2011 Climate Change Monitoring and Response Plan

East Bay Municipal Utility District

EBMUD

July 2011

TABLE OF CONTENTS

1.0 Introduction

1.1 Background

Climate change is a growing threat to the entire planet, and water resources are predicted to be one of the first significant areas to be impacted. Although the full impact of climate change has not been felt, the District must plan for climate change to ensure that it can continue to provide reliable, high quality water and wastewater services to its customers. In 2008, a climate change objective was added to the Long Term Water Supply Goal in the District's Strategic Plan to ensure the District plans for the impacts of climate change and mitigates its own impact on climate change.

The District's work on climate change is an interdepartmental effort led by the Operations and Maintenance Department. The Operations and Maintenance Department leads the Climate Change Committee, which was established to coordinate the District's work on climate change. Members of the committee include staff from the Office of General Counsel, Engineering and Construction Department, Wastewater Department, Natural Resources Department, Water Conservation Division, and the Office of the General Manager. Five working groups were established to focus on science and assessment; impacts, vulnerability, and adaptation; mitigation; legislation and regulation; and public outreach.

This plan updates the Climate Change Monitoring and Response Plan prepared in July 2010. The next update to this plan will be completed in 2014 when the Intergovernmental Panel on Climate Change (IPCC) releases its Fifth Assessment Report or sooner if there is a significant climate change update.

1.2 Purpose

The purpose of this document is to advise the District's future water supply, water quality, and infrastructure planning, to support "no regrets" infrastructure investment decisions, and to guide mitigation of District greenhouse gas emissions that contribute to climate change.

The science of climate change is still developing; consequently, the District's work to address climate change will continue to evolve as the science of climate change is better understood, and the District will adapt to changes in the environment.

1.3 Accomplishments

The District is a leader in the water industry in addressing climate change and has made many significant accomplishments. These include:

- Analysis of climate change impacts on the District's water supply.
- Producing renewable energy from several sources including hydropower, photovoltaic (PV) and biogas cogeneration at the District's main wastewater treatment plant
- Installed 776 kilowatts of new PV at five District facilities.
- Continued participation in industry committees, conferences, and workshops on climate change including the Climate Ready Water Utility Working Group and the EPA's Climate Change Risk Assessment and Awareness Tool Working Group.
- Reducing potable water demand through water conservation and recycling.
- Maintaining a 58 vehicle hybrid-electric sedan fleet.

1.4 Action Plan Overview

The District's overall climate change strategy is to develop a plan to inform the District's future water supply, water quality, and infrastructure planning, and support "no regrets" infrastructure investment decisions, and mitigate District greenhouse gas emissions that contribute to climate change. This strategy will be accomplished through the following objectives:

- Assess climate change science and develop scenarios that illustrate a range of impacts from key variables including temperate rise, sea level rise, precipitation, snow pack and runoff
- Use the scenarios to identify critical infrastructure vulnerabilities and make cost-effective infrastructure investments adaptable to a range of foreseeable conditions (i.e., "no regrets" investments)
- Account for operational and infrastructure greenhouse gas emissions and participate in carbon credit generating programs
- Encourage and promote the cost-effective use and generation of renewable energy within the District's water and wastewater system operations consistent with District Policy 7.07.
- Educate policymakers on District and industry climate change concerns and interests, and advocate for reasonable legislation and regulatory changes
- Inform the public how the District is affected by and responding to climate change

1.5 Recommendations

The District continues to invest in climate change research, risk assessment, education and mitigation. The Climate Change Committee recommends the District focus on the following areas over the next two years:

- Incorporate climate change considerations into all level one (primary) and level two (sub-element) master plans. This includes, but is not limited to, identifying GHGs resulting from project construction and operations, and evaluating potential impacts of climate change when assessing facility sizing, location, operational flexibility, water quality, and water supply diversification.
- Complete the District's 2011 greenhouse gas emissions inventory.
- Investigate new renewable energy projects consistent with Policy 7.07 on renewable energy.
- Develop an energy management strategy and publish an annual report on energy use and generation at the District.
- Compile key internal studies and memos on climate change into a single resource document.
- Continue to monitor key parameters in our watersheds and around the state including temperature, precipitation, snow-covered area and runoff.
- Identify operational efficiencies and land-use practice changes to mitigate District emissions.
- Monitor, review, and, where warranted, actively participate in shaping legislation and proposed rules on climate change (Section 5).
- Review and update EBMUD's website information about climate change annually.
- Inform the public on the District's response to climate change.
- Identify planned capital projects that would help the District respond to climate change.
- Partner with other agencies and/or local universities to understand the impact of climate change on the District.
- Participation on the EPA's Climate Resilience Evaluation and Awareness Working Group.
- Continue to participate in climate change activities at the national level to help guide the climate change research and policies related to the water and wastewater industry.

2.0 Science and Assessment

Information in this section is based on the findings in the Fourth Assessment Report (AR4) and other studies as notes in the report. Development of the IPCC Fifth Assessment Report (AR5) is currently underway and is scheduled to be completed by October 2014. Working Group I's report on the Physical Science Basis for the AR5 is scheduled to be completed September 2013.

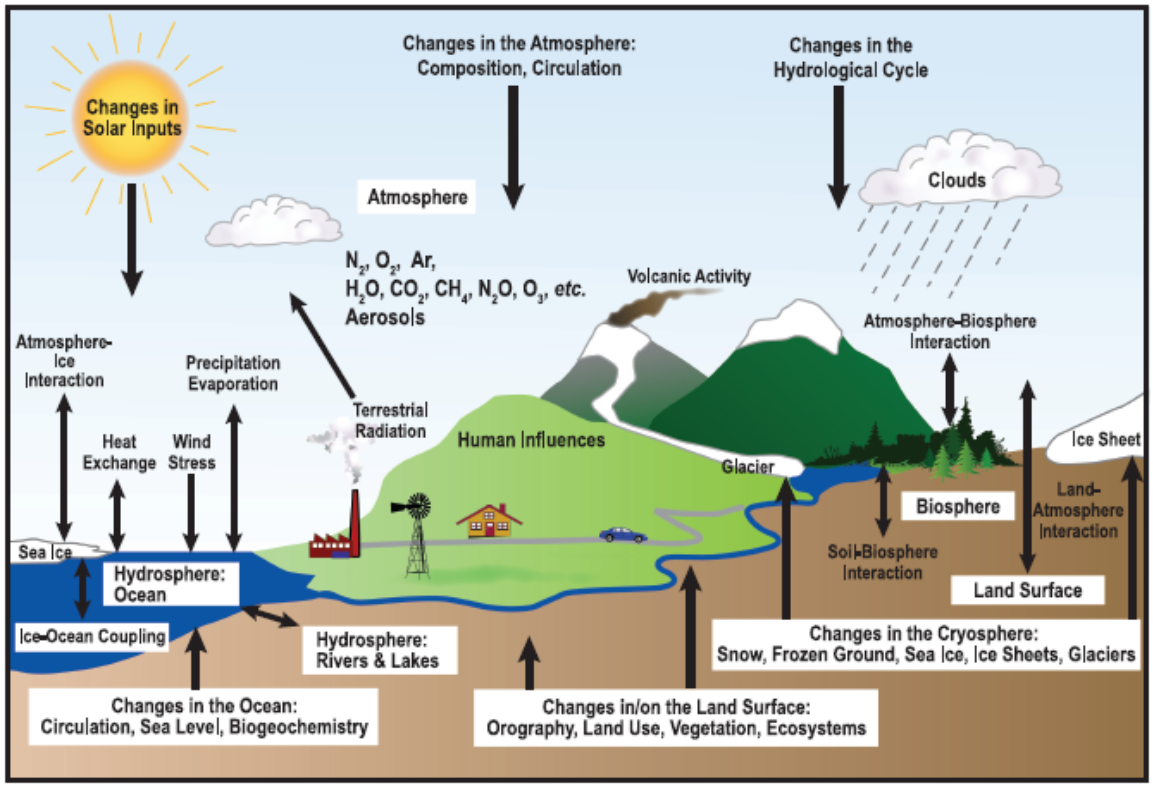
2.1 Relationship Between Climate Change and Weather

Chapter 1 of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) provides a good description of the relationship between climate and weather. An excerpt from the chapter is summarized below.

> Climate is generally defined as average weather. Observations can show that there have been changes in weather, and it is the statistics of changes in weather over time that identifies climate change. A common confusion between weather and climate arises when people ask how climate can be predicted 50 years from now when we cannot predict the weather the next week. The chaotic nature of weather makes it unpredictable beyond a few days. Projecting changes in weather (i.e., long-term average weather) due to changes in atmospheric composition is a more manageable issue. As an analogy, it is impossible to predict the age at which any particular man will die; however, we can say with high confidence that the average age of death for men in industrialized countries is about 75 years.

Figure 2.1 shows the components of the climate system, their processes and interactions.

Figure 2.1: Components of the Climate System (IPCC AR4, 2007)



2.1 Human and Natural Drivers of Climate Change

CLIMATE CHANGE SCENARIOS

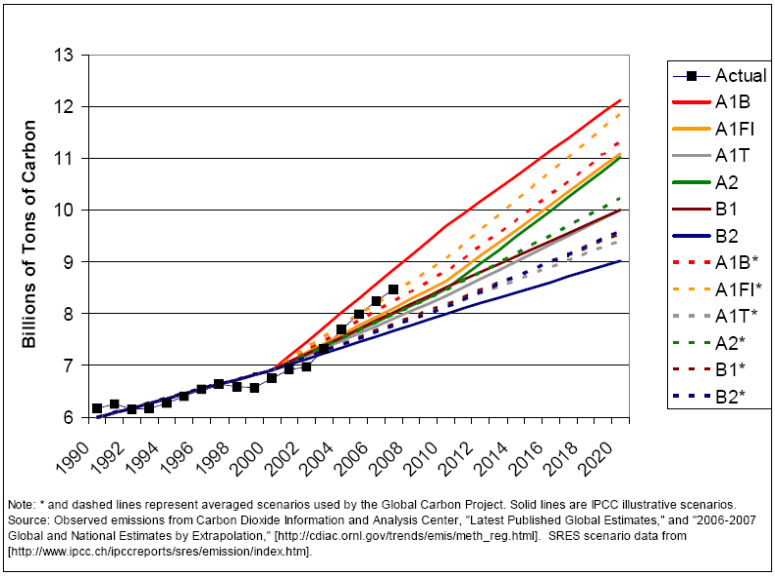
According to the IPCC AR4, there is a high level of agreement and considerable evidence that global GHG emissions will continue to grow over the next few decades given the current climate change mitigation policies and related sustainable development practices. The AR4 climate projections are based on a number of General Circulation Models (GCM) and emission scenarios (identified as A1, A2, B1 and B2). These scenarios are described in Table 2.1 below and are covered in greater detail in the AR4 report.

TABLE 2.1: GHG Emissions Scenarios[i]

Scenario	Description
A1	A world of very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technologies
A1fi	Technology change is fossil-intensive
A1t	Non-fossil energy sources
A1b	Balance of fossil and non-fossil intensive
A2	Very heterogeneous world with high population growth, slow economic development and slow technological change
B1	A convergent world with the same global population as A1, but more rapid changes in economic structures toward a service and information economy
B2	A world with intermediate population and economic growth, emphasizing local solutions to economic, social and environmental sustainability

The AR4 scenarios are the basis for the temperature, precipitation, and sea level rise projection ranges used in this Monitoring and Response Plan. In 2008, the Congressional Research Service compared actual GHG emissions to the IPCC scenarios and concluded that the actual GHG emissions is less than the worse-case scenario in the IPCC but greater than the numerical average of all model results for each of the IPCC scenario storylines (Figure 2.2).

Figure 2.2: Comparison of Actual Carbon Emissions with SRES Illustrative and Average Scenarios[ii]



Note: * and dashed lines represent averaged scenarios used by the Global Carbon Project. Solid lines are IPCC illustrative scenarios.
Source: Observed emissions from Carbon Dioxide Information and Analysis Center, "Latest Published Global Estimates," and "2006-2007 Global and National Estimates by Extrapolation," [http://cdiac.ornl.gov/trends/emis/meth_reg.html]. SRES scenario data from [http://www.ipcc.ch/ipccreports/sres/emission/index.htm].

ATMOSPHERIC GHG CONCENTRATION AND RADIATIVE FORCING COMPONENTS

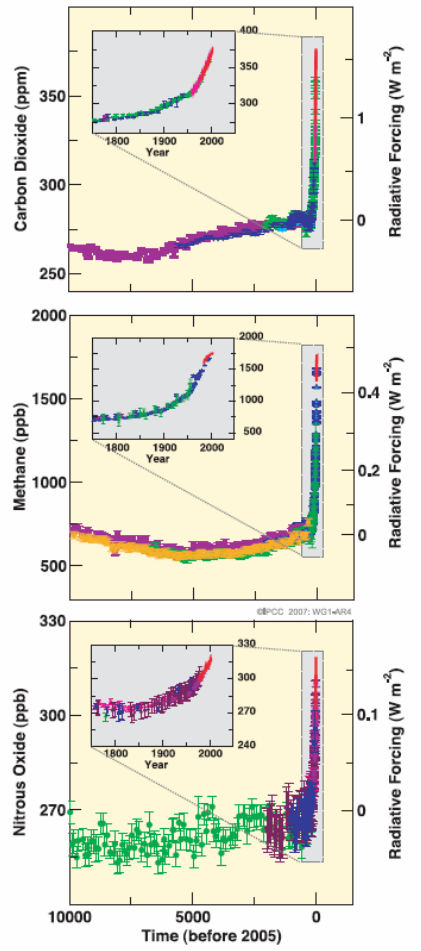
The AR4 report concluded that global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have "increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years." Global GHG emissions due to human activities have grown since pre-industrial times with an increase of 70 percent between 1970 and 2004.[iii]

The source of the increase in anthropogenic greenhouse gases is from fossil fuel use, agriculture, and to a lesser extent, land-use changes.

- Carbon dioxide has increased from a pre-industrial level of about 280 ppm to 379 ppm in 2005 and exceeds the natural range over the last 650,000 years (180 ppm to 300 ppm) as determined from ice cores.[iv]
- Methane has increased from pre-industrial levels of about 715 ppb to 1774 ppb in 2005 and exceeds the natural range over the last 650,000 years (320 ppb to 790 ppb) as determined from ice cores.[v]
- Nitrous oxide has increased from pre-industrial levels of about 270 ppb to 319 ppb in 2005.[vi]

Figure 2.3 below shows the historical changes in GHG concentrations for carbon dioxide, methane and nitrous oxide.

FIGURE 2.3: Changes in GHG from Ice Core and Modern Data (IPCC 2007)



In addition to GHGs, there are a number of other sources that contribute to radiative forcing. Other anthropogenic factors include ozone, stratospheric water vapor, and surface albedo. Natural factors include solar irradiance and volcanic aerosols.

The understanding of anthropogenic warming and cooling influences on climate have improved since the IPCC's Third Assessment Report, leading to a very high confidence the global average net effect of human activities since 1750 has been one of warming.[vii]

2.2 Observations of Recent Climate Change

The AR4 report concluded the warming of the climate is "unequivocal" based on observations of increases in global air and ocean temperatures, widespread melting of snow and ice, and rising sea levels.

Some of the findings from the AR4 report are listed below.

