changes, several million acre-feet of natural snowpack storage could be lost annually, reducing available water supply. In addition, the increasing severity of storms and increased runoff could overwhelm existing reservoir flood protection capacity and increase flood risks downstream.

Water and environmental resources can be adversely affected in many ways, including by rising air and surface water temperatures, reduced snow pack, longer droughts, less frequent more intense storms, increased size and frequency of wildfires, and rising sea levels. These changes can affect all elements of water supply systems, from watersheds to reservoirs, conveyance systems, and treatment facilities.

Planning for these changes is necessary in order to ensure a reliable water supply, maintain water quality, protect against flooding and protect and restore ecosystems and habitat. As part of the MoKeWISE program, a review of climate change information developed by the Mokelumne-Amador-Calaveras (MAC) and Eastern San Joaquin (ESJ) Integrated Regional Water Management (IRWM) Regions and related subsequent publications was conducted to determine how climate change may impact the upper and lower watersheds, what water resources are most vulnerable, and strategies for addressing these vulnerabilities. This section provides a summary of the climate change vulnerabilities identified in the MAC and ESJ Regions, with updates from the State publications “Our Changing Climate 2012” and the “California Water Plan 2013 (CWP)”, which provide strategies included each of the regions’ IRWM plans. The summary identifies how the strategies address the vulnerabilities, and summarizes how each of the MoKeWISE projects aligns with these strategies for adaptation to climate change and to mitigate greenhouse gas emissions.

Consideration of climate change impacts to water resources is a required IRWM Plan Standard and the state recommends it in several planning efforts, including the Safeguarding California Plan, the California Water Plan (CWP), and the California Water Action Plan (CWAP). The potential for climate change impacts in the MoKeWISE region is significant. Projects implemented through this program should consider climate change to ensure that objectives are met and maximum benefit is achieved for the region.

Climate Change Vulnerabilities

Assessments of climate change vulnerabilities were identified in the MAC and ESJ IRWM Regions for their respective IRWM Plan updates. These vulnerability assessments focused on determining how vulnerable each Region's water resources are to climate change impacts on water demand, water supply, water quality, flood management, hydropower, ecosystems and habitat, and sea level rise. The vulnerability to increased wildfires of the MAC region has been added based on subsequent published information. The vulnerabilities identified for each IRWM region are listed in **Table 1**.

The MAC Region's highest priority vulnerabilities are water supply, water quality, ecosystem and habitat, increased water demand to fight wildfires, and hydropower. The ESJ Region's highest priority vulnerabilities include water reserve storage and management, water demand uncertainty, water quality and saline intrusion, and flooding and water logging in agricultural areas.

Table 1: Climate Change Vulnerabilities by IRWM Region

Vulnerability		MAC Region	ESJ Region	Both Regions
Water Demand	Increased water demand to fight increase in wildfires			X
	Increased demand for process cooling water for food processing industries with increased surface water temperatures			X
	Increased domestic demands with increased evapotranspiration			X
	Increased agricultural demands due to longer growing season, increased temperatures and evapotranspiration, and more frequent/severe drought			X
	Vulnerability of agricultural products to continued high temperature and changes to chilling hours (e.g. grapes for wine production, cherries)		X	
	Harm to grapes vines and impacts to harvest due to excessive winter precipitation		X	
	Increased power demands due to increased cooling needs in buildings		X	

	Increased power demands at vineyards to use power operated cooling equipment		X	
Water Supply	Decreased water supply due to decreased snowpack in the Sierra Nevada Mountains and shift in timing of seasonal runoff			X
	Water table decline due to inadequate recharge		X	
Water Quality	Reduced water quality due to saline water intrusion from sea-level and from lowered water tables/reduced streamflow		X	
	Higher concentrations of surface and groundwater contaminants due to lower surface water flows and lower groundwater tables			X
	Increased pesticide contamination to surface waters due to increased pesticide use (higher temperatures are more conducive to pests)			X
	Reduced dissolved oxygen content due to increased surface water temperatures			X
	Increased nutrient load to surface waters due to increase in wildfires			X
	Increased nutrient loading due to increased urban and agricultural seasonal runoff		X	
	Degraded surface and groundwater quality due to reduction of meadow area that can provide contaminant reduction	X		
Flood Management	Increased flooding in low-lying areas due to sea level rise and sea water intrusion into Delta		X	
	Increased flood inundation due to increased runoff in the winter and potentially fall			X
	Increased seasonal flooding due to increases in seasonal precipitation during winter and fall			X

