

## **Appendix Q Climate Change Vulnerability Assessment**

---

# FINAL Technical Memorandum



---

## AWA UWMP 2015 Update

**Subject:** Climate Change Vulnerability Assessment  
**Prepared For:** Gene Mancebo, AWA  
**Prepared by:** Rachel Gross, RMC  
**Reviewed by:** Lindsey Wilcox and Leslie Dumas, RMC  
**Date:** February 16, 2016  
**Reference:** 0117-013

---

## 1 Climate Change Vulnerability Assessment

The *Draft 2015 Urban Water Management Plans Guidebook for Urban Water Suppliers* (DWR, 2015a) recommends climate change be addressed in 2015 Urban Water Management Plans (UWMPs). Specifically, the Guidebook recommends addressing climate change as follows:

- Include a narrative summary of climate change vulnerabilities as identified through completion of the Integrated Regional Water Management (IRWM) Climate Change Vulnerability Assessment, included as Appendix I to the Guidebook. The summary should include any planned actions to address the vulnerabilities and be included in Chapter 3, System Description.
- Discuss potential climate change impacts on water demands in Chapter 4, System Water Use. The results from the Water Demand portion of the Vulnerability Assessment can be incorporated into Chapter 4.
- Discuss potential climate change impacts on water supplies in Chapter 6, System Supplies. The results from the Water Supply portion of the Vulnerability Assessment can be incorporated into Chapter 6.

The following sections summarize the vulnerabilities of Amador Water Agency's water supply system to climate change as identified through completion of the Climate Change Vulnerability Assessment and based on the climate change analysis completed for the 2013 Mokelumne/Amador/Calaveras (MAC) IRWM Plan Update. The IRWM Climate Change Vulnerability Assessment Checklist is included as an attachment to this technical memorandum (TM). The TM provides the basis for the narrative that will be incorporated in Chapters 3, 4, and 6 of the Amador Water Agency (AWA or the Agency) 2015 UWMP.

### 1.1 Water Demand

Land use in the Agency's service area largely consists of forested and agricultural areas. Primary agricultural industries are wine grapes, cattle, grazing, alfalfa, corn, wheat, walnuts, and timber harvesting, and water demand for irrigation for these industries varies based on precipitation. Wine grapes alone make up 43% of the agricultural industry in Amador County, and they are particularly climate sensitive (Amador County Department of Agriculture, 2015). Shifts in daily heat patterns could result in additional water demand for these crops. The effects of increased air temperatures on agriculture will include faster plant development, shorter growing seasons, changes to evapotranspiration, potential heat stress, and shifts in demand for irrigation water. Irrigation demands in the nearby Sacramento Valley are expected to increase

by as much as 6% in the future, and similar increases would be expected in AWA's service area, resulting in increased water demands during summer months (RMC, 2013).

Overall, climate change is expected to cause more frequent and severe droughts, thus increasing the seasonal and annual variability of water demand. Water use in AWA's service area varies by more than 50% seasonally, making the region vulnerable to increases in seasonal water use. Seasonal water uses, such as landscape irrigation demands, are expected to increase due to climate change (RMC, 2013). An increase in drought frequency and severity could also cause an increased dependence on groundwater pumping. Although groundwater makes up a small portion of AWA's supply, the groundwater source is fractured aquifers and shallow alluvial basins, which may lack resiliency to drought events. During the current drought (2012-2016), wine grape growers in the Shenandoah Valley area have been experiencing falling ground water levels. Reports indicate that some growers (such as Vino Noceto) are drilling wells from their current elevation of 175 feet to over 400 feet in order to obtain adequate water supplies. Other grape growers are experiencing similar ground water problems. One grape grower, Rancho Victoria, will initiate use of reclaimed water due to insufficient groundwater. Currently, grape growers in the Shenandoah Valley are undertaking a study to evaluate options for surface water due to the concerns over adequate ground water. There are approximately 3,000 acres of wine grapes in the Shenandoah Valley in addition to other agricultural crops. Although AWA's customers have responded excellently to use curtailments put in place during the current drought (2012-2016), demand hardening may become a concern as droughts become more frequent and severe.

Climate change may lead to difficulty with balancing water demands, as changes in snowmelt, drought frequency, and seasonal use patterns may exacerbate ecosystem vulnerabilities. Other users of the Mokelumne River, including East Bay Municipal Utility District (EBMUD) and Pacific Gas & Electric Company (PG&E), have regularly released cold pool water to keep the water temperatures downstream appropriate for Steelhead trout and other anadromous fish. This environmental demand may compete with municipal and agricultural water needs in the future.