- Eleven of twelve years between 1995 to 2006 rank among the twelve warmest years in the instrumental record of global surface temperature since 1850
- Global average sea level has risen since 1961 at an average rate of 1.8 mm per year and since 1993 at 3.1 mm per year
- Satellite data since 1978 show annual average Arctic sea ice extent has shrunk by 2.7 percent per decade, with larger decreases in summer by 7.4 percent per decade
- Mountain glaciers and snow cover on average have declined in both hemispheres
- There is high confidence some hydrological systems have been affected through increased runoff, earlier spring runoff and earlier spring peak discharge in many glacier-fed and snow-fed rivers and through effects on thermal structure and water quality of warming rivers and lakes
- In some marine and freshwater systems, shifts in ranges and changes in algal, plankton and fish abundance are with high confidence associated with rising water temperatures, as well as related changes in ice cover, salinity, oxygen levels and circulation.

Spring runoff over the last century has decreased as shown in Figure 2.4. The figure shows the fraction of spring runoff in eight major rivers in the western Sierra Nevada (as a fraction of the water year total) has decreased approximately 10 percent over the last century.

FIGURE 2.4: April to July Spring Runoff as a Fraction of Water Year Total[viii]

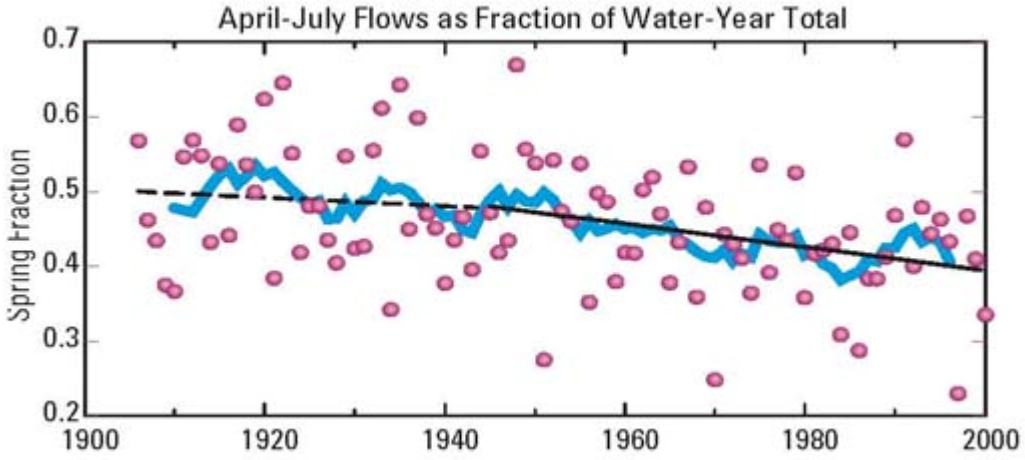
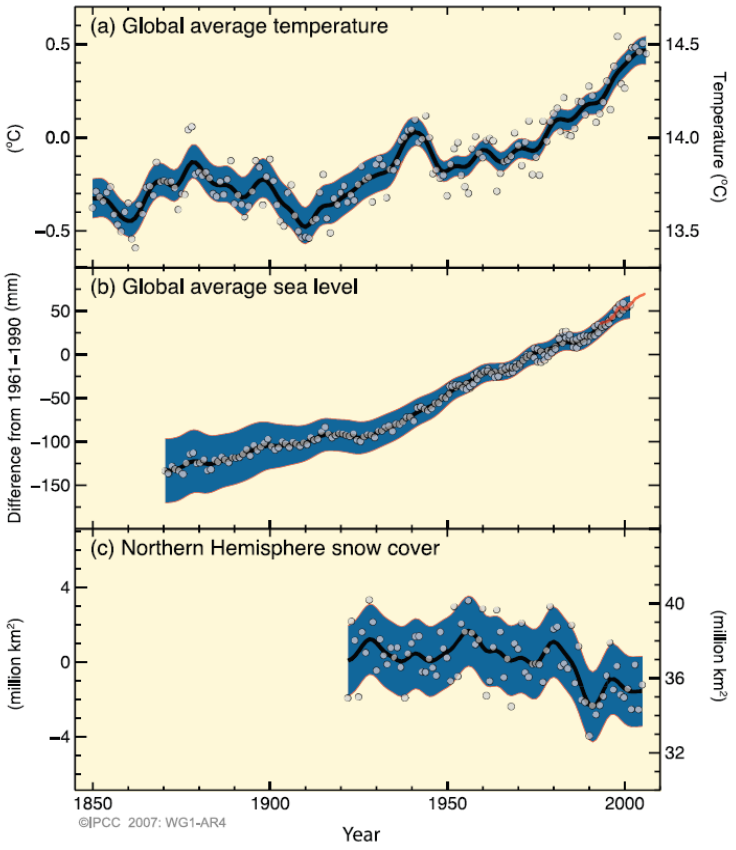


Figure 2.5 below from the AR4 report illustrates the observed increase in global temperature and sea level and decrease in snow covered area over the past 150 years. These trends show the global average temperature has risen approximately 1°C over the last 150 years, the sea level has risen approximately 180 mm over the same period of time, and the snow covered area in the Northern Hemisphere has decreased by approximately 5 percent over the last 90 years.

FIGURE 2.5: Temperature, Sea Level and Snow Cover Changes[ix]



Most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations. In fact, models show the increase in temperature across the globe over the land and in the ocean can only be attributed to natural and anthropogenic forcings. Natural forcings alone cannot account for the observed increase in temperature.[x]

2.3 Projections of Future Climate Change

The science of climate change is continuing to evolve and there are challenges in applying the projections to determine the impact to water utilities. These challenges include the difficulty in downscaling the GCMs to project regional effects, unknown future emission conditions and unknown future water demands. In addition, there are uncertainties and biases with all of the GCM, which adds to the challenges of interpreting the data and incorporating the results into planning studies. However, it is generally agreed that climate change will alter precipitation and temperature in the future, which will likely affect water supply and, water demand, and the way in which water is managed.

The potential impacts to the District include:

- Increased demands for outdoor water use

- Increased challenges in reservoir management (balancing water supply and flood control)
- Increased drought frequency, intensity, and duration
- Increased flooding resulting in infrastructure impacts
- Decreased snowpack
- Changes in the timing of the Mokelumne River spring runoff

TEMPERATURE

Table 2.2 shows the estimated global average surface warming from the AR4 report at 2090-2099 relative to 1980-1999.

TABLE 2.2: Projected Global Average Surface Warming[xi]

Case	Best Estimate	
	Best Estimate	Likely Range (^oC)
Constant Year 2000 Concentrations	0.6	0.3-0.9
B1 Scenario	1.8	1.1-2.9
A1T Scenario	2.4	1.4-3.8
B2 Scenario	2.4	1.4-3.8
A1B Scenario	2.8	1.7-4.4
A2 Scenario	3.4	2.0-5.4
A1FI	4.0	2.4-6.4

For the Western United States, temperatures could rise 2 to 7.5^{o}C by the end of the century depending on the emissions scenario by the end of the century, which is higher than the average global increase in surface temperature. Table 2.3 shows the projected warming (2090-2099 temperatures relative to 1980-1999) for Western North America.

TABLE 2.3: Projected Average Surface Warming for Western North America from 2090 to 2099[xii]

Low Emissions	Medium Emissions	High Emissions
Likely Range: 2-5^{o}C	Likely Range: 3-7^{o}C	Likely Range: 4-8^{o}C

PRECIPITATION

The AR4 report concluded that increases in the amount of precipitation are *very likely (>90 percent probability)* in higher latitudes, while decreases are *likely (>66 percent probability)* in most subtropical land regions (by as much as 20 percent). For North America there is a trend toward greater precipitation with the ensemble mean projecting a 20 percent increase. For Central California, however, there is a weak trend towards greater precipitation, and depending on the model possibly a decrease in precipitation.[xiii]

SEA LEVEL RISE

Sea level is projected to rise another 0.6 to 1.9 feet by the end of the century. Table 2.4 shows the projected sea level rise from the AR4 report for the various emission scenarios. The projections in the table exclude future rapid dynamical changes in ice flow.

Models for sea level rise do not include the full effects of changes in ice sheet flow. The projections include a contribution due to increased ice flow from Greenland and Antarctica at rates observed from 1993 to 2003, but these rates could increase or decrease in the future. Larger values cannot be excluded, but understanding of these effects is too limited to assess their likelihood or provide a best estimate or an upper-bound for sea level rise.

TABLE 2.4: Projected Sea Level Rise[xiv]

Case	Sea Level Rise (measured at 2090-2099 relative to 1980-1999)
Constant Year 2000 Concentrations	NA
B1 Scenario	0.18-0.38
A1T Scenario	0.20-0.45
B2 Scenario	0.20-0.43
A1B Scenario	0.21-0.48
A2 Scenario	0.23-0.51
A1FI	0.26-0.59

APRIL 1 SNOW COVERED AREA

The California Department of Water Resources concluded for a 4°C rise in temperature, the April 1 snow-covered area in the Mokelumne Watershed could decrease to 26 percent (compared to the current April 1 snow-covered area of 50 percent) as shown in Table 2.5. This represents 52 percent reduction in the snow covered area when compared to the current April 1 snow covered area. This estimate is based on a projected rise of 500 feet in the snow level for every 1°C rise in temperature.

TABLE 2.5: Snow Covered Area Changes with Temperature (Mokelumne Basin)[xv]

Mean Elevation (feet)	Avg Apr 1 Snow line (feet)	Total Area (sq mi)	Snow Covered Area	1°C Rise	2°C Rise	3°C Rise	4°C Rise	5°C Rise
5030	5000	575	50%	43%	38%	31%	26%	20%

HEAT WAVE DURATION AND FREQENCY

Heat waves, defined by the IPCC as at least five consecutive days with a maximum temperature higher than the average by at least 5°C, are projected to become more frequent. The AR4 report projected by the end of the 21st century, the heat wave durations for the Western United States could increase from approximately 5 days today to 85 days in the worse case scenario by 2100.[xvi] Table 2.6 summarizes the projected increase in heat wave duration for the Western United States.

TABLE 2.6: Heat Wave Duration

Scenario	2050	2100
Low Emissions	20 days	40 days
Medium Emissions	30 days	70 days
High Emissions	35 days	85 days

GROWING SEASON LENGTH

The AR4 report projected that by the end of the 21st century, the growing season length for the Western United States could lengthen between 19 to 28 days depending on the emissions scenario. Table 2.7 below summarizes the projected increases in growing season length for the Western United States. An increasing growing season length will result in increased water usage and a shift in water demand patterns.

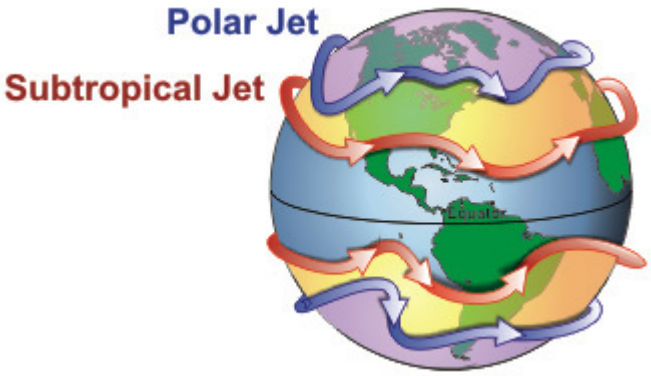
TABLE 2.7: Increase in Growing Season Length

Scenario	2050	2100
Low Emissions	12 days	19 days
Medium Emissions	14 days	26 days
High Emissions	18 days	28 days

JET STREAM

Recent research describes how the jet stream may be affected by climate change. The studies find the troposphere (the lowest level of the atmosphere) is warming and moving higher in elevation (by about 900 feet). [xvii] [xviii] Since the troposphere is where most of the weather occurs and the difference in the temperature between the troposphere and the stratosphere is the main factor in what creates the jet stream, the warming and rising of the troposphere is being linked to the poleward shift and weakening of the jet stream.

The mechanisms behind the wind circulation and the jet stream are complex; the graphic below illustrates the subtropical and polar jet streams in both the northern and southern hemispheres.



Both the subtropical and polar jet streams have been observed moving poleward according to the recent research. Previous computer models showed the tropical zone (the region of the earth between the Tropic of Cancer and the Tropic of Capricorn) would expand approximately 2 degrees (125 miles) by the end of the 21st century due to the poleward shift of the jet stream resulting from climate change,. However, recent studies show that the zone has already expanded more than this prediction – approximately 2 to 4.8 degrees of latitude (125 miles to 300 miles). Therefore, if the tropical climate is heading poleward, the typically drier subtropical zones (areas immediately north and south of the tropical zone) may be moving poleward as well. And with the jet stream moving poleward, presumably so would the storm tracks.

The latest research reports poleward movement on the order of 12 miles per decade; however, previous studies indicate the poleward movement may be as high as 30 miles per decade. By the middle of the century (in the next 40 years), the jet streams may shift anywhere from 48 to 120 miles, which may make our current climate more like Central California.

FOREST FIRES

Recent studies conclude the increase in wildfire activity can be correlated with rising seasonal temperatures and the earlier arrival of spring. In a review of 1,166 forest wildfires from 1970 to 2003 in the Western United States, researchers compared the number and potency of wildfires to spring and summer temperatures and the timing of snowmelts.[xix]

The study found in the mid 1980's there was a jump of four times the average number of wildfires in the West compared with the early 1980's and 1970's. The total area burned was six-and-a-half times greater in the mid 1980's than the earlier years examined. The wildfire season also has extended by 78 days in the more recent period of 1987 to 2003 compared to 1970 through 1986.

2.4 District Climate Observations

MOKELUMNE RIVER TRUE NATURAL FLOW

Figure 2.6 shows the Mokelumne River true natural flow (TNF) since water year 1930.

Figure 2.6: Mokelumne River TNF – Water Years 1930 to 2010

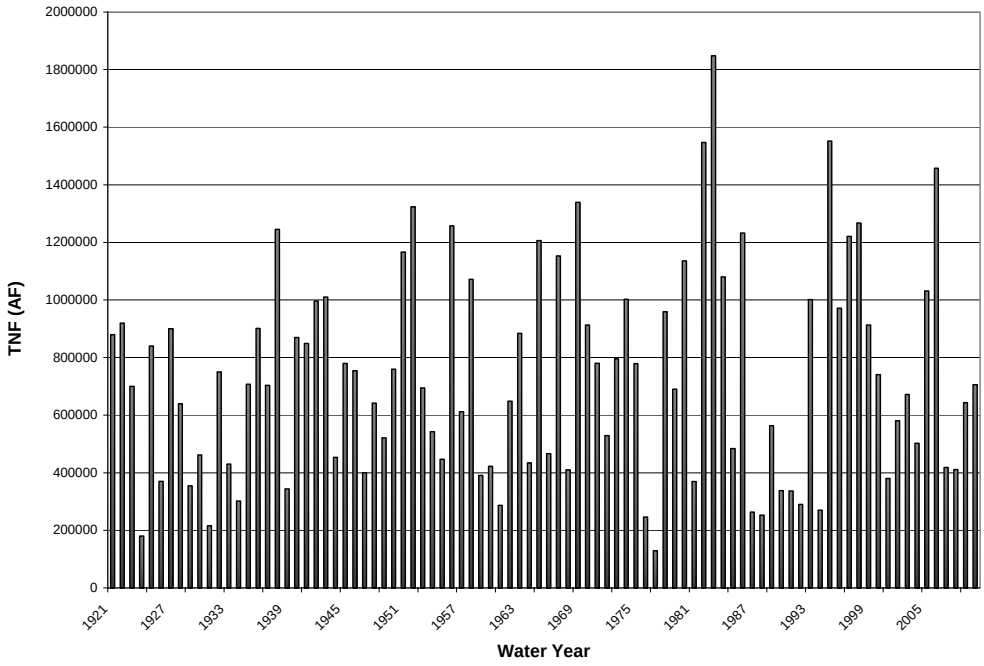


Figure 2.7 shows the rolling 10-year average of the percent of dry years. This graph assumes that a dry year is when the annual TNF is less than 500 TAF.