	Increased flooding due to reduction of meadow area which help reduce floods in winter	X		
Hydro-power	Reduced hydropower generation due to lower reservoir levels caused by increased customer demand and changes in timing of seasonal runoff/flasher storm systems			X
Ecosystem and Habitat	Impacts to vegetation due to increased temperatures and evapotranspiration, changes in precipitation patterns and distribution, and more frequent/severe droughts and wildfires			X
	Reduced quality of fish habitat due to reduced water quality, lower flows and warmer water temperatures			X
	Hindered upward migration of anadromous fish due to low spring flow			X
	Shift of freshwater-saltwater habitat due to lower summer stream flows		X	
Sea Level Rise	Impacts to agricultural land in the Delta's reclaimed regions due to sea level rise		X	
	Exacerbated saline intrusion to surface and groundwater		X	
	Greater risk of levee overtopping or failure due to sea level rise		X	

Strategies for Addressing Climate Change

Identifying strategies that address the climate change vulnerabilities described above is a key step in adapting to climate change as well as mitigating greenhouse gas emissions. The MAC Region and the ESJ Region each identified Resource Management Strategies (RMS) from the 2009 California Water Plan (CWP) Update that would help them to meet their water resource management objectives, including identifying RMS that could address the Regions' climate change vulnerabilities. In addition, the RMS were evaluated for their ability to potentially reduce GHG emissions and mitigate climate change impacts of the energy needed to treat and distribute water.

Since selection of these strategies, the 2013 CWP Update was published. The following 10 “Essential Actions” are from the California Water Action Plan (CWAP) released by the California Governor in 2014, which align with the CWP. These essential actions are considered priorities for the State of California.

- Make Conservation a California way of life
- Invest in integrated water management and increase regional self-reliance
- Achieve the coequal goals for the Delta
- Protect and restore important ecosystems
- Manage and prepare for dry periods
- Expand water storage capacity and improve groundwater management
- Provide safe drinking water and secure wastewater systems to all communities
- Increase flood protection
- Improve operational and regulatory efficiency
- Identify sustainable and integrated financing

Within these Essential Actions there are 17 objectives:

- Strengthen Integrated Regional Water Management Planning
- Use and Reuse Water More Efficiently
- Expand Conjunctive Management of Multiple Supplies (groundwater & surface storage)
- Protect and Restore Surface Water and Groundwater Quality
- Practice Environmental Stewardship
- Improve Flood Management Using an Integrated Water Management
- Manage the Delta to Achieve the Coequal Goals for California
- Prepare Prevention, Response, and Recovery Plans
- Reduce the Carbon Footprint of Water Systems and Water Uses
- Improve Data, Analysis, and Decision-Support Tools
- Invest in Water Technology and Science
- Strengthen Tribal/State Relations and Natural Resources Management
- Ensure Equitable Distribution of Benefits
- Public Access to Waterways, Lakes, and Beaches
- Strengthen Alignment of Land Use Planning and Integrated Water Management
- Strengthen Alignment of Government Process and Tools
- Improve Integrated Water Management Finance Strategy and Investments

There are more than 300 specific actions in Update 2013, Vol. 1, Ch. 8, “Roadmap for Action” and Vol. 3, “Resource Management Strategies (RMS).” The strategies in the 2013 CWP Update are largely the same as those listed in the 2009 CWP Update, but with some additional strategies added including sediment management, outreach and engagement, and water and culture. The 2013 CWP Update strategies will be considered in detail in the next update of each regions’ IRWM Plans.

RMS selected for inclusion in the MAC and ESJ Regions’ Plans, the climate change vulnerabilities they help to address, and their contribution to GHG emissions mitigation in the Regions are shown in **Table 2**. The categories identified in this table correspond to the major areas identified in the CWP Update. Note that these RMS, defined in the 2009 CWP Update, were identified as relevant in the respective IRWM Plans, and reference in the MokeWISE program does not reflect endorsement of the strategies by any or all MCG members.

