Los Angeles Region Framework for Climate Change Adaptation and Mitigation

Current State of Knowledge & Water Quality Regulatory Program Considerations

Los Angeles Regional Water Quality Control Board

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July 2015

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This report is available online at: http://www.waterboards.ca.gov/losangeles/

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1. Introduction

Human activities over the past century have resulted in releases of large quantities of carbon dioxide and other greenhouse gases into the atmosphere. This has led to the onset of significant changes in the earth's climate that will have substantial impacts on the planet's natural ecosystems as well as on human health and activities. Expected climate changes include major changes in temperature, precipitation and wind patterns and substantial sea level rise, among others. Those changes will in turn affect water resources, including water quality.

Much focus has been directed on the effect of climate change on water resources; this has been further emphasized by the significant drought that California has been experiencing over the last four years. However, little consideration has been given to the effects that the various predicted alterations to weather, sea level rise or water resources themselves will have on water quality and the beneficial uses of our waters. This is a problem that needs immediate attention, because preserving water quality is essential to protect both human populations and natural ecosystems, and to ensure their prosperity into the future.

The State Water Resources Control Board (State Water Board) Board is taking an active role in adapting to the effect of climate change through efforts led by the Water Rights Division to manage water resources in the current drought[1]. The State Water Board is also engaged in the development of adaptation and mitigation strategies to deal with environmental conditions resulting from climate change and participates in various working groups such as the California Environmental Protection Agency (Cal/EPA) Climate Action Team[2], and assists with the development of guidance documents such as the California Water Plan[3].

On a local level, the Los Angeles Regional Water Quality Control Board (Regional Water Board) is committed to addressing threats to water quality resulting from climate change. Specific Regional Water Board efforts began with sharing ideas and stimulating a dialogue with other states and EPA colleagues, followed by a presentation by the Chief Deputy Executive Officer to the Regional Water Board in July 2014. This commitment continues through the development of a framework for climate change adaptation within the Regional Water Board's programs, which is outlined here. This document is intended as a living document and will be updated and expanded as our knowledge of impacts on water quality and our efforts to address these impacts evolve. This framework constitutes a first step in the development of a regional climate change action plan for the Los Angeles Regional Water Board.

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[1] California State Water Resources Control Board. http://www.waterboards.ca.gov/
[2] Cal/EPA Climate Action Team. http://www.climatechange.ca.gov/climate_action_team/
[3] California Water Plan (2013). http://www.waterplan.water.ca.gov/

2. Expected Impacts of Climate Change in California

2.1. Temperature

Models agree that climate change will bring a number of changes that will impact our lives. In general, ambient temperatures will rise, and we will see more extreme conditions, such as an increase in extreme heat days, and an increase in extreme precipitation events leading to more frequent and more severe flood events. In the Los Angeles area, by 2050, annual average temperatures are predicted to rise by 4-5 °F, and the occurrence of "extreme heat days" is expected to increase by two to six times even with efforts to reduce greenhouse gas emissions.[4] These changes, together with reductions in snowpack, will make drought periods, which are a natural occurrence in the region, increasingly harmful. A likely consequence of this warmer climate will be an increase in the amount and intensity of fires. In southern California, the fire season is expected to last about three weeks longer, and the annual acreage burned could increase by 20 to 30 percent by 2050.[5] Increases in burned areas add to impacts from erosion, increases in pollutant runoff, and increase the loss of wildlife habitat.

2.2. Precipitation and Snowpack

Concurrently, Los Angeles area mountains will lose at a minimum 31% of snowfall.[6] This decrease in snowfall, combined with warmer temperatures, will induce a decrease in the amount and duration of snowpack, with seasonal melting occurring on average 16 days earlier than usual in the spring. This is especially concerning since the Sierra Nevada snowpack is an essential source of freshwater to the region. While snowfall (which releases precipitation to streams more slowly) is projected to decline, throughout California, changes to mean precipitation are expected to be small. However, the increasing occurrence of extreme precipitations events will amplify the risk of flood, and overall extremely wet years are expected to increase by a factor of three by the end of the century.[7,8,9]

2.3. Sea Level Rise

In addition to these effects, thermal expansion of sea water combined with the melting of land-based ice will induce a global sea level rise of 7 - 19 inches from 2000 to 2050; and 20-55 inches by 2100. In the Los Angeles region, projections show an increase of 5 – 24 inches by 2050 and 17 – 66

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[4] Mid-Century Warming in the Los Angeles Region. Part I of the "*Climate Change in the Los Angeles Region"* Project. http://c-change.la/

[5] Yue X. et al. (2013) Ensemble projections of wildfire activity and carbonaceous aerosol concentrations over the western United States in the mid-21st century. *Atmospheric Environment.* DOI 10.1016/j.atmosenv.2013.06.003

[6] Mid- and End-of-Century Snowfall in the Los Angeles Region. Part II of the "*Climate Change in the Los Angeles Region"* Project. http://c-change.la/

[7] Das T. et al. (2013) Increases in flood magnitudes in California under warming climates. *Journal of Hydrology*. 501: 101–110.

[8] Pierce D.W. et al. (2012) Probabilistic estimates of future changes in California temperature and precipitation using statistical and dynamical downscaling. *Climate Dynamics,* DOI 10.1007/s00382-012-1337-9.