Figure 2.7: Rolling 10-year Average Percent of Dry Years

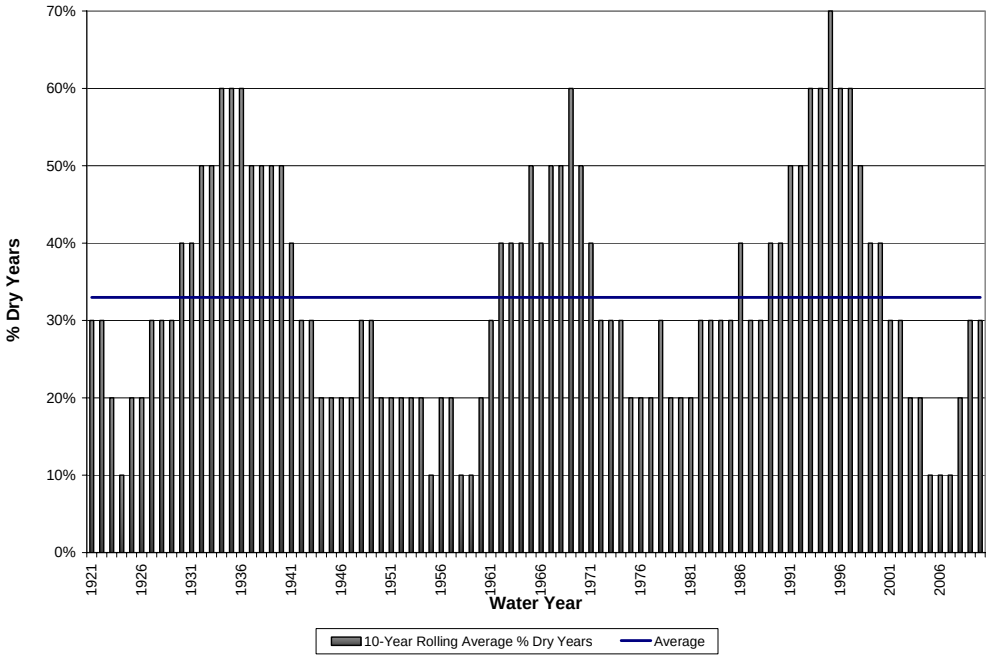
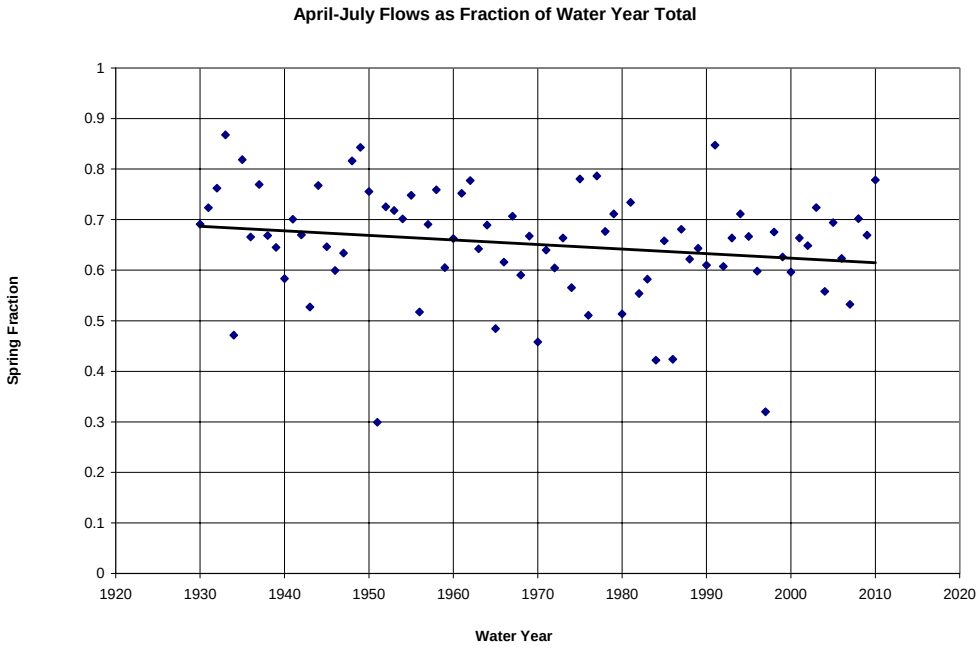


Figure 2.8 shows the percent spring runoff versus the total annual runoff since water year 1930 for the Mokelumne River.

Figure 2.8: April to July Flows as Fraction of Water Year Total



SNOW WATER CONTENT

Figures 2.9 and 2.10 show the snow water content (SWC) on April 1 at two stations (Elevation 8000 feet and 7100) since the 1930's. Also shown on the plot is the average SWC over all years and the 10-year average.

Figure 2.9: Caples Lake April 1 Snow Water Content

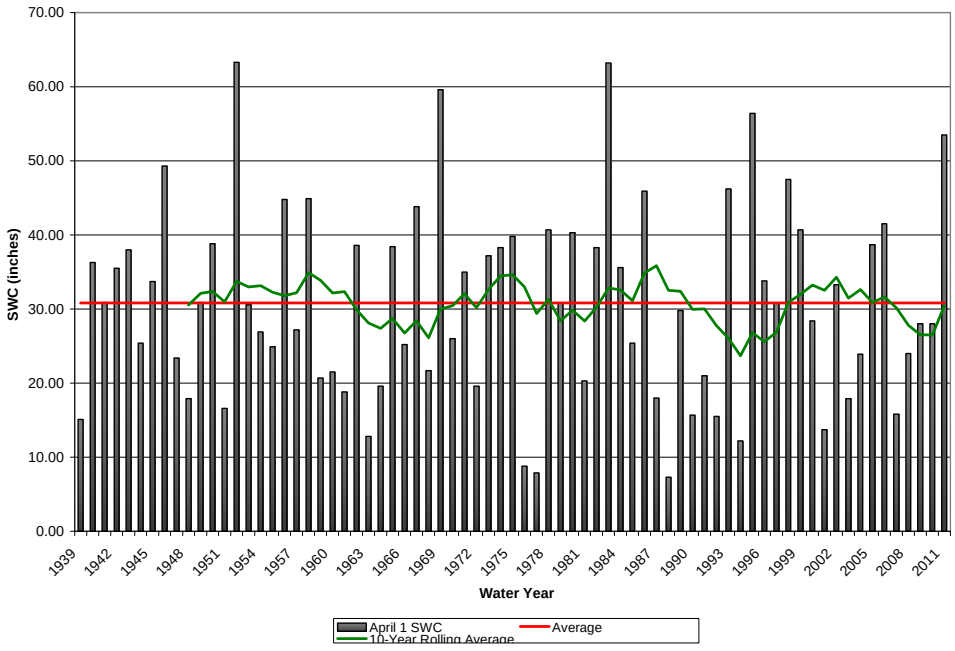
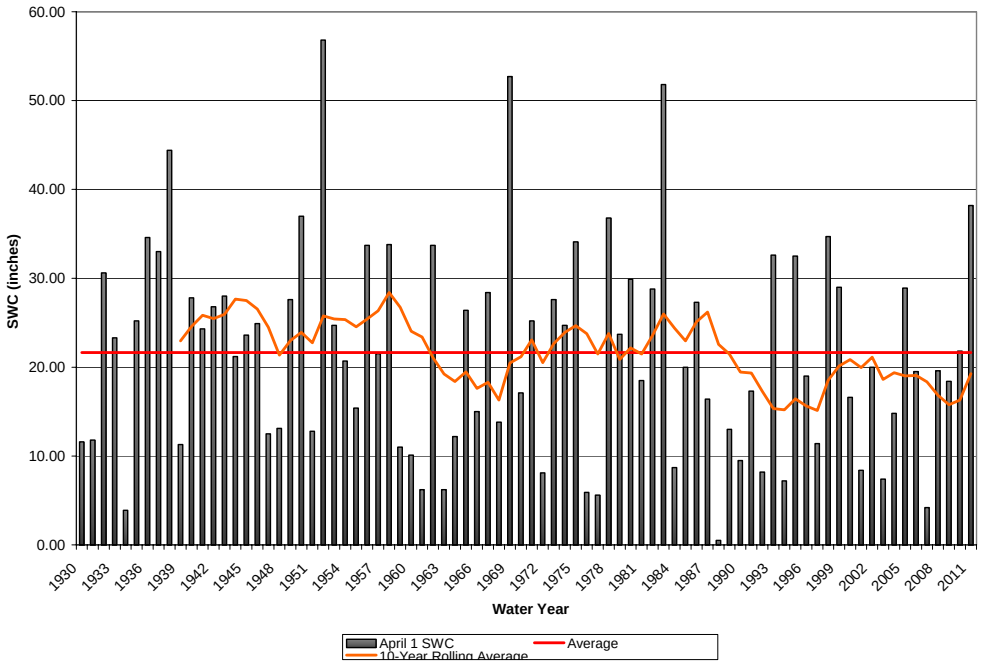


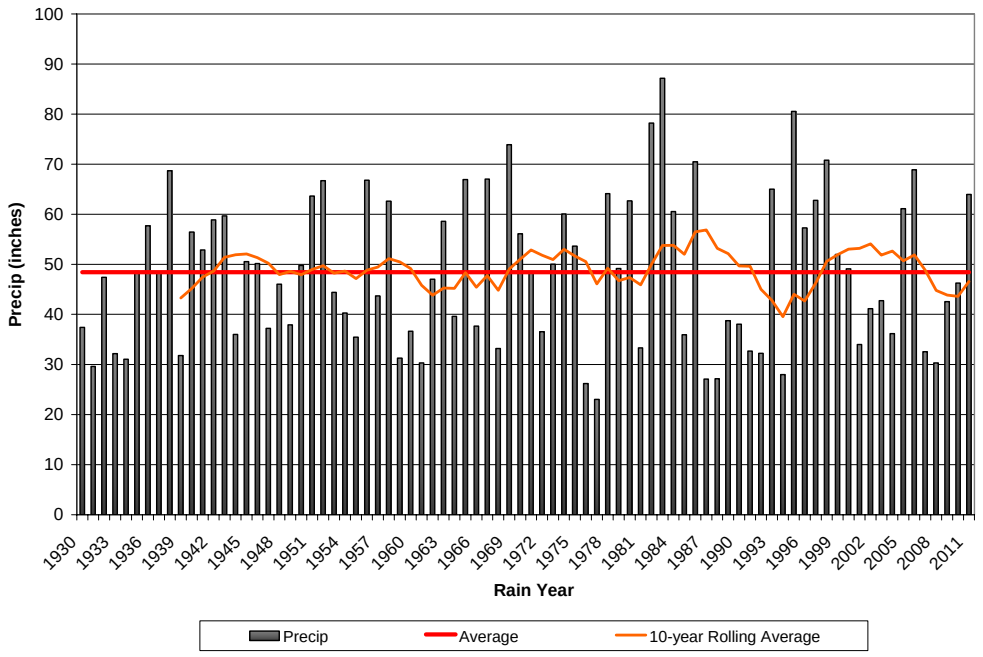
Figure 2.10: Silver Lakes April 1 Snow Water Content



PRECIPITATION

Figure 2.11 shows the Mokelumne 4-Station annual precipitation since 1930. Also shown on the figure are the average precipitation and the 20-year standard deviation from the average.

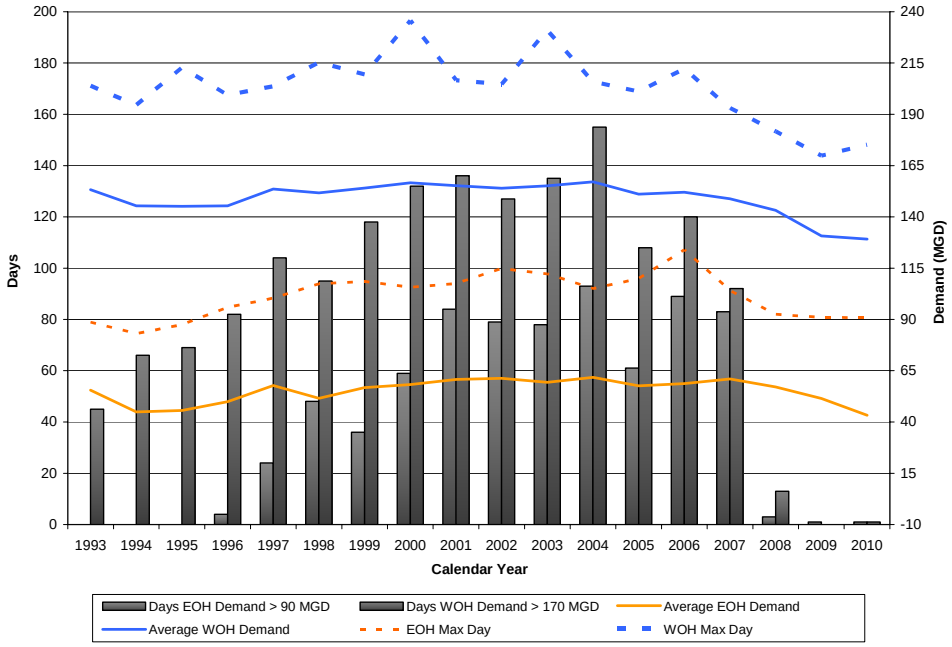
Figure 2.11: Mokelumne 3-Station Annual Precipitation



WATER DEMAND

Figure 2.12 shows gross water production since 1993. The bar chart shows the number of days East-of-Hills production was greater than 90 MGD and West-of-Hills production was greater than 170 MGD. For the same period, the graph also shows the average production and max day demand for both East- and West-of-Hills.

Figure 2.12: East and West-of-Hills Max Day Demands



2.5 Assessment of Climate Change Impacts

Climate change is projected to have many impacts on the District. This section provides a brief assessment of the potential impacts to the District and is covered in greater detail in Section 3 of this plan.

- **Water Supply.** Impacts to carryover storage as a result of decreased runoff and the timing of the runoff.
- **Water Year Types.** Increase in the number of critically dry years.
- **Water Demand.** Increase in water usage and droughts as a result of a warmer climate.
- **Water Quality.** Decrease in water quality as a result of warmer water temperatures and increasing peak runoff.
- **Hydropower Generation.** Impact to generation as a result of changes in runoff patterns and management of cold water pool.
- **Flooding.** Increase in storm surge flood events as a result of sea level rise.
- **Flood Control Management.** Challenges managing flood control as a result of the timing of the runoff and increasing peak runoff.
- **Cold Water Management.** Challenges managing cold water pool in Camanche and Pardee Reservoirs as a result of increases in dry water year types and warming rivers and reservoirs.
- **Fishery Impacts.** Challenges managing fisheries in the Mokelumne River.
- **Infrastructure Impacts.** Impacts to infrastructure and the Delta due to sea level rise.
- **Wastewater.** Challenges managing more extreme and/or concentrated flows, increased risk of flooding and infiltration and inflow associated with sea level rise.