Table 2: RMS that Address Climate Change Vulnerabilities

Resource Management Strategy	Vulnerability Adaptation							Mitigation		
	Water Demand	Water Supply	Water Quality	Flood Management	Hydropower	Ecosystem & Habitat	Sea Level Rise	Energy Efficiency	Emissions Reduction	Carbon Sequestration
Reduce Water Demand										
Agricultural Water Use Efficiency	✓	✓			✓	✓		✓	✓	
Urban Water Use Efficiency	✓	✓			✓	✓		✓	✓	
Improve Operational Efficiency and Transfers										
Conveyance – Regional/Local		✓	✓	✓		✓		✓	✓	
System Reoperation		✓		✓	✓			✓	✓	
Water Transfers		✓						*	*	
Increase Water Supply										
Conjunctive Management and Groundwater Storage		✓	✓	✓		✓		*	*	
Precipitation Enhancement		✓			✓	✓		✓		
Recycled Municipal Water		✓				✓		*	*	
Surface Storage – Regional/Local		✓	✓	✓	✓	✓		*	✓	
Improve Water Quality										

Resource Management Strategy	Vulnerability Adaptation							Mitigation		
	Water Demand	Water Supply	Water Quality	Flood Management	Hydropower	Ecosystem & Habitat	Sea Level Rise	Energy Efficiency	Emissions Reduction	Carbon Sequestration
Drinking Water Treatment and Distribution		✓	✓					✓	✓	
Groundwater Remediation/Aquifer Remediation		✓	✓					*	*	
Matching Quality to Use	✓	✓	✓			✓		*	*	
Pollution Prevention		✓	✓			✓			✓	
Salt and Salinity Management		✓	✓			✓			✓	
Urban Runoff Management			✓	✓		✓		✓	✓	
Practice Resource Stewardship										
Agricultural Lands Stewardship	✓		✓							✓
Economic Incentives	✓	✓	✓		✓		✓	✓	✓	✓
Ecosystem Restoration		✓	✓	✓	✓		✓			✓
Forest Management		✓	✓	✓	✓					✓

Resource Management Strategy	Vulnerability Adaptation							Mitigation		
	Water Demand	Water Supply	Water Quality	Flood Management	Hydropower	Ecosystem & Habitat	Sea Level Rise	Energy Efficiency	Emissions Reduction	Carbon Sequestration
Land Use Planning and Management	✓	✓	✓	✓	✓		✓	✓	✓	✓
Recharge Area Protection		✓	✓	✓						✓
Water-dependent Recreation			✓	✓						✓
Watershed Management		✓	✓	✓	✓		✓	✓	✓	✓
Improve Flood Management										
Flood Risk Management		✓	✓	✓	✓		✓			✓
Other Strategies										
Irrigated Land Retirement	✓	✓	✓		✓			*	*	
Rain-fed Agriculture	✓	✓	✓		✓			✓	✓	

Strategies identified in the 2009 California Water Plan Update (Bulletin 160-09)

Key:

- ✓ Indicates that, in general, this will provide a beneficial effect
- X Indicates that, in general, this will provide an adverse effect
- * Indicates that this may provide either beneficial or adverse effects

MokeWISE Projects' Ability to Address Climate Change Vulnerabilities

The projects selected for inclusion in the MokeWISE program align with a number of the strategies identified above, and therefore are expected to help the Upper and Lower Mokelumne River watersheds adapt to climate change as well as mitigate greenhouse gas emissions. **Table 3** provides the name of each MokeWISE program project, and indicates each related vulnerability, resource management strategies implemented, and greenhouse gas (GHG) mitigation effects expected by the project. These projects provide a balance of benefits that will help to respond to climate change vulnerabilities.