## 1.2 Water Supply

Climate change is expected to lead to a shift in precipitation patterns so that more winter precipitation falls as rain rather than snow, thus increasing the winter streamflow and decreasing the spring and summer streamflow of the Mokelumne River (RMC, 2013). Overall Sierra Nevada snowpack is also expected to decline by 48-65% (DWR, 2015b), threatening AWA's heavily surface water dependent supply. This decline in snowpack, combined with earlier springtime runoff and reduced spring and summer stream flows will likely affect AWA's surface water supplies and could lead to an increase in the use of groundwater resources. However, groundwater in the AWA service area is limited and unreliable and exhibits significant supply and quality issues. If groundwater use increased and extreme drought conditions occurred, impacts to groundwater quantity and quality could be expected to be similar to the 1976-1977 drought, in which wells went dry. Because the Agency's existing water supply sources consist of primarily surface water (96%) and groundwater (4%), its supply portfolio is not diverse, resulting in significant vulnerabilities to climate change. If surface water supplies are reduced in the future, reliance upon the unpredictable yields and quality of groundwater would increase. While the Agency has never failed to meet customer demands during droughts, unpredictable supply reliability in the future emphasizes the need for diversification of water supplies. Projects including increases in storage, recycled water, conjunctive use, and long-term planning proposed through MokeWISE and the MAC IRWMP would help to diversify supply to strengthen resiliency against drought and changing streamflow patterns.

The current reservoir system must leave some space open for flood control, a function that will continue to be important as climate change causes earlier springtime runoff and increased storm intensity. Increasing storage volume in this reservoir system would increase resilience to droughts by increasing capacity to store excess water during wet years. This capacity is currently extremely limited, as AWA has very little carry-

over storage, aside from 1,600 AFY in the Lower Bear Reservoir for the CAWP system. Proposed projects in MokeWISE and the MAC IRWMP would alleviate this issue by increasing storage through dam replacement, sediment removal, or conjunctive use.

### 1.3 Water Quality

Water quality is likely to be affected by climate change through extreme increases and decreases in precipitation and increasing air and water temperatures. In surface water, earlier snowmelt and more severe storm events may lead to increased erosion and turbidity, which may exacerbate AWA's existing sensitivity to storm-related high turbidity events. Buckhorn Water Treatment Plant was replaced in 2004 in large part due to inability to meet water quality standards after severe storm events. It is still sensitive to high levels of turbidity, as are the Tanner and Ione treatment plants. These plants must sometimes be operated at a reduced capacity following severe storm events, as chemical and backwash use increases to adequately treat highly turbid water. Maintaining adequate water quality may become more challenging as storm events become more frequent and severe.

Conversely, overall decreases in summertime precipitation may lead to higher concentrations of contaminants in water supply sources such as surface and groundwater and increased surface water temperatures (RMC, 2013). The combination of higher water temperatures and decreased low flows in the Mokelumne River may result in poor water quality that will not meet ecosystem demands. Additionally, current water quality issues in Lake Amador due to wastewater discharge into Jackson Creek by the City of Jackson may worsen as seasonal low flows decrease.

While low dissolved oxygen levels and algal blooms have not been issues in local reservoirs, higher water temperatures in still water bodies, such as Camanche Reservoir and Pardee Reservoir, could lead to water quality issues such as these (RMC, 2013). Other threats to water quality include increased surface water contamination due to increased probability of wildfires and sewer system overflows due to flooding. Amador County is a high fire danger area, and the recent Sand and Butt fires demonstrate the degraded water quality during major rain event. The decrease in water quality was demonstrated by EBMUD's water quality monitoring data below the Butt Fire area. If surface water supplies become scarce and reliance on groundwater increases, the Agency would be relying upon a water supply with more unpredictable yields and quality. As groundwater reliance increases, overdraft could occur and quality could be further degraded.

### 1.4 Sea Level Rise

Since the Agency's service area is not located in a coastal region, it is not vulnerable to sea level rise issues such as flooding, impacts to structures, or impacts to habitat. There is the potential for the Agency's service area to be affected by sea level rise indirectly if required stream releases from the Mokelumne River increase in the future to maintain salinity fronts in the Sacramento-San Joaquin Delta. This would decrease the amount of water from the Mokelumne River available for supply to the Agency.