3.0 Impacts, Vulnerabilities, and Adaptation

This section evaluates the District services and operations that could potentially be impacted by climate change, identifies potential vulnerabilities to District's critical facilities, and identifies possible adaptation measures.

3.1 Potential Impacts

This section provides an overview of the services and operations the District provides, the potential effects that climate change may have, and how these effects could potentially impact the services provided by the District.

OVERVIEW OF OPERATIONS AND SERVICES PROVIDED BY THE DISTRICT

The District provides a number of services including water supply, water treatment and distribution, wastewater treatment, power generation, and recreation. As part of the impact evaluation, these water services are grouped into Demand and Supply, and wastewater services are divided into Collection, Treatment, and Discharge as shown in Figure 3.1.

POTENTIAL IMPACTS OF CLIMATE CHANGE ON SERVICES PROVIDED BY THE DISTRICT

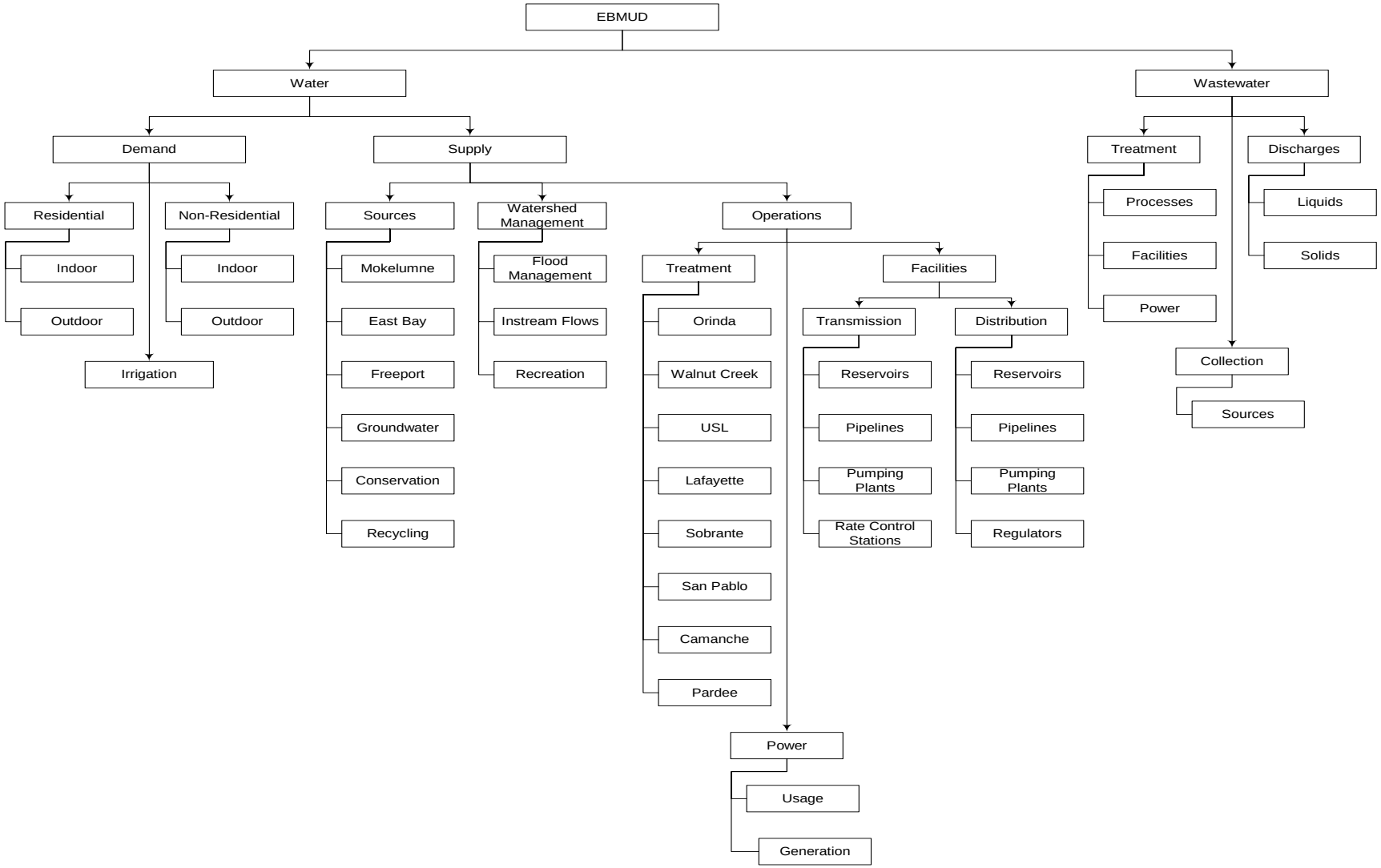
As identified in the Science and Assessment chapter, climate change may affect the following areas:

- Increasing average atmospheric temperature
- Increasing or decreasing precipitation
- Sea level rise
- Reduced April 1 snow-covered area
- Increased variability in runoff patterns
- Increasing heat wave duration, frequency, and intensity
- Increase in water demand
- Increasing growing season length
- Shifting jet stream
- Increasing forest fires

These effects may result in the following changes:

- Increased average annual atmospheric temperatures and heat wave days
- Increased water temperatures
- Increased ratio of rain to snow (R/S), delayed onset of the snow season, accelerated rate of spring snowmelt, and shortened overall snowfall season
- Changes in the timing, intensity, location, and amount of precipitation
- Increased evaporation
- Long-term changes in watershed vegetation
- Changes in source water quality

Figure 3.1: Overview of Operations and Services Provided By EBMUD



The potential changes can significantly impact water supply regionally and locally. Regionally, the potential impacts of climate change on California's water resources are identified in the Progress on Incorporating Climate Change into Management of California's Water Resources Technical Memorandum issued by Department of Water Resources (DWR) in July 2006[xx]. The potential local climate change impacts on District operations and services are identified and summarized in Tables 3.1 and 3.2.

Table 3.1: Potential Water Resource Impacts and Local Expected Consequences

Potential Water Resource Impact	Expected Consequences
Increased temperatures and heat wave days	• Increased water demand • Increased power demand • Increased water-based recreation demand
Increased ratio of rain to snow, delayed onset of the snow season, accelerated rate of spring snowmelt, and shortened overall snowfall season	• Potential annual water storage loss in the EBMUD's snowpack • Increased challenges for reservoir management and balancing the competing concerns of flood protection and water supply
Changes in the timing, intensity, location, and amount of precipitation	• Potential increased storm intensity and increased potential for flooding; increased stormwater flows in wastewater system • Possible increased frequency, intensity and duration of droughts • Increase in the number of critically dry years • Possible reduced reservoir storage levels • Possible significant fluctuations in reservoir storage levels
Increased evaporation	• Decrease in water supply • Increase in water demand • Increase in fire hazard
Long-term changes in watershed vegetation	• Changes in the intensity and timing of runoff • Possible increased incidence of flooding and increased sedimentation • Possible critical effects on listed and sensitive plant and animal species • Potential changes in source water quality
Sea level rise	• Inundation of coastal marshes and estuaries • Increased salinity intrusion into the Sacramento-San Joaquin River Delta • Increased potential for Delta levee failures • Increased potential for salinity intrusion into coastal aquifers (groundwater) • Increased potential for flooding near the mouths of river due to backwater effects • Impacts on wastewater outfalls/backflow • Potential impact on customer base
Increase in water temperatures	• Possible critical effects on listed and sensitive aquatic species • Increased environmental water demand for temperature control • Possible increased problems with foreign invasive species in aquatic ecosystems • Potential adverse changes in water quality, including the reduction of dissolved oxygen levels and increased nutrients
Increased frequency and intensity of wildfires	• Potential adverse changes in water quality, including increased sediment and nutrients • Increased water demand

Table 3.2: Potential Impacts and Consequences to Operations and Services provided by the District

Potential Impacts	Expected Consequences	
	Operations & Services	**Expected Consequences**
Increased temperatures & heat wave days	Demand - Non-residential	Increases in commercial landscape irrigation (golf courses, outdoor commercial usages such as golf courses, cemeteries, etc.) and commercial and industrial cooling Changes in season demand patterns (food processing, irrigation)
	Demand - Residential	Increases in water demand (due to increase net evapotranspiration) Changes in seasonal demand patterns (primarily irrigation)
• Increased ratio of R/S, delayed onset of the snow season, accelerated rate of spring snowmelt & shortened overall snowfall season. • Increased evaporation • Long-term changes in watershed vegetation • Change in the timing, intensity, location & amount of precipitation	Sources	Loss of annual water supply from the Sierra snowpack Increase in drought frequency Increase in potential for invasive species Increase in adverse changes in water quality (physical and biological) Increase in erosion/sedimentation
• Increased temperatures & heat wave days • Long-term changes in watershed vegetation • Increased frequency & intensity of wildfires • Increased ratio of R/S, delayed onset of the snow season, accelerated rate of spring snowmelt & shortened overall snowfall season • Change in the timing, intensity, location & amount of precipitation	Watershed Management	Increase in flooding incidence Increase in needs to balance between flood protection and water supply Increase in difficultly maintaining instream flows Increase in environmental water demand for instream temperature control Increased difficulty in maintaining recreational quality
• Increased temperatures & heat wave days • Increased ratio of R/S, delayed onset of the snow season, accelerated rate of spring snowmelt & shortened overall snowfall season • Increased water temperatures • Increased frequency and intensity of wildfires • Change in water quality • Increased evaporation • Change in the timing, intensity, location & amount of precipitation	Operations	Increased difficultly and cost in treatment due to degraded water quality (taste& odor; sediment) More stringent regulations Increase in O&M cost to prevent/treat invasive species Increase in potential for salinity intrusion into coastal aquifers (groundwater) Greater challenges for reservoir management and balancing the competing concerns of flood protection and water supply Shorten facility life cycles due to higher usage -

Table 3.2: Potential Impacts and Consequences to Operations and Services provided by the District

Potential Impacts	Expected Consequences	
	Operations & Services	**Expected Consequences**
• Sea level rise		to treat and to deliver - to meet higher demands Changes in demand patterns potentially offsetting storage to demand ratio Increase in energy usage and costs to meet higher seasonal demands
• Sea Level Rise • Change in the timing, intensity, location & amount of precipitation	Wastewater Collection	Increase in energy usage due to increased infiltration and inflow Increase in corrosion rates due to lower wastewater flows and longer residence times in collection systems Increased vulnerability to sanitary sewer overflows due to increased intensity of precipitation events
• Increased temperatures • Change in the timing, intensity, location & amount of precipitation	Wastewater Treatment	Increase in wastewater contaminant concentrations, possibly impacting biological treatment processes, due to reduction in wastewater flows caused by decreased runoff and water conservation under drought conditions Increase in stormwater infiltration and inflow, caused by increases in rainfall intensity during wet weather, resulting in higher peak flows at treatment plants
• Increased temperatures • Change in the timing, intensity, location & amount of precipitation • Sea level rise	Wastewater Discharge	More stringent discharge requirements and higher pollutant reduction rates due to lower freshwater flows, under drought conditions, to receiving waters Increase in saltwater infiltration for collection systems in low-lying areas which may cause an increase in wastewater total dissolved solids concentration and potential for plant upsets. Increased pumping energy required at outfall

3.2 Vulnerability

While it is generally accepted that average temperature will increase in California over the next century, other predictions are less certain. EBMUD reviewed the state of climate change science and concluded that it was not advisable to take one of many global climate change models and try to estimate temperature and precipitation at the watershed level. Instead, the District took a bottom-up approach by evaluating the vulnerability of the District supply system. A sensitivity analysis was completed to determine how the system would be most vulnerable to changing climatic parameters.

CLIMATE CHANGE SENSITIVITY ANALYSES FOR WSMP 2040

A number of parameters were varied in a model of the EBMUD water supply system to determine the sensitivity of the District's operations and services to climate change. As part of the sensitivity analysis, assumptions were varied one at a time and not compounded for the following cases:

- Changes in customer demands resulting from a 4°C increase in air temperature
- Changes in the timing of Mokelumne River runoff corresponding to 2°C, 3°C, and 4°C increases in air temperature
- Reductions in Mokelumne River runoff corresponding to 10% and 20% reductions in precipitation

The following is a summary of the District's sensitivity analyses.

- **Supply.** Carryover storage is susceptible to earlier springtime runoff because winter storage capacity is reduced during winter to provide flood control reserve, making it more likely that some runoff cannot be captured in the District's reservoirs in the spring. The District analysis found that carryover storage was more likely to be reduced and to a greater degree as temperature increases and runoff occurs earlier. For example, for 4°C of warming, carryover storage was reduced in 56 percent of the years modeled, with an average decrease of 6 percent during those years. Carryover storage is even more sensitive to a decrease in annual runoff. In approximately 70 percent of years analyzed in the hydrologic record, carryover storage is reduced by 12 percent and 24 percent for the 10 percent and 20 percent annual decrease in runoff scenarios, respectively. This likely would result in a severe shortage of water.
- **Demand.** A warmer climate is projected to increase water demand. EBMUD estimated that water demand will increase by 10 MGD by 2040 if average temperature in the service district increases by 4°C.
- **Flood Control Management.** The volume of flood control releases in winter and spring are significantly reduced when annual runoff is reduced. Annual flood volumes decrease, on average, by 43 percent for the 10 percent reduction scenario and decrease by almost 75 percent for the 20 percent reduction scenario. The volume of flood releases in winter and spring are affected by earlier spring runoff. November through March flood control release volumes increased by 66 percent, 81 percent, and 89 percent, on average, for the 2°C, 3°C, and 4°C scenarios, respectively. For the April through July period, releases decreased by slightly smaller magnitudes.
- **Water Temperature**. Simulations were run to evaluate the anticipated changes in water temperature flowing into Pardee Reservoir as a result of 2°C, 3°C, and 4°C increases in ambient air temperature. The results show that minimum, average and maximum water temperatures would be expected to increase as a result of increasing ambient temperature. In a dry year, water temperature increases ranged from 0.3°C to 1.5°C. In a below normal year, water temperature increases ranged from 1.0°C to 3.5°C. In an above normal year, water temperature increases ranged from 1.1°C to 2.5°C.

Historically, three out of ten years are dry years in the Mokelumne basin. Runoff is strongly correlated with precipitation and spring snow water content. With a 10 percent reduction in precipitation, the number of dry years is projected to increase to four out of ten years, and with a 20 percent reduction in precipitation, the number of dry years is projected to increase to five out of ten years.

VULNERABILITY ASSESSMENT

The Impacts, Vulnerability, and Adaptation (IVA) Working Group is comprised of representatives from Water Distribution Planning, Water Supply Operations, Wastewater Planning, Legislative

Affairs, Water Supply Improvements, Natural Resources, and Water Treatment and Distribution. The IVA Working Group identified the following as high-priority areas of vulnerability:

Water Supply & Demand

Reduced precipitation would greatly impact water supplies and the need for supplemental supplies to meet increased demand.