Table 3: Project Potential for Implementing Resource Management Strategies

Projects	Related Vulnerabilities	RMS Implemented	GHG Mitigation Effects
1a. Re-Introduction of Fall-Run Chinook Salmon Upstream of Pardee Reservoir	<ul style="list-style-type: none"> • Impacted ecosystem and habitat 	<ul style="list-style-type: none"> • Ecosystem Restoration • Water-Dependent Recreation • Flood Risk Management 	<ul style="list-style-type: none"> • None
1b. High Country Meadow Restoration Program	<ul style="list-style-type: none"> • Degraded surface water and groundwater quality Impacted ecosystems and habitat 	<ul style="list-style-type: none"> • Ecosystem Restoration • Recharge Area Protection • Watershed Management • Flood Risk Management 	<ul style="list-style-type: none"> • Carbon Sequestration
1c. Mokelumne River Day Use Area Floodplain Habitat Restoration Project	<ul style="list-style-type: none"> • Increased flooding • Impacted ecosystem and habitat 	<ul style="list-style-type: none"> • Ecosystem Restoration • Recharge Area Protection • Watershed Management • Flood Risk Management 	<ul style="list-style-type: none"> • Carbon Sequestration
1d. Fish Screens for Riparian Diversions in the Lower Mokelumne River	<ul style="list-style-type: none"> • Impacted ecosystems and habitat 	<ul style="list-style-type: none"> • Watershed Management 	<ul style="list-style-type: none"> • None
1f. Riparian Restoration Program – Below Camanche River	<ul style="list-style-type: none"> • Degraded surface water and groundwater quality Increased flooding • Impacted ecosystems and habitat 	<ul style="list-style-type: none"> • Ecosystem Restoration • Recharge Area Protection • Watershed Management • Flood Risk Management 	<ul style="list-style-type: none"> • Carbon Sequestration
1g. Mokelumne Water Quality, Soil Erosion & Sedimentation Inventory/ Monitoring	<ul style="list-style-type: none"> • Decreased surface water quality 	<ul style="list-style-type: none"> • Sediment Management • Watershed Management 	<ul style="list-style-type: none"> • None

Projects	Related Vulnerabilities	RMS Implemented	GHG Mitigation Effects
2a. Municipal Recycled Wastewater Recharge Program	<ul style="list-style-type: none"> • Decreased water supply / Water table decline • Degraded surface water and groundwater quality 	<ul style="list-style-type: none"> • Conjunctive Management and Groundwater Storage • Recycled Municipal Water • Matching Quality to Use • Pollution Prevention 	<ul style="list-style-type: none"> • Energy Efficiency • Emissions Reduction
2b. Woodbridge Winery Wastewater Reuse	<ul style="list-style-type: none"> • Decreased water supply • Degraded surface water and groundwater quality 	<ul style="list-style-type: none"> • Conjunctive Management and Groundwater Storage • Recycled Municipal Water • Matching Quality to Use • Pollution Prevention 	<ul style="list-style-type: none"> • Energy Efficiency • Emissions Reduction
2c. Amador County Reuse	<ul style="list-style-type: none"> • Decreased water supply • Degraded surface water and groundwater quality 	<ul style="list-style-type: none"> • Recycled Municipal Water • Matching Quality to Use • Pollution Prevention 	<ul style="list-style-type: none"> • Energy Efficiency • Emissions Reduction
4a. Groundwater Banking within the Eastern San Joaquin Groundwater Basin	<ul style="list-style-type: none"> • Decreased water supply / Water table decline • Degraded surface water and groundwater quality 	<ul style="list-style-type: none"> • Water Transfers • Conjunctive Management and Groundwater Storage 	<ul style="list-style-type: none"> • Energy Efficiency • Emissions Reduction
4b. Amador and Calaveras Counties Hydrologic Assessment	<ul style="list-style-type: none"> • Decreased water supply / Water table decline • Degraded surface and groundwater quality 	<ul style="list-style-type: none"> • Water Transfers • Conjunctive Management and Groundwater Storage • Flood Risk Management 	<ul style="list-style-type: none"> • Energy Efficiency • Emissions Reduction