### 1.5 Flooding

Since climate change is likely to increase the intensity of precipitation events, floods may become more common. Storm-related runoff may also increase due to rising snowlines that increase the surface area in watersheds that receive precipitation as rain instead of snow (RMC, 2013). Additionally, the increase in the risk of wildfires also increases the risk of floods, as burned areas increase the level of runoff after a storm event. Many of the dams in Amador County are operated for flood control, so operations of reservoirs may require modifications in response to flood events and earlier springtime runoff. These dams are aging, but there are no immediate concerns about their ability to provide flood protection. Although the overall risk

of flooding due to climate change will increase, it is unlikely that it will heavily affect the Agency's service area since none of the county is in the 200-year flood plain.

## 1.6 Ecosystem and Habitat Vulnerability

Amador County is primarily a natural area, including a section of Eldorado National Forest and large areas of designated rural or open space. There are riparian, wetland, forest, and alpine habitats in this region that support a broad variety of plant and animal life. Increasing temperatures due to climate change will lead to declines in alpine and subalpine forest as well as a shift from evergreen conifer forest to mixed evergreen conifer forests and grasslands (RMC, 2013). The increase in wildfire risk due to hotter and drier conditions will augment the conversion of woodlands to grassland as grasses are more drought tolerant and re-establish more rapidly than forest after burning (RMC, 2013). Most recently, the Butt Fire (2015) in the Mokelumne River Watershed is expected to augment the conversion of woodland to grasslands. Additionally, trees are threatened by higher temperatures that will reduce trees' capacity to resist pest attacks while also increasing pest survival rates. Endangered or threatened plant species may have a lower capacity to adapt to climate change. In Amador County, these species include Ione manzanita, Ione buckwheat, Irish hill buckwheat and Sacramento orcutt grass (AECOM, 2014).

Other species in Amador County that may have difficulty adapting to climate change due to their threatened or endangered status are vernal pool fairy shrimp, valley elderberry longhorn beetles, vernal pool tadpole shrimp, Central Valley steelhead, Chinook salmon, California tiger salamanders, California red-legged frogs, Swainson's hawks, Bald eagles, Bank swallows, and wolverines (AECOM, 2014).

Increasing temperatures will increase freshwater temperatures which may reduce local salmon and steelhead trout populations and increase the risk of their extinction (RMC, 2013). Salmon and other anadromous fish are also threatened by increased silt levels in water due to the increased likelihood of erosion and sedimentation due to climate change. Additionally, the migration patterns of these fish are impeded by dams, so increasing storage may negatively affect anadromous fish populations. Other aquatic life and riparian habitats will be affected by the changes in chemical composition of surface water due to warmer temperatures. Lower summertime flows caused by climate change may exacerbate intermittent flow of smaller streams, so fish may be confined in warm, stagnant pools during portions of the summer (AECOM, 2014).

Decreased flows in the Mokelumne River may have negative impacts on both ecosystem and recreational activities. Criteria for the minimum environmental flow requirements for the Mokelumne River are included in EBMUD's water right under D-1641 and are actively managed by EBMUD, the Department of Fish and Wildlife, and the U.S. Fish and Wildlife Service. Through the Federal Energy Regulatory Commission License Project No. 137, PG&E must also manage flow releases and certain recreational activities on the Mokelumne River in the Amador County. AWA must work with these agencies to balance these flow requirements with municipal and recreational needs (including kayaking and river rafting) if there is a decrease in summertime flows on the Mokelumne River due to climate change.

## 1.7 Hydropower

Both (PG&E) and (EBMUD) own and operate hydroelectric facilities on the Mokelumne River. PG&E's Mokelumne River Hydroelectric Project consists of four hydropower generating units that have a total capacity of 206 megawatts (MW). EBMUD generates an average of 185 million kilowatt-hours (KWh) annually at dams at the Pardee and Camanche reservoirs. Both of these hydropower generation systems are reliant on snowmelt from the Sierra Nevada. Changes to the volume of snowfall and timing of melting as a result of climate change may require modifications to reservoir operations for the purposes of flood control. Changing operations within the hydropower systems may affect electrical general capabilities in addition to downstream water releases.

Demand for hydropower is expected to increase, as overall energy demand will increase due to development in the area and renewable energy demand will increase due to consumer and government pressure on PG&E to produce energy from clean sources.

## 2 References

AECOM. 2014. *Amador County General Plan Environmental Impact Report, Biological Resources*. October 2014.

Amador County Department of Agriculture. 2015. *2014 Amador County Agricultural Crop & Livestock Report*. July 2015.

California Department of Water Resources (DWR). 2015a. *Draft 2015 Urban Water Management Plans Guidebook for Urban Water Suppliers*. November 2015.

California Department of Water Resources (DWR). 2015b. *California Climate Science and Data for Water Resources Management*. June 2015.

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