Watershed Management

- A recent report showed that 1 foot rise in sea level changes a "1 in 100" storm surge flood event into a "1 in 10" storm surge flood event.
- Increases in water temperature may also affect the water system because of its fishery responsibilities, which include maintaining a "cold water" pool in reservoirs to manage downstream river temperatures. Temperature management is a vital part of the reservoir operation plans so the District can provide cold water during fish migration periods.
- As a result of the ocean upwelling conditions in 2005, there were significant reductions in returns of fall-run Chinook salmon to the Central Valley in 2007 (including the Mokelumne River). The upwelling provides food to juvenile salmon that enter the ocean in March-July. Delayed early-season upwelling is consistent with predictions of the influence of climate change. Stream temperatures are likely to increase as the climate warms and are very likely to have both direct and indirect effects on aquatic ecosystems. Changes in temperature will be most evident during low flow periods.
- Increase in intensity and frequency of wildfires will tax the limited resources available to respond to wildfires.
- Current District policies and management plans do not address the fire risk mitigation associated with climate change consequences.
- Source water quality protection measures to address possible increases in nutrients and sediments associated with climate change consequences not currently identified.
- Significant reservoir fluctuations conflict with water-based recreation services and impact source water quality.
- Increased temperatures and heat wave days will affect ability to meet water-based recreation demands.

Operations

- Limited ability to regulate reservoir release temperatures, particularly at Camanche Dam
- Increase in intensity and frequency of wildfires will increase water demand for suppression
- Increased temperature leads to increased demands, which then would require additional infrastructure improvements, especially to meet peak demands.
- Increases in the severity of storms could increase turbidity levels in raw water supplies. Severe storms can dramatically increase turbidity and slow the District's ability to treat water. Simultaneously, this will also increase the cost of treatment. In addition, increasing water temperature may affect water quality by promoting algae growth and result in increased taste-and-odor compounds.
- Rising sea levels may pose a threat to low lying infrastructure including the Delta levees and the Mokelumne Aqueducts.
- The California Climate Change Center reported in 2006 a warmer climate would not only increase the demand for energy but also increase the demand for peak energy use by 4.1 percent to 19.3 percent by the end of the century. In addition, if precipitation deceases or runoff patterns change significantly, hydropower generation may correspondingly decrease between 10 to 30 percent. For the District, this would result in a reduction of 18 to 54 GW hours in energy production resulting in a loss of revenue.

Wastewater

- Vulnerable to high storm flows if rainfall intensity increases: remote pumping stations, remote wet weather treatment facilities, influent pump station, effluent pump station, and interceptor capacity (resulting in sanitary sewer overflows).
- Vulnerable to lower sewage flows during droughts: wastewater interceptor system (due to increased corrosion) and biological wastewater treatment processes (e.g., secondary activated sludge due to more concentrated contaminants).
- Vulnerable to higher sea levels: biological wastewater treatment processes (e.g., secondary activated sludge or clarifier upsets due to higher dissolved solids concentrations).

3.3 Adaptation

The District is developing many adaptation strategies to address climate change. This section discusses some initial adaptation ideas being considered. These strategies will be revised over time as our understanding of climate change and its impacts are better understood.

WATER SUPPLY PLANNING

The recommended adaptation approach to climate change is to adjust the District's water supply portfolio as the impact of climate change manifests itself over time. The Board has identified a preferred portfolio approach with a 10 percent rationing target. By reducing the rationing target from 25 percent, the District will have more flexibility to respond to changing conditions related to climate change or any other factor, because it will have the ability to increase rationing if the emergency is more severe than planned. In addition, on-going water conservation and recycling programs will further reduce demand and lessen impacts on supplies impacted by climate change.

Furthermore, the preferred portfolio includes several supplemental supply projects that would be pursued on parallel tracks in the event that one (or more projects) is not able to produce the expected dry-year yield. These projects include water transfers, groundwater, desalination, and regional upcountry projects.

This gives the District a number of projects to develop as the impacts of climate change are better understood.

OTHER DISTRICT ADAPTATION NEEDS

Short-term measures

- Incorporate climate change considerations in all level one and two master plans
- Incorporate potential climate change impacts in watershed management plans
- Evaluate the feasibility of selective withdrawal system for Camanche and Pardee reservoirs to manage release water temperatures
- Continue to monitor influent total dissolved solids concentrations to prevent impacts to the secondary treatment process at the wastewater treatment plant

Long-term measures

- WSMP 2040 approach to adaptation
- Improve fire protection measures to reduce demand for fire suppression
- Implement measures at District reservoirs to maintain water-based recreation services (e.g., extended boat ramps and shoreline access)

- Employ measures to reduce sediment/nutrient influx resulting from reservoir fluctuations and wildfires
- Evaluate Army Corps flood control guidelines in Mokelumne watershed to add flexibility to fill our reservoirs based on an earlier runoff scenario while still maintaining adequate flood control space
- Reduce inflow and infiltration to the collection system in order to reduce the impact of high intensity precipitation events on the wastewater collection and treatment systems
- Develop corrosion prevention plans, which may include chemical addition in the interceptor system

4.0 Mitigation

The sources of GHG emissions are primarily related to the electrical energy generation, transportation, industry and agricultural processes, and deforestation (both burning and cutting). According to the IPCC Fourth Assessment Report, climate change mitigation means implementing policies to reduce greenhouse gas (GHG) emissions and enhance carbon sinks. The goal is to achieve the stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Over the next 20 years or so, even the most aggressive climate policy can do little to prevent warming already 'loaded' into the climate system. In other words, the climate is changing and will continue to change over time. The benefits of avoided climate change will only accrue beyond the near future. Emissions reductions and carbon sequestration have a time value (i.e., early actions have a greater long term benefit). Over longer time frames, beyond the next few decades, mitigation investments have a greater potential to reduce climate change damage.

Mitigation of EBMUD emissions will be driven by a combination of regulatory requirements, District policies and programs, and the availability of funding.

4.1 Regulatory Framework

EXECUTIVE ORDER S-3-05

Since California is vulnerable to the impacts of climate change (due to a reliance on the snowpack for water and recreation, a long coastline, and vulnerability to drought). Governor Schwarzenegger has taken a leadership role by setting goals for emissions reductions. The Governor also recognized that emissions reductions can lead to new technologies which will help reduce operating costs and increase profits for companies within the state. Consequently, Governor Schwarzenegger issued Executive Order S-3-05 on June 1, 2005 setting the following goals for the state:

- By 2010, reduce GHG emissions to 2000 levels
- By 2020, reduce GHG emissions to 1990 levels
- By 2050, reduce GHG emissions to 80 percent below 1990 levels

AB 32 GLOBAL WARMING SOLUTIONS ACT

AB 32 sets specific tasks for the California Air Resources Board (CARB) based on the goals established in Executive Order S-3-05 (i.e., establish a plan for a statewide GHG emissions cap for 2020, based on 1990 emissions). CARB must adopt mandatory reporting rules for significant sources of greenhouse gases, adopt a list of discrete, early action measures that can be implemented before January 1, 2010, adopt a plan indicating how emission reductions will be achieved from significant GHG sources via regulations, market mechanisms and other actions; and adopt regulations to achieve the maximum technologically feasible and cost-effective reductions in GHGs, including provisions for using both market mechanisms and alternative compliance mechanisms.

CEQA REQUIREMENTS

Senate Bill 97 (Chapter 185, 2007) required the Governor's Office of Planning and Research (OPR) to develop recommended amendments to the State CEQA Guidelines for addressing greenhouse gas emissions. On April 13, 2009, OPR submitted to the Secretary for Natural Resources its recommended amendments to the State CEQA Guidelines for addressing greenhouse gas emissions, as required by Senate Bill 97. Those recommended amendments were developed to provide guidance to public agencies regarding the analysis and mitigation of

greenhouse gas emissions and the effects of greenhouse gas emissions in draft CEQA documents. On July 3, 2009, the Natural Resources Agency commenced the Administrative Procedure Act rulemaking process for certifying and adopting these amendments pursuant to Public Resources Code section 21083.05. The Natural Resources Agency transmitted the adopted amendments and the entire rulemaking file to the Office of Administrative Law (OAL) on December 31, 2009. The Amendments became effective on March 18, 2010.

4.2 EBMUD Mitigation Goals

The District's emissions are very small compared to those of many other industries, and compared to state, national, and global emissions; therefore, by itself, the District cannot have a significant or measurable impact on global climate change. Nevertheless, EBMUD will take steps to reduce its carbon footprint because:

1. EBMUD is an environmentally responsible company and as such should minimize its impact on the environment,
2. The District has policies on water efficiency, sustainability and renewable energy in part to minimize and mitigate our environmental impacts.
3. Mitigating climate change primarily involves reducing energy use or making operations more efficient which ultimately reduces operating costs,
4. California and most likely Federal legislation will require the District to take some actions in order to meet the goals set by Governor Schwarzenegger and the IPCC.

This is consistent with the District's Sustainability Policy (Policy 7.05). Taking action now prepares the District for a carbon constrained world of the future. The only question is how much of the District's resources the District should invest in mitigating its emissions.

GHG reductions can be realized from carbon sequestration, energy and water efficiency, and low carbon energy (e.g., renewable, nuclear, etc.) use. Options for reductions include reducing demand for water and energy, optimizing processes for energy use, generating renewable energy, alternative fuels, and creating carbon offsets. The first step in effectively managing emissions is establishing a measurable goal. Setting goals can lead to innovation and improved performance. There are two basic kinds of goals: absolute and intensity based.

ABSOLUTE TARGETS

Absolute targets reduce total emissions over a specific time period. The advantage of this kind of goal is it defines a specific quantity of emissions that is measurable and unambiguous. The disadvantage is it can indicate a reduction in emissions just by reducing production not necessarily due to gains in efficiency. For example, the District's overall emissions in the last few years (i.e., 2007 through 2009) have gone down primarily because water demands have gone down, which resulted in fewer indirect emissions. However, there are external factors out of the District's control that may drive up emissions even though overall production is lower (e.g., use of Freeport in a drought).

GHG INTENSITY

GHG intensity allows an agency to account for changes in production over time. GHG intensity is the ratio of GHG emissions divided by a normalizing factor (e.g., million gallons potable water delivered or million gallons of wastewater treated). The advantages of GHG intensity is the goal is independent of production and is a measure of efficiency. The disadvantages are the goal does not indicate whether total emissions are increasing overall and the quantity of emissions generated must be related to GHG emitting activities for the goal to be relevant.

Selection of a goal must be pertinent to the District's operations and meet the organizational needs. The sectors that describe our emissions have different characteristics. Emissions from

two sectors (Water Treatment and Distribution and Wastewater) are directly related to production and the District has some control over the outcome. However, the remaining sectors only have an indirect relationship (Raw Water) or no relationship to production (Buildings and Fleet). Consequently, a GHG intensity is a more appropriate method to evaluate the Water Treatment and Distribution and Wastewater sectors and absolute goals are more appropriate for Fleet and Buildings sectors. The District has little control over the Raw Water emissions, so a goal is not necessarily relevant.

SETTING GOALS AND EVALUATING PROGRESS

The Scoping Plan resulting from AB32 set a goal of matching the 1990 emissions in 2020. This is equivalent to a 15 percent reduction from 2008 emissions by 2020. There are several agencies that have set absolute goals for GHG emissions. The City of San Francisco has a goal of 20 percent reduction from 1990 levels by 2012. The Portland Water Bureau wants to reduce emissions 10 percent from 1990 levels by 2015. American Water Company, a large publicly-traded water and wastewater company, set an intensity based goal under the EPA's Climate Leaders Program to reduce their greenhouse gas emissions per volume of water produced by 16 percent from 2007 levels by the year 2017.

Setting an absolute goal for the District is logical and it establishes a specific quantity for reduction. However, analysis of the individual sectors may be reported by intensity or in absolute numbers based on the sector's relationship to production, the factors the District can control and knowledge of the external factors.

The July 2008 Strategic Plan has a KPI under Water Quality and Environmental Protection Goal, Strategy 4 - Reduce, Recycle, Reuse, Reclaim to achieve a 10 percent net reduction in GHG emissions from District facilities over 2000 Baseline by 2015 (calendar years). The FY10 and FY11 Targets were,52,582 and 52,209 metric tons respectively.

4.3 Emissions Inventory

In general, GHG emissions are not measured directly. Emissions are derived from protocols that provide guidance on estimating emissions based on energy use (e.g., electricity, gasoline, natural gas, etc.) and operations (e.g., water and wastewater treatment). The use of protocols provides a level of transparency, consistency, and credibility for reporting GHG emissions and offsets.

Emissions are generally divided according to an internationally recognized standard into three groups. Direct emissions (Scope 1) are emissions from sources within the organizational boundary that the District owns or controls. These emission are primarily from stationary combustion, mobile combustion, process related emissions, or fugitive emission. Indirect emissions (Scope 2) are those emissions occurring outside the District from the production of electricity that is used by the District. The third group of emissions (optional indirect emissions or Scope 3) is emissions over which the District exerts significant influence or control like raw material transport or waste removal. The District does not track Scope 3 emissions.

VOLUNTARY EMISSIONS REPORTING

The District was among the first water agencies to take membership in the California Climate Action Registry (the California Registry or CCAR), in March 2006. CCAR (www.climateregistry.org) was established by California statute in 2000 as a non-profit voluntary registry for GHG emissions. CCAR members voluntarily measure, verify, and publicly report their GHG emissions.

The Climate Registry (TCR) is the sister organization of CCAR and was formed to continue voluntary reporting throughout North America. The Climate Registry is a nonprofit collaboration among North American states, provinces, territories and Native Sovereign Nations to set

consistent and transparent standards for the calculation, verification and public reporting of greenhouse gas emissions into a single registry.

CCAR will continue to accept 2009 greenhouse gas emission reports through the end of 2010, and thereafter all emission reports should be submitted through The Climate Registry. After 2010, CCAR will continue to advocate on behalf of its members emission inventories to protect early actions made prior to the passing of AB32 and all emissions reports submitted to CCAR will continue to exist in perpetuity.

The District is no longer a member of CCAR or The Climate Registry (TCR), but the District still uses the General Reporting & Verification Protocols to complete its emissions inventories. The District did not realize a significant benefit from membership given its current financial situation. However, the CCAR (and now TCR) protocols do provide value for calculating inventories that can be used for comparison with other entities. CCAR developed a number of protocols to assist in the process of calculating, reporting and verifying an emissions inventory. The protocols provide rigorous standards for emissions reporting that are consistent across jurisdictions and inline with international standards.

GREENHOUSE GASES

As established in the Kyoto Protocol developed by the United Nations Convention on Climate Change, the following gases are generally included in an emission inventory:

1. Carbon Dioxide (CO2)
2. Methane (CH4)
3. Nitrous Oxide (N2O)
4. Hydrofluorocarbons (HFCs)
5. Perfluorocarbons (PFCs)
6. Sulfur Hexafluoride (SF6)

Each gas has a different ability to trap heat in the atmosphere. This characteristic is represented by the Global Warming Potential (GWP) relative to CO2. For example, methane has approximately 25 times more capacity to trap heat in the atmosphere than carbon dioxide. Therefore, the GWP for methane is 25. The GWP is used to convert the amount of each gas (usually in tons) to a carbon dioxide equivalent (CO2-e) for ease of comparison.

The District's inventory only includes carbon dioxide for the following reasons:

- In order to be consistent with the District's baseline and early inventories. Carbon dioxide was the only gas required in our inventory as part of the CCAR protocols until the 2008 reporting period.
- Collecting additional data to report on all six gases (e.g., vehicle mileage by type, location and maintenance history for refrigerants, and location and maintenance history for SF6) is labor intensive and would not likely yield significant changes in our inventories.