Projects	Related Vulnerabilities	RMS Implemented	GHG Mitigation Effects
4d. NSJWCD Infrastructure Improvements	<ul style="list-style-type: none"> Decreased water supply / Decreased water supply / Water table decline 	<ul style="list-style-type: none"> Conveyance – Regional/Local 	<ul style="list-style-type: none"> Energy Efficiency Emissions Reduction
5a. Regional Urban Water Conservation Program	<ul style="list-style-type: none"> Increased domestic / urban and commercial, industrial and institutional (CII) demands Degraded surface water and groundwater quality 	<ul style="list-style-type: none"> Urban Water Use Efficiency Matching Quality to Use Pollution Prevention Urban Runoff Management Economic Incentives 	<ul style="list-style-type: none"> Energy Efficiency Emissions Reduction
5b. Regional Agriculture Conservation Program	<ul style="list-style-type: none"> Increased agricultural demands Degraded surface water and groundwater quality 	<ul style="list-style-type: none"> Agricultural Water Use Efficiency 	<ul style="list-style-type: none"> Energy Efficiency Emissions Reduction Carbon Sequestration
7b. Raise Lower Bear Feasibility Study	<ul style="list-style-type: none"> Decreased water supply Increased seasonal flooding 	<ul style="list-style-type: none"> System Reoperation Water Transfers Conjunctive Management and Groundwater Storage Surface Storage – Regional/Local Watershed Management Flood Risk Management 	<ul style="list-style-type: none"> Energy Efficiency Emissions Reduction Carbon Sequestration
7c. Surface Storage Regional Assessment	<ul style="list-style-type: none"> Decreased water supply Increased seasonal flooding 	<ul style="list-style-type: none"> Surface Storage – Regional/Local 	<ul style="list-style-type: none"> Energy Efficiency Emissions Reduction
7d. Re-operation of Existing Storage	<ul style="list-style-type: none"> Increased seasonal flooding Reduced hydropower generation 	<ul style="list-style-type: none"> System Reoperation Surface Storage – Regional/Local Flood Risk Management 	<ul style="list-style-type: none"> Energy Efficiency Emissions Reduction
7f. Blue & Twin Lakes Dams Reliability & Replacement Assessment	<ul style="list-style-type: none"> Decreased Water Supply Increased Seasonal Floods 	<ul style="list-style-type: none"> Local/Regional Surface Storage 	<ul style="list-style-type: none"> Energy Efficiency Emissions Reduction

Projects	Related Vulnerabilities	RMS Implemented	GHG Mitigation Effects
8a. Jeff Davis Water Treatment Plant Replacement	<ul style="list-style-type: none"> Decreased water supply 	<ul style="list-style-type: none"> Urban Water Use Efficiency Surface Storage – Regional/Local Drinking Water Treatment and Distribution 	<ul style="list-style-type: none"> Energy Efficiency Emissions Reduction
8b. Rehabilitation of Transmission Main	<ul style="list-style-type: none"> Decreased water supply 	<ul style="list-style-type: none"> Urban Water Use Efficiency Conveyance – Regional/Local 	<ul style="list-style-type: none"> Energy Efficiency Emissions Reduction
8c. Barney Way Septic System Conversion	<ul style="list-style-type: none"> Decreased water supply Degraded surface water and groundwater quality 	<ul style="list-style-type: none"> Pollution Prevention Recharge Area Protection 	<ul style="list-style-type: none"> None
8d. Camanche Village Recycled Water Project	<ul style="list-style-type: none"> Decreased water supply Degraded surface water and groundwater quality 	<ul style="list-style-type: none"> Recycled Municipal Water Matching Quality to Use Pollution Prevention 	<ul style="list-style-type: none"> Energy Efficiency Emissions Reduction

References

California Natural Resources Agency. 2014. *California Water Agency Plan Implementation Report 2014-2018*. 30 January 2015. Available at:

http://resources.ca.gov/docs/california_water_action_plan/CA_WAP_Impl_Rpt-150130.pdf

Northeastern San Joaquin County Groundwater Basin Authority (GBA). 2007. *Eastern San Joaquin Integrated Regional Water Management Plan*. July 2007.

RMC Water and Environment. 2013. *Mokelumne/Amador/Calaveras Integrated Regional Water Management Plan Update*. January 2013.

DWR. 2009. *California Water Plan Update*. Bulletin 160-09. December 2009.

DWR. 2013. *California Water Plan Update 2013*. Bulletin 160-13. October 30, 2014.

CEC/CNRA. 2012. *Our Changing Climate, Vulnerability & Adaptation to the Increasing Risks from Climate Change in California*. California Energy Commission and California Natural Resource Agency. (Summary Report on the Third Assessment from the California Climate Change Center). July 2012.