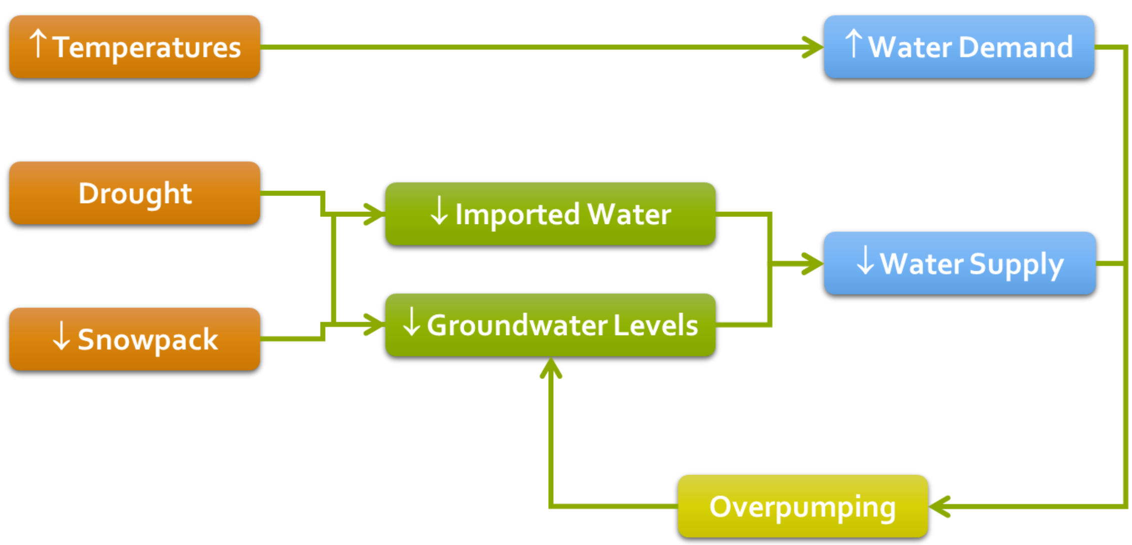
[9] Berg N. and A. Hall, 2015: Increased interannual precipitation extremes over California under climate change. *Journal of Climate.* DOI 10.1175/JCLI-D-14-00624.1

inches by 2100. As mean sea level rises, the incidence of extreme high-sea-level events such as extreme tides, wave-driven run-up[10] and storm surge[11] will become increasingly common, causing more extensive and frequent damage including flooding, and land and beach erosion.[12,13] These extreme events could flood or permanently submerge treatment facilities, particularly those that are subsurface.

2.4. Water Supplies

Climate change will likely impact both water demand and water supply through various pathways, as illustrated in Figure 1. Drought periods and a lower snowpack could trigger a drop in groundwater levels and a decrease in the amount of imported water available to the region, which would have major impacts on the water supply. In addition, higher temperatures will likely increase water demand. In order to cope with these added stresses on water supply and water demand, augmented pumping of local aquifers would exacerbate the decrease in groundwater levels.

Figure 1: Simplified schematic of the impacts of climate change to water supplies.



2.5. Water Quality

Each of these changes has the potential to drastically alter hydrological and ecosystem processes in the region. As a whole, they could have major impacts not only on water supplies, but also on water quality. Those impacts could manifest in multiple ways, such as a decrease in stream flow, a

[10] Wave run-up: maximum vertical extent of wave up-rush on a beach.
[11] Storm surge: abnormal rise of water generated by a storm, over and above the predicted astronomical tide.
[12] National Research Council, 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Washington, DC: The National Academies Press, 117. Available at: www.nap.edu/catalog.php?record_id=13389.
[13] Grifman P.M. et al.. (2013) *Sea Level Rise Vulnerability Study for the City of Los Angeles.* USCSG-TR-05-2013.

reduction of aquatic habitats, a rise in surface water temperature, an increase in pollutant levels and sedimentation, an intensification of algae growth, or changes in salinity levels and acidification in coastal areas. These are described in more detail below.

3. Regional Water Board Considerations for Addressing Climate Change in the Region

Preserving water quality is essential to the protection of both human populations and natural ecosystems, and to ensure their prosperity. Water quality standards adopted by the nine Regional Water Quality Control Boards (Regional Water Boards), and in some cases, the State Water Resources Control Board (State Water Board) are the foundation of programs that protect and restore the chemical, physical, and biological integrity of the Nation's and State's waters, as required by the Federal Clean Water Act and the Porter-Cologne Water Quality Control Act. These standards are comprised of designated beneficial uses (e.g., municipal and domestic supply, water recreation, support of aquatic habitat; see full list and definitions in Appendix A); water quality objectives to protect those designated beneficial uses; as well as provisions to prevent the degradation of existing water quality (antidegradation provisions). California's Water Quality Control Plans (Basin Plans) adopted by each Regional Water Board along with Statewide plans also include implementation programs to achieve and maintain compliance with water quality objectives. Because each of these elements will be challenged by climate change, strategies need to be developed to ensure their continued efficacy in light of these pressures. Additionally, we need to examine how the Regional Water Board can insert climate change considerations into its planning, permitting and monitoring programs.