Future inventories may include all six gases should we determine or suspect GHGs other than carbon dioxide will make a significant contribution to our inventory.

EMISSIONS CALCULATIONS

The District participated in CCAR for three years and calculated, verified, and publicly-reported its District-wide CO2 emissions inventories for calendar years 2005, 2006, and 2007. The District ended its participation in CCAR since the benefits did not justify the verification and reporting costs. However, the District continues to quantify and track District-wide GHG emissions using CCAR protocols. Utility GHG emissions are not measured directly. Emissions are calculated indirectly using conversion factors specified by the CCAR protocols.

Although there are some minor emissions from process activities and fugitive emissions, the District's Scope 1 or direct emissions are primarily from stationary and mobile combustion. Direct emissions from combustion are calculated using the total annual fuel consumption multiplied by an emissions factor for that specific fuel (natural gas, gasoline or diesel).

The District's indirect emissions result from the use of electricity. To calculate the emissions from electrical use, the annual electrical use is multiplied by an electrical emissions factor for the electricity source. The emissions factor is derived based on the electrical utility's mix of generation.

2010 GREENHOUSE GAS INVENTORY

The District's Scope 1 and 2 GHG emissions were 39,024 MT in 2010 compared to 41,017 MT in 2009 and estimated emissions in baseline year 2000 of 55,938 MT. The District's overall GHG emissions for 2010 decreased by 5 percent compared with 2009 levels and by 30 percent compared to 2000 levels. The major factor for the decrease between 2009 and 2010 was that the electricity emissions factor decreased indicating PG&E's power generation in 2010 was from lower carbon sources compared to 2009.

Emissions Sectors

A GHG inventory for a water utility is more meaningful if the data are broken down into sectors associated with specific activities or sectors. The following five sectors allow more detailed analysis of the emissions, comparison with other water agencies, and comparison of emissions over time:

- Raw Water – emissions resulting from activities associated with water intake and transport to a treatment facility.

- Water Treatment and Distribution – all emissions resulting from treating raw water for potable use and distributing the treated water to customers.

- Buildings – emissions resulting from operation of all facilities not associated water or wastewater operations like the Administration Building, Adeline Maintenance Center, and service yards.

- Fleet – emissions associated with energy use in District vehicles and mobile equipment including cars, trucks, heavy equipment, and portable pumps and generators.

- Wastewater – all anthropogenic (i.e., caused by humans) emissions resulting from operation of the District's wastewater collection and treatment facilities. Emissions from combustion of digester gas are considered biogenic (i.e., part of the normal carbon cycle) and, therefore, not included in the inventory.

Each sector has different drivers for emissions. In 2010, the District's emissions were allocated among the sectors as follows:

Table 4.1: 2010 Emissions by Sector

Sector	Percentage of Total
Raw Water	3
Water Treatment and Distribution	51
Buildings	15
Fleet	19
Wastewater	12

Evaluation of Emission Sectors

There are many different factors that influence the District's emissions (see Appendix D). Some items can be managed by the District and some are external to the District. In a drought year for example, the District may utilize its alternate water supply from the Sacramento River. This water supply requires much more energy to move the water from Sacramento to the service area since most of the Mokelumne River supply flows to Bay Area via gravity. In addition, the Sacramento River water must be treated in the conventional treatment plants (USL and Sobrante) which require much more energy mostly for production of ozone.

California's Renewable Portfolio Standard (RPS) requires the electric utilities to incorporate additional renewable energy in their mix of generation. PG&E is currently using 17.7 percent renewables. The RPS requires 33 percent renewables by 2020. The increased use of renewable energy will drive down the emissions factor for electrical use. The electric emissions factor peaked at 878.71 lbs CO_2/MWhr in 2007 and dropped to 681.01 CO_2/MWhr in 2010.

Biofuels (e.g., digester gas, biodiesel or ethanol) can be carbon neutral; however, that condition is dependant on the life-cycle carbon impact of the production, transportation, and use of the biofuel. Some biofuels such as corn-based ethanol are not carbon neutral.

The Water Treatment and Distribution and Wastewater sectors are driven primarily by indirect emissions from electrical energy use. The RPS program will continue to drive increased use of renewables which will drive the emissions factor even lower in future years. Since water treatment and distribution production and wastewater treatment volume will vary from year to year, which will influence the corresponding emissions, the emissions should be reviewed based on the intensity. The GHG intensity for Water Treatment and Distribution and Wastewater is shown below:

Table 4.2: GHG Intensity for Water Treatment and Distribution, and Wastewater

Year	2000	2006	2007	2008	2009	2010
Water Treatment and Distribution Intensity (Tons/MG)	0.3627	0.3656	0.4013	0.3121	0.3239	0.3026
Change from baseline (2000)	N/A	1%	11%	-14%	-11%	-17%
Wastewater Intensity (Tons/MG)	0.3522	0.1896	0.3033	0.2313	0.2444	0.2043
Change from baseline (2000)	N/A	-46%	-14%%	-34%	-31%	-42%

Fleet emissions currently result from combustion of diesel and gasoline. Most of the fleet emissions are related to water operations, but 464 tons or about 6 percent of the total fleet emissions were related to wastewater operations in 2010. GHG intensity could be used to evaluate fleet emissions based on miles traveled. However, a good portion of our fleet is heavy equipment such as backhoes and portable pumps that may not be moving while being operated. Therefore, Fleet emissions should be reviewed on an absolute basis and compared to planned investments in new vehicles and equipment and plans for alternative fuels. Fleet emissions are

given in the table below. The most likely reason for emissions reductions is the fleet size has been reduced since 2000.

Table 4.3: Fleet Emissions

Year	2000	2006	2007	2008	2009	2010
Fleet Emissions (Tons)	8,322	6,680	6,409	7,603	7,537	7,292
Change from baseline (2000)	N/A	-20%	-23%	-9%	-9%	-12%

The emissions in the Buildings category are mostly driven by electrical use for heating and lighting. This category could have an intensity based goal based on number of people in the buildings or square footage. However, those numbers are not changing significantly. Reporting based on absolute emissions would be appropriate and easily measurable. The emissions for the Buildings sector are given below. Emissions in the Buildings sector are generally greater than the baseline year because we are now using microturbines to generate electricity, heating, and cooling as a cost saving measure.

Table 4.4: Building Emissions

Year	2000	2006	2007	2008	2009	2010
Buildings Emissions (Tons)	4,394	5789	5859	4832	5404	5323
Change from baseline (2000)	N/A	32%	33%	10%	23%	21%

As mentioned above, the Raw Water sector emissions are highly variable based on the amount of pumping required and whether an alternate water supply is employed. A comparison from year to year in this sector is not recommended since the drivers for this sector (e.g., precipitation, demands, etc.) are not within the District's control.

MANDATORY EMISSIONS INVENTORY REPORTING

Based on the requirements of AB32, CARB has established mandatory reporting regulations requiring annual reporting from the largest facilities in the state which account for 94 percent of greenhouse gas emissions from industrial and commercial stationary sources in California. Transportation sources, which account for 38 percent of California's total greenhouse gas emissions, are not covered by these regulations but will continue to be tracked through other means. The standards and approaches to reporting were developed in close consultation with the California Climate Action Registry, as required by the law.

There are about 800 separate sources that fall under the new reporting rules and include electricity generating facilities, electricity retail providers and power marketers, oil refineries, hydrogen plants, cement plants, cogeneration facilities and industrial sources that emit more than 25,000 tons of carbon dioxide each year from on-site stationary source combustions such as large furnaces. Backup generators, schools and hospitals are excluded from the requirements. Although most of the MWWTP's emissions are biogenic, the cogeneration facility falls under this requirement.

Affected facilities began tracking their emissions in 2008, which were reported beginning in 2009. Emissions for 2008 could be based on best available emission data. Beginning in 2010, however, emissions reports must be more rigorous and will be subject to third-party verification. Verification will take place annually or every three years, depending on the type of facility. District staff is collecting fuel quantity and quality data for both biogas and diesel to comply with CARB requirements.

At the federal level, the EPA has issued the Mandatory Reporting of Greenhouse Gases Rule. The rule requires reporting of greenhouse gas (GHG) emissions from large sources and suppliers in the United States, and is intended to collect accurate and timely emissions data to inform future policy decisions. Under the rule, suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions are required to submit annual reports to the EPA. The rule became effective December 29, 2009. Emissions from the MWWTP must be reported under this rule.

4.4 Emissions Reductions and Offsets

The District has already implemented a number of measures that reduce GHG emissions including converting to a hybrid sedan fleet, installing microturbine cogeneration systems at the Administration Building and Adeline Maintenance Center, installing photovoltaic arrays at the Sobrante Water Treatment Plant and Adeline Administration Center, and installing cogeneration engines using biogas at the Main Wastewater Treatment Plant. Further reductions will be accomplished by reducing GHG emissions from routine operations through energy and water conservation, use of additional energy efficiency methods, and new alternative energy sources. In addition, the District could consider purchasing offsets accomplished through conservation easements and improved watershed practices through afforestation or reforestation. These further reductions are particularly important given the anticipated significant impact of operating the Folsom South Canal Connection (FSCC) and contemplated future energy-intensive projects such as desalination.

In dry years when a supplemental water supply is needed, the energy required to operate the FSCC will constitute a substantial portion of the District's overall energy demand. The corresponding GHG emissions also will be large. During an average year of operation, the two pumping plants in the FSCC will require approximately 35 million kWh of electric power, with associated emissions of 9,800 metric tons (MT) of CO2. Using historical records, the FSCC facilities are only expected to operate for three years out of every ten. However, climate change could increase drought frequencies and thus increase the need to operate the FSCC.

INDIRECT EMISSIONS REDUCTIONS

In 2009, the indirect emissions from District operations were approximately 29,586 Tons of CO2 (about 61 percent of the total emissions) from use of electrical energy. Power is one of the largest controllable operating costs and sources of GHG emissions. The process of managing electrical energy use is best handled by a plan-do-check-act process. The basic process is:

- **Plan.** Establish and prioritize energy conservation targets
- **Do.** Implement specific practices to meet these targets
- **Check.** Monitor and measure energy performance improvements and cost savings
- **Act.** Periodically review progress and make adjustments to energy programs

Energy budgets for individual facilities (e.g., administration and process facilities) should be established similar to water budgets that were established to address the recent drought. Each facility should manage to its budget. In addition, the District can pursue individual projects to conserve water and energy or create renewable energy. The District adopted Policy 7.07 to encourage and promote the cost-effective use of renewable energy. The District has developed opportunities to serve its facilities with onsite renewable generation under a net energy metering agreement such as the Sobrante Photovoltaic (PV) Project.

Examples of projects that could reduce the District's indirect emissions include:

- Reducing energy consumption in office buildings by installing motion activated light switches, installing more efficient lighting, and adding window films to reduce heat gain
- Installing submetering at process facilities (e.g., water and wastewater treatment facilities) to better manage larger electrical loads
- Regularly performing pump efficiency tests to evaluate efficiency degradation over time
- Replace low efficiency pumps/motors with higher efficiency equipment
- Install variable frequency drive units where applicable
- Include minimizing GHG emissions as a goal in planning new projects
- Reduce water use at District facilities through equipment upgrades and metering
- Reviewing the District's master equipment specifications to ensure energy efficient systems are appropriately procured.

DIRECT EMISSIONS REDUCTIONS

In 2009, the direct emissions from District operations were approximately 11,818 Tons of CO2 (about 29 percent of the total emissions). Fleet operations (vehicles and portable equipment) produce 18 percent of EBMUD's total emissions. Other sources of direct emissions include the natural gas-powered microturbines at the AB and AMC and stationary generators. .

The natural gas powered microturbines are a best practice for controlling emissions because they are relatively clean burning and are used in a cogeneration facility to generate heating and cooling (i.e., relatively high thermal efficiency). Therefore, the focus for direct emissions reductions should be on fleet operations.

Examples of actions that could reduce the District's direct emissions are:

- Procuring alternative fueled (e.g., LNG, CNG, biodiesel) engines, hybrid electric vehicles, plug-in hybrid vehicles
- Downsizing vehicles/engines/fleet size
- Partnering with other agencies/cities/companies to build infrastructure (e.g., CNG fueling station)
- Partnering with agencies/companies/etc. to develop new applications for existing technology (e.g., hybrid electric drives for service trucks)
- Employee outreach programs to promote best practices for operating efficiencies (e.g., proper tire inflation and minimized idling)
- Actions that reduce the vehicle miles traveled such as carpooling to meetings, webinars, and webcast conferences.

The result of this review should be reduced fuel use and fewer direct emissions.

OFFSETS

A carbon offset is an activity that results in less carbon dioxide or other greenhouse gases in the atmosphere than would otherwise occur. Offsets are typically achieved through financial support of projects that reduce the emission of greenhouse gases in the short- or long-term. The most common project type is renewable energy, such as wind farms, biomass energy, or hydroelectric dams. Others include energy efficiency projects, the destruction of industrial pollutants or agricultural byproducts, destruction of landfill methane, and forestry projects. Carbon offsets allow an organization to forgo reducing its own emissions, but in exchange the organization pays someone to reduce their emission or invests in a project to reduce or sequester carbon emissions. Offsets can be created by renewable energy projects, energy efficiency, and land use and agriculture-based projects, like methane abatement.

In order to be valid, offsets must be, unique (i.e. not counted elsewhere), additional (i.e., go beyond business as usual), not part of a regulatory requirement, permanent, verifiable, and real.

Future District offset projects could include:

- Purchase offsets through an offset provider (e.g., myclimate.org, etc.) for District business travel
- Afforestation or reforestation of District watershed property
- Further expansion of the cogeneration facility at the MWWTP using biogenic gas
- Enhancement of the hydro-power facilities at Camanche and Pardee

The District owns and manages a large share of watershed property. Afforestation or reforestation can be a good method to sequester carbon. There may be areas where additional vegetation could be planted to capture carbon.

Expansion of the cogeneration facilities at the MWWTP will be complete in 2011 with the installation of a 4.5 MW gas turbine. The facility will have excess renewable power to sell and will generate Renewable Energy Credits (RECs), a type of offset. The District is currently pursuing tradable REC sales with the expectation that a REC market under the Renewable Portfolio Standard (RPS) will be developed and implemented by the California Public Utilities Commission (CPUC) in the near future.

The Camanche and Pardee hydropower facilities are older facilities that were constructed before carbon markets were established. The goal of a cap and trade system is to provide incentives to reduce emissions. Therefore, improvements to the Camanche and Pardee facilities could potentially be sold as offsets. Examples of modifications include generator rewinding and governor replacements that would allow more power to be generated.

5.0 Legislation and Regulations

5.1 Introduction

The California Global Warming Solutions Act of 2006 (AB 32), is far and away the dominant legislative initiative on climate change both statewide and nationally. While California's greenhouse gas (GHG) emissions constitute only about 1.4 percent of the global total (and 6.2 percent of the U.S. total), the Legislature and Governor have determined that California should take a leadership role in advancing technological and political solutions that could be adopted later by other states and nations.

AB 32 was intended to take California beyond the terms of the Kyoto Protocol, which was negotiated in 1997. The protocol, which was adopted by 183 countries, required industrial countries to reduce GHG emissions 5.2% (1990 baseline) over 10 years, beginning in 2005. However, the Clinton administration acknowledged that the treaty failed to meet a condition within Senate Resolution 98, requiring a meaningful participation by developing countries in binding commitments limiting greenhouse gases; therefore, the treaty was never brought to the Senate for ratification.

AB 32 goes further than the Kyoto Protocol in establishing the first comprehensive program of regulatory and market mechanisms to achieve real, quantifiable, cost-effective reductions in GHG emissions by major industrial sources in California.

AB 32 built on previous state legislation (AB 1493, passed in 2002) which requires automakers to reduce greenhouse gas emissions from new cars and trucks sold in the state beginning in 2009. EBMUD was among the few water agencies that played an active role in supporting both of these bills in the Legislature. More than a year before AB 32 was signed into law, the Governor took action on climate change with an Executive Order establishing goals to reduce California's GHG emissions to:

- 2000 levels by 2010 (11 percent below business as usual)
- 1990 levels by 2020 (25 percent below business as usual)
- 80 percent below 1990 levels by 2050

The second of these goals became the centerpiece of AB 32.

The federal government, by contrast, has been much slower to require efforts by businesses and public agencies intended to reduce GHG emissions. Despite the passage through the House of Representatives of the Waxman-Markey (cap and trade) bill in 2009, the Senate declined to advance similar legislation and the prospects for comprehensive federal legislation appear increasingly remote. The most significant actions at the federal level have been in the executive and judicial branches.

In April 2009, the U.S. EPA made a finding under the authority of the Clean Air Act that six greenhouse gases endangered public welfare, opening the door to more aggressive federal regulation. Then in December 2009, the Supreme Court ruled that GHGs are pollutants under the Clean Air Act. The court also found that the U.S. government has the authority to regulate CO2 and other GHGs. While the Obama Administration has expressed a preference for Congressional action, it has clearly signaled that it will use existing legislative authority as needed to address climate change.

EBMUD is represented at the national level by a number of associations including AMWA, AWWA, the Western Urban Water Coalition, NACWA, and others. These organizations, and particularly AMWA, have been intensifying their focus on climate change and are seeking to ensure that the water industry perspective is included in future legislation. Because EBMUD's

interests are similar to the general membership of these organizations, EBMUD's focus in monitoring and influencing climate regulations is on the state AB 32 implementation process, which is discussed below.

5.2 AB 32 Implementation

AB 32 requires the state to achieve a reduction in GHGs emitted in California to 1990 levels by 2020; in quantitative terms, this is 174 million metric tons of CO2 equivalent (174 MMT CO2E). This reduction will be accomplished through an enforceable statewide cap on GHGs that will be phased in starting in 2012. AB 32 directs the California Air Resources Board (ARB) to develop appropriate regulations and establish a mandatory reporting system to track and monitor GHG emissions levels.

In January 2009, ARB adopted the AB 32 Scoping Plan (Table 5.1), which serves as the state's policy blueprint containing the broad overview of the programs, measures, and approaches to comply with AB 32. In developing the Plan, ARB was advised by the Climate Action Team (CAT), comprised of 14 state agencies and divided into 11 subgroups that address specific issue areas. The Water/Energy subgroup (WETCAT) is dedicated to examining the GHG reduction benefits from increased water use efficiency, given the energy demands of treating and distributing water; however, other subgroups such as the Land Use subgroup are also evaluating actions that could have a bearing on water/wastewater industry operations.

In January 2010, ARB adopted a number of "Discrete Early Action Measures" constituting the first steps in reducing GHGs (steps that are considered the most readily implementable). These steps are expected to achieve approximately 36 percent of the GHG reductions mandated by AB 32. Only one of the measures the ARB identified directly relates to water:

> DWR will adopt standards for projects and programs funded through water bonds that would require consideration of water use efficiency in construction and operation. This strategy is expected to result in GHG emissions reduction of 1 MMT CO2E by 2020.

In association with the CAT, DWR also proposed the following:

> Water Delivery Planning: DWR has begun a five year analysis and modeling effort to determine the impacts of climate change on California's water systems. The GHG emissions reductions from this strategy are still to be determined.
>
> Water-Energy Nexus: DWR will consider options that would compel local agencies to incorporate climate change adaptation into regional water planning. Such options would ensure that local agencies consider water-energy nexus in Integrated Regional Water Management Plans and construction and operation of facilities. DWR expects to include consideration of GHG emissions as a part of the application criteria for future water management plan Proposal Solicitation Processes. The GHG emissions reductions from this strategy are still to be determined.

In the Scoping Plan, ARB is proceeding along two parallel paths: developing specific emission reduction measures and major program design options. It is expected to be a mix of traditional regulations, cap and trade, fees and incentives (including targeted carbon fees/taxes), voluntary measures, and offsets (which must be implemented in-state). At least 10 of the 69 proposed measures identified in the Scoping Plan may have some impact on the water and wastewater sectors.

Table 5.1: ARB Scoping Plan

Scoping Plan Measure	Responsible Agency	Adoption / Implementation Date	Type of Action (Regulation, Voluntary, etc.)
Renewable Electricity Standard ; Renewable Portfolio Standards	ARB, CEC, CPUC	Sep 2010 / 2020; Ongoing / 2010	Regulation; Various
Cap-and-Trade	ARB	Dec 2010 / 2012	Regulation
Increase Renewable Energy Production (from Water sector)	CEC, CPUC	TBD / 2020	Voluntary
Water System Energy Efficiency	CEC, CPUC, D WR, SWRCB	TBD / 2020	Voluntary
Anaerobic Digestion	CalRecycle	TBD / 2020	Voluntary
Increasing Combined Heat and Power Use by 30,000 GWh	CPUC, CEC, ARB	TBD / TBD	Various
Public Goods Charge for Water	DWR, ARB, CPUC, SWRCB	TBD / 2012	Regulation
Water Use Efficiency	DWR, SWRCB, CEC, CPUC, ARB	Spring 2009 / 2020	Various
Reuse Urban Runoff	SWRCB	TBD / 2020	Regulation
Water Recycling	SWRCB, DWR	TBD / 2030	Regulation

The reductions expected from these measures related to water and wastewater are small in comparison to the “core measures”, which will include tailpipe emission regulations, a low carbon fuel standard, reducing vehicle miles traveled (VMT), increasing energy efficiency, and developing renewable resources and high global warming potential measures. These actions are expected to achieve approximately 60 percent of the emissions reductions established in the 2020 goal, and largely target the electrical utility and transportation sectors. The remaining tonnage will be reduced through a combination of additional regulations, a cap and trade program, and carbon fees.

EBMUD has been working both independently and in collaboration with various associations to monitor, assess, and comment on proposals coming out of the AB 32 process. On the water side, California Urban Water Agencies (CUWA) has completed, in cooperation with the Water Research Foundation, a greenhouse gas emission inventory and management guide for water utilities. In addition, the Association of California Water Agencies (ACWA) convened a Climate Change Subcommittee, which is focusing on AB 32 implementation, developing climate change policy principles, and advancing renewable energy for water suppliers.

In 2007, EBMUD became one of the first members of the California Wastewater Climate Change Group (CWCCG). The CWCCG represents over 40 wastewater agencies that treat approximately 90 percent of the municipal wastewater in the state of California. The primary purpose of the CWCCG is to respond to climate change and forthcoming regulations and to provide a unified voice for the California wastewater industry. District staff actively engages in CWCCG activities, which include tracking regulatory and legislative developments, participating in proceedings, meetings, and workshops of the CPUC and California Energy Commission (CEC), and providing industry information to the appropriate decision makers.

In September 2010 the ARB approved the Renewable Electricity Standard (RES) regulation, which will require retail sellers of electricity to demonstrate by 2020 that 33 percent of electricity sold to their customers is generated from renewable energy resources. The regulation is expected to reduce GHG emissions from the electricity sector by about 13 MMTCO2e per year by 2020. The regulation will allow the use of renewable energy credits from CPUC’s existing Renewable Portfolio Standard (RPS) and will also allow the use of unbundled tradable renewable energy credits (TRECs), which may allow for the District to produce saleable credits for

renewable energy produced and used on-site. The CPUC is also developing a method to include TRECs under their existing RPS program, under the guidelines of recently adopted Senate Bill (SB) 2 (1X), which will also require subject electricity producers to meet the same 33 percent goal as in the RES.

In December 2010, the ARB held a hearing to consider a Cap-and-Trade Rule. Beginning in 2012, electricity (including imports) and large industrial facilities emitting more than 25,000 MTCO2e per year will be included under the cap. In 2015 the scope of the cap will increase to include emissions from combustion of fuels. Capped facilities will be allocated a certain amount of emissions per year and will be required to either reduce their emissions or purchase offsets annually. The current emissions limit for large industrial facilities excludes emissions from biogenic sources. The majority of the District's emissions, in particular at the MWWTP, result from the use of digester gas, considered a biogenic source. Therefore, the District is currently excluded from the cap. ARB expects to finalize the Cap-and-Trade regulation including details on components such as offset protocols, compliance and emissions allocations by fall 2011; however, at this time, the cap and trade program is being challenged in court.

WATER USE EFFICIENCY

Although the Scoping Plan devotes only limited attention to the water sector, within a short section it proposes "a public goods charge for funding investments in water efficiency that will lead to reductions in greenhouse gases." Such a charge is modeled on surcharges that appear on electrical utility bills, with revenues used to finance energy efficiency programs. Revenues from this charge would be "collected on water bills and then used to fund end-use water efficiency improvements, system-wide efficiency projects and water recycling," and could generate $100-million to $500 million annually. On a per capita basis as a rough measure, this could mean a new revenue demand of $3 million to $15 million annually from EBMUD's ratepayers.

While the Scoping Plan indicates that public goods charge revenues would be plowed back into efficiency programs, it offers no assurances that funds raised by one water agency would remain entirely within that water agency's service area. In a general reference to revenues raised under the Scoping Plan, it states: "These revenues could be used to support AB 32 requirements for GHG emission reductions and associated socio-economic considerations." In other words, it is far from settled that revenues raised by a public goods charge would be directed back solely to water use efficiency measures or to the service areas where the charges originated as is currently done in the energy sector.

The ARB has taken no further action to advance the proposals described above. The passage of SB X7 7 (Steinberg) in 2009, requiring a 20% per capita reduction in urban water use consumption by 2020, marked the most significant state effort to advance water conservation in recent years. If effective, this statute will achieve some of the GHG emission reductions sought in the Scoping Plan.

5.3 Upcoming ARB Action on AB 32

During 2011, the ARB is focusing its efforts on finalizing the cap-and-trade regulatory program, following a series of workshops and issuance and final rulemaking in the fall. Under AB32, 2020 is the deadline for the state to achieve 1990 levels of GHG emissions.

5.4 Other State Climate Change Legislation

AB 32 was preceded by two bills that established the California Climate Action Registry in 2001 (SB 527), and the regulation of tailpipe CO_2 emissions in 2002 (AB 1493). The first law that explicitly addressed climate change was AB 4420, passed in 1988, that directed the Energy

Commission to prepare and maintain the state's inventory of greenhouse gas (GHG) emissions and to study the effects of GHGs.

In 2008, another major bill relating to climate change policy was enacted. SB 375 (Steinberg) requires the ARB to set regional targets for the purpose of reducing greenhouse gas emissions from passenger vehicles, for 2020 and 2035. If regions develop integrated land use, housing and transportation plans that meet the SB 375 targets, new projects in these regions can be relieved of certain review requirements of the California Environmental Quality Act.

Table 5.2 summarizes state legislation relevant to EBMUD that addresses climate change either directly or indirectly.

Table 5.1: California Legislation on Climate Change

Bill (Author)	Subject	Impact on EBMUD
AB 1493 (Pavley)* 2002	Requires regulation of CO2 emissions from noncommercial vehicles	Indirect benefit of increased fuel efficiency
AB 32 (Núñez)* 2006	Creates a cap and trade regime for GHG emissions statewide.	Increased costs for fuel and electricity.
AB 118 (Núñez) 2007	Creates Alternative and Renewable Fuel and Vehicle Technology Program, to transform fuel and vehicle types	$120M in state grants available – could provide future funding for EBMUD fleet replacements.
AB 236 (Lieu) 2007	Requires the State to revise criteria for purchasing motor pool vehicles to rank environmental and energy benefits.	Potential impact on developing market for EBMUD fleet vehicles.
AB 662 (Ruskin)* 2007	Requires cost-effective operating efficiency standards for appliances related to energy and water.	Assists EBMUD in meeting water conservation goals.
AB 1109 (Huffman) 2007	New standards for lighting efficiency and hazardous components	Beneficial impact on energy consumption at District facilities
AB 1470 (Huffman)* 2007	Sets goal of 200,000 solar water heating systems by 2017.	Advances use of renewable energy.
AB 1560 (Huffman)* 2007	Prescribes water efficiency and conservation standards for new buildings	Supports District goals for conservation and supply reliability.
AB 1613 (Blakeslee) 2007	Requires capturing waste heat to improve electrical generating efficiency	No direct impact
SB 97 (Dutton) 2007	Requires CEQA evaluation of GHGs for projects.	Additional analysis of District project impacts
SB 7X 7 (Steinberg) 2009**	Requires 20% per capita reduction in urban water use by 2020.	Consistent with EBMUD's water conservation goals
SB 104 (Oropeza) 2009	Adds nitrogen trifluoride to the state list of regulated GHGs.	No direct impact.

*EBMUD supported **EBMUD support if amended

5.5 National Regulations

EPA Mandatory Reporting – Adopted October 2009. Similar to ARB reporting rule but excludes biogenic emissions, therefore the majority of wastewater facilities are not subject to reporting.

EPA Tailoring Rule – Regulates GHG emissions under the Clean Air Act (CAA) through New Source Review (NSR) and Title V Operating Permits. The rule is called the "Tailoring Rule" because EPA had to tailor or modify the typical threshold used for conventional pollutants. Under

the CAA, facilities that emit over 100 to 250 tons per year of traditional pollutants (e.g., SOx, NOx) are regulated. However, applying the same threshold to GHG emissions is not feasible, since GHGs are emitted at much greater quantities. Under this rule, facilities with GHG emissions exceeding certain thresholds will be subject to Prevention of Significant Deterioration (PSD) under NSR and Title V permitting under the CAA. Facilities that are subject to PSD will be required to install “best available control technology”, which is still being identified, to control GHG emissions. Facilities subject to Title V will be subject to monitoring and record keeping requirements for GHGs. Currently, EPA has deferred the inclusion of biogenic emissions under the rule for the next three years. The effect of this deferral is that no new wastewater facilities will be subject to PSD or Title V. The District’s MWWTP is already a Title V facility and will only be required to report GHG emissions upon modification or renewal of the Title V permit.

6.0 Public Education and Industry Participation

6.1 Public and Employee Education

EBMUD continues to work to inform the public and ratepayers about climate change, potential impacts to the District, and actions the District is taking. The District website includes pages on climate change. EBMUD also promotes employee awareness of climate change issues by sharing information and activities using a climate change Wiki on its Intranet and by sponsoring presentations about climate change for staff.

6.2 Industry Participation

EBMUD is participating on a number of working groups to address the impact of climate change on water utilities. Below is a brief summary of each of the working groups. More information can be found on the Wiki (http://wiki/water_ops/index.php5/EBMUD_Climate_Change_Portal).

CLIMATE READY WATER UTILITIES WORKING GROUP

In the fall 2009, EPA convened a Climate Ready Water Utility (CRWU) Working Group under the National Drinking Water Advisory Council (NDWAC). Senior EBMUD staff participated in the working group including a number of face-to-face meetings. The charge of the CRWU Working Group is to evaluate the concept of "Climate Ready Water Utilities" and provide recommendations to the full NDWAC on the development of an effective program for drinking water and wastewater utilities, including recommendations to

- Define and develop a baseline understanding of how to use available information to develop climate change adaptation and mitigation strategies, including ways to integrate this information into existing complementary programs such as the Effective Utility Management and Climate Ready Estuaries Program
- Identify climate change-related tools, training, and products that address short-term and long-term needs of water and wastewater utility managers, decision makers, and engineers, including ways to integrate these tools and training into existing programs
- Incorporate mechanisms to provide recognition or incentives that facilitate broad adoption of climate change adaptation and mitigation strategies by the water sector into existing EPA Office of Water recognition and awards programs or new recognition programs

The final NDWAC report was delivered to the EPA Administrator in January 2011 and included eleven findings and twelve recommendations, an adaptive response framework to guide climate ready activities, and identification of resources and incentives to support and encourage utility climate readiness. A full copy of the report is available on the EPA's Climate Ready Water Utilities website at http://water.epa.gov/infrastructure/watersecurity/climate/.

EPA CLIMATE RESILIENCE EVALUATION AND AWARENESS TOOL

As part of the CRWU Program, the EPA developed a Climate Resilience Evaluation and Assessment Tool (CREAT) to assist drinking water and wastewater utility owners and operators in understanding potential climate change impacts and in assessing the related risks at their utilities. EBMUD staff participated served on the Working Group assisting the EPA with the development of CREAT.

The charge of the working group was to assist in the evaluation of whether the framework for the existing Vulnerability Self Assessment Tool (VSAT) could be revised to address climate change issues and provide input and inform tool development throughout all phases of the process. VSAT was developed to assess vulnerabilities regarding man-made threats and natural disasters. The Working Group completed the evaluation of the VSAT tool and completed the framework for

the climate change risk assessment and awareness tool in early 2010. CREAT is a stand-alone application that allows utilities to assess vulnerabilities related to climate change impacts with the purpose of elevating awareness and generating provisional adaptation options.

Last year, EBMUD and the New York Department of Environmental Protection hosted pilots for the CREAT software. EPA incorporated comments from these pilots and released CREAT version 1 to the public in December 2010. EPA is planning new functionality for CREAT version 2.0 including supporting multiple climate change scenarios, extreme events, energy efficiency and climate change analysis comparison. EBMUD is participating in version 2 and attended a face-to-face meeting in June 2011 with EPA's technical team.

VULNERABILITY ASSESSMENT AND RISK MANAGEMENT TOOL FOR CLIMATE CHANGE

EBMUD staff is participating on the Project Advisory Committee for the Water Research Foundation's Project, Vulnerability Assessment and Risk Management Tools for Climate Change: Assessing Potential Impacts and Identifying Adaptation Options. This project is being funded by the Climate Change Strategic Initiative and by a partnership between the Water Research Foundation and the New York State Energy Research and Development Authority. The objective of this project is to develop tools to assist water utilities in identifying and managing risks associated with potential impacts from climate change.

In 2009, the Stockholm Environment Institute (SEI) was selected to develop this tool. The first phase of the work will synthesize existing knowledge on climate change risk identification and assessment. In 2010, SEI reviewed the literature and prepared a draft synthesis of the state of current knowledge related to climate risk identification and assessment. As part of this task, SEI has developed a draft survey instrument to seek more targeted information. In 2011, SEI plans to complete their synthesis report, develop their risk management approach, and continue with the pilot studies with New York City and Colorado Springs.

Appendix A – Glossary and Acronyms

AB32	Assembly Bill 32 (California Global Warming Solutions Act)
Adaptation	Initiatives and measures to reduce the vulnerability of natural and human systems to actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned. Examples are raising river or coastal dikes, the substitution of more temperature-shock resistant plants for sensitive ones, etc.
Afforestation	Direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources. See also Re- and Deforestation.
AMWA	Association of Metropolitan Water Agencies
Anthropogenic	Resulting from or produced by human actions
AR4	IPCC Fourth Assessment Report
AWWA	American Water Works Association
Biofuel	Any liquid, gaseous, or solid fuel produced from plant or animal organic matter e.g. soybean oil, alcohol from fermented sugar, black liquor from the paper manufacturing process, wood as fuel, etc. Second-generation biofuels are products such as ethanol and biodiesel derived from ligno-cellulosic biomass by chemical or biological processes.
Biogenic	Resulting from or produced by biological processes.
Biomass	The total mass of living organisms in a given area or volume; dead plant material can be included as dead biomass.
Cap	Mandated restraint as an upper limit on emissions. The Kyoto Protocol mandates emissions caps in a scheduled timeframe on the anthropogenic GHG emissions released by Annex B countries. By 2008-2012 the EU e.g. must reduce its CO_2-equivalent emissions of six greenhouse gases to a level 8 percent lower than the 1990-level.
Carbon Cycle	The set of processes such as photosynthesis, respiration, decomposition, and air-sea exchange, by which carbon continuously cycles through various reservoirs, such as the atmosphere, living organisms, soils, and oceans.
CARB	California Air Resources Board
CAT	Climate Action Team
CCAR	California Climate Action Registry
CCX	Chicago Climate Exchange
CFC	Chlorofluorocarbon
CH_4	Methane
CFI	Carbon Financial Instrument

Climate Change	As defined in the IPCC AR4 report, climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity.
CNG	Compressed Natural Gas - Natural gas that has been compressed under high pressures, typically between 2000 and 3600 psi, and held in a container
CO_2 Equivalent	The amount of CO_2 emission that would cause the same radiative forcing as an emitted amount of a well mixed greenhouse gas, or a mixture of well mixed greenhouse gases, all multiplied with their respective Global Warming Potentials to take into account the differing times they remain in the atmosphere.
Deforestation	The natural or anthropogenic process that converts forest land to non-forest. See afforestation and reforestation.
De Minimis	So small or minimal in difference that it does not matter or the law does not take it into consideration
DWR	Department of Water Resources
Emissions Trading	A market-based approach to achieving environmental and air quality objectives. It allows those reducing GHG emissions below their emission cap to use or trade the excess reductions to offset emissions at another source inside or outside the country. In general, trading can occur at the intra-company, domestic, and international levels. The Second Assessment Report by the IPCC adopted the convention of using permits for domestic trading systems and quotas for international trading systems. Emissions trading under Article 17 of the Kyoto Protocol is a tradable quota system based on the assigned amounts calculated from the emission reduction and limitation commitments listed in Annex B of the Protocol.
ENSO	El Nino-Southern Oscillation
FSCC	Folsom South Canal Connection
GCM	General Circulation Model
GHG	Greenhouse Gas - Greenhouse gases are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. This property causes the greenhouse effect. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances, dealt with under the Montreal Protocol. Besides carbon dioxide, nitrous oxide and methane, the Kyoto Protocol deals with the greenhouse gases sulfur hexafluoride, hydrofluorocarbons, and perfluorocarbons.
Global Warming	Global warming refers to the gradual increase, observed or projected, in global surface temperature, as one of the consequences of radiative forcing caused by anthropogenic emissions.

Greenhouse Effect	Greenhouse gases effectively absorb infrared radiation, emitted by the Earth's surface, by the atmosphere itself due to the same gases and by clouds. Atmospheric radiation is emitted to all sides, including downward to the Earth's surface. Thus, greenhouse gases trap heat within the surface-troposphere system. This is called the greenhouse effect. Thermal infrared radiation in the troposphere is strongly coupled to the temperature at the altitude at which it is emitted. In the troposphere, the temperature generally decreases with height. Effectively, infrared radiation emitted to space originates from an altitude with a temperature of, on average, –19°C, in balance with the net incoming solar radiation, whereas the Earth's surface is kept at a much higher temperature of, on average, +14°C. An increase in the concentration of greenhouse gases leads to an increased infrared opacity of the atmosphere and therefore to an effective radiation into space from a higher altitude at a lower temperature. This causes a radiative forcing that leads to an enhancement of the greenhouse effect, the so-called enhanced greenhouse effect.
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
Inertia	In the context of climate-change mitigation, inertia relates to the difficulty of adaptive change resulting from pre-existing conditions within society such as physical man-made capital, natural capital and social non-physical capital, including institutions, regulations and norms. Existing structures lock in societies, making change more difficult.
IPCC	Intergovernmental Panel on Climate Change
IRWMP	Integrated Regional Water Management Plan
JSA	Joint Settlement Agreement
LNG	Liquified Natural Gas - Natural gas liquified either by refrigeration or by pressure
Market Based Regulation	Regulatory approaches using price mechanisms (e.g., taxes and auctioned tradable permits), among other instruments, to reduce GHG emissions.
MGD	Millions Gallons per Day
Mitigation	Technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce an emission reduction, with respect to climate change, mitigation means implementing policies to reduce GHG emissions and enhance sinks.
MMT	Million Metric Tons
MT	Metric Tons
MWWTP	Main Wastewater Treatment Plant
NO_2	Nitrous Oxide

No Regrets Investment	Investment that is expected to provide a positive benefit during the useful life of the investment with minimal risk of impacts from climate change.
NOx	Reactive nitrogen oxides (the sum of NO and NO_2)
PDO	Pacific Decadal Oscillation
ppm	Parts per Million
PV	Photovoltaic
Radiative Forcing	As defined in the IPCC AR4 report, radiative forcing is a measure of the influence that a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system and is an index of the importance of the factor as a potential climate change mechanism. Positive forcing tends to warm the surface while negative forcings tend to cool the surface.
REC	Renewable Energy Credit
Reforestation	Direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was previously forested but converted to non-forested land. See also afforestation and deforestation.
Relative Sea Level	Sea level measured by a tide gauge with respect to the land upon which it is situated. Mean sea level is normally defined as the average relative sea level over a period, such as a month or a year, long enough to average out transients such as waves and tides. See Sea level change.
Sea Level Change	Sea level can change, both globally and locally, due to (i) changes in the shape of the ocean basins, (ii) changes in the total mass of water and (iii) changes in water density. Sea level changes induced by changes in water density are called steric. Density changes induced by temperature changes only are called thermosteric, while density changes induced by salinity changes are called halosteric. See also Relative Sea Level; Thermal expansion.
Sequestration	Carbon storage in terrestrial or marine reservoirs. Biological sequestration includes direct removal of CO_2 from the atmosphere through land-use change, afforestation, reforestation, carbon storage in landfills and practices that enhance soil carbon in agriculture.
SimClim	**SimClim is an integrated modeling software used to assess climate change impacts and adaptation.**
Snow Line	The lower limit of permanent snow cover, below which snow does not accumulate.
SWC	Snow Water Content
Thermal Expansion	In connection with sea level, this refers to the increase in volume (and decrease in density) that results from warming water. A warming of the ocean leads to an expansion of the ocean volume and hence an increase in sea level. See Sea level change.

TNF	True Natural Flow
UNFCCC	United Nations Framework Convention on Climate Change
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound
WSMP 2040	EBMUD's Water Supply Management Program plan to ensure adequate and reliable high-quality water supplies that will meet our customers' water needs up to year 2040

Appendix B – Committee and Working Group Members

CLIMATE CHANGE COMMITTEE

Michael J. Wallis
Operations & Maintenance
Chair

Michael Ambrose
Regulatory Compliance

Clifford Chan
Water Treatment &
Distribution

Richard Sykes
Water and Natural Resources

Jylana Collins
Office of the General Counsel

Cheryl Farr
Office of the General Manager

Richard Harris
Water Conservation

Xavier Irias
Engineering and Construction

Kanouse, Randy
Bay-Delta Consensus Team

Saji Pierce
Office of the General Counsel

Mike Tognolini
Water Supply Improvements

Doug Wallace
Bay-Delta Consensus Team

Eileen White
Water Operations

David Williams
Wastewater

SCIENCE AND ASSESSMENT WORKING GROUP

Clifford Chan
Water Treatment &
Distribution
Working Group Leader

Ben Bray
Water Resources Planning

Hubert Lai
Water Treatment &
Distribution

Kevin Richards
Water Treatment &
Distribution

James R. Smith
Natural Resources Admin

Joseph A. Young
Water Treatment &
Distribution

IMPACTS, VULNERABILITIES AND ADAPTATIONS WORKING GROUP

Michael Tognolini
Water Supply Improvements
Working Group Leader

Clifford Chan
Water Treatment &
Distribution

Ed McCormick
Support Services

John Hurlburt
Water Supply

William Kirkpatrick
Water Distribution Planning

James R. Smith
Natural Resources Admin

Doug Wallace
Bay-Delta Consensus Team

MITIGATION WORKING GROUP

Michael Ambrose
Regulatory Compliance
Working Group Leader

David Beyer
Water Treatment &
Distribution

Stephanie Cheng
Environmental Services

Laura Johnson
Pipeline Construction &
Equipment

Eva Lucia
Regulatory Compliance

Ed McCormick
Support Services

John Schroeter
Regulatory Compliance

Susan Suzuki
Regulatory Compliance

Doug Wallace
Bay-Delta Consensus Team

LEGISLATION AND REGULATIONS WORKING GROUP

Doug Wallace
Bay-Delta Consensus Team
Working Group Leader

Michael Ambrose
Regulatory Compliance

Stephanie Cheng
Environmental Services
Division

Saji Pierce
Office of the General Counsel

PUBLIC OUTREACH WORKING GROUP

Cheryl Farr
OGM - Communications
Working Group Leader

Appendix C – References

[i] Intergovernmental Panel on Climate Change (IPCC), "Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report for the Intergovernmental Panel on Climate Change", Cambridge University Press 2007, page 18.

[ii] CRS Report for Congress, "Are Carbon Dioxide Emissions Rising More Rapidly than Expected?, Congressional Research Service, October 17, 2008.

[iii] IPCC, "Climate Change 2007: Synthesis Report. Summary for Policymakers', Cambridge University Press 2007, page 5.

[iv] Ibid endnote i, page 2.

[v] Ibid endnote i, page 3.

[vi] Ibid endnote i, page 3.

[vii] Ibid endnote i, page 3.

[viii] Dettinger, M, "Changes in Streamflow Timing in the Western United States in Recent Decades", USGS, March 2005.

[ix] Ibid endnote i

[x] Ibid endnote 2, page 5.

[xi] Ibid endnote ii, page 8.

[xii] IPCC, "Working Group I Report: The Physical Science Basis", Cambridge University Press, 2007, page 858.

[xiii] Ibid endnote xii, page 890.

[xiv] Ibid endnote ii, page 8.

[xv] California Department of Water Resources, "Progress on Incorporating Climate Change in Management of California's Water Resources", July 2006.

[xvi] Collins, Bill, "The Future of the Earth's Climate: Frontiers in Forecasting", Lawrence Berkeley National Laboratory, 2007.

[xvii] Archer, Cristina L, Caldeira, Ken, "Historical Trends in the Jet Streams", Geophysical Research Letters, Vol. 35, April 18, 2008, pages 1-6.

[xviii] Fu, Qiang, Johanson, Celeste M, Wallace, John M, Reichler, Thomas, "Enhanced Mid-Latitude Tropospheric Warming in Satellite Measurements", Science, Vol. 312, May 26, 2006.

[xix] Running, Steven W, "Climate Change: Is Global Warming Causing More, Larger Wildfires?", Science Express Magazine, July 6, 2006, pages 927-928

[xx] Ibid endnote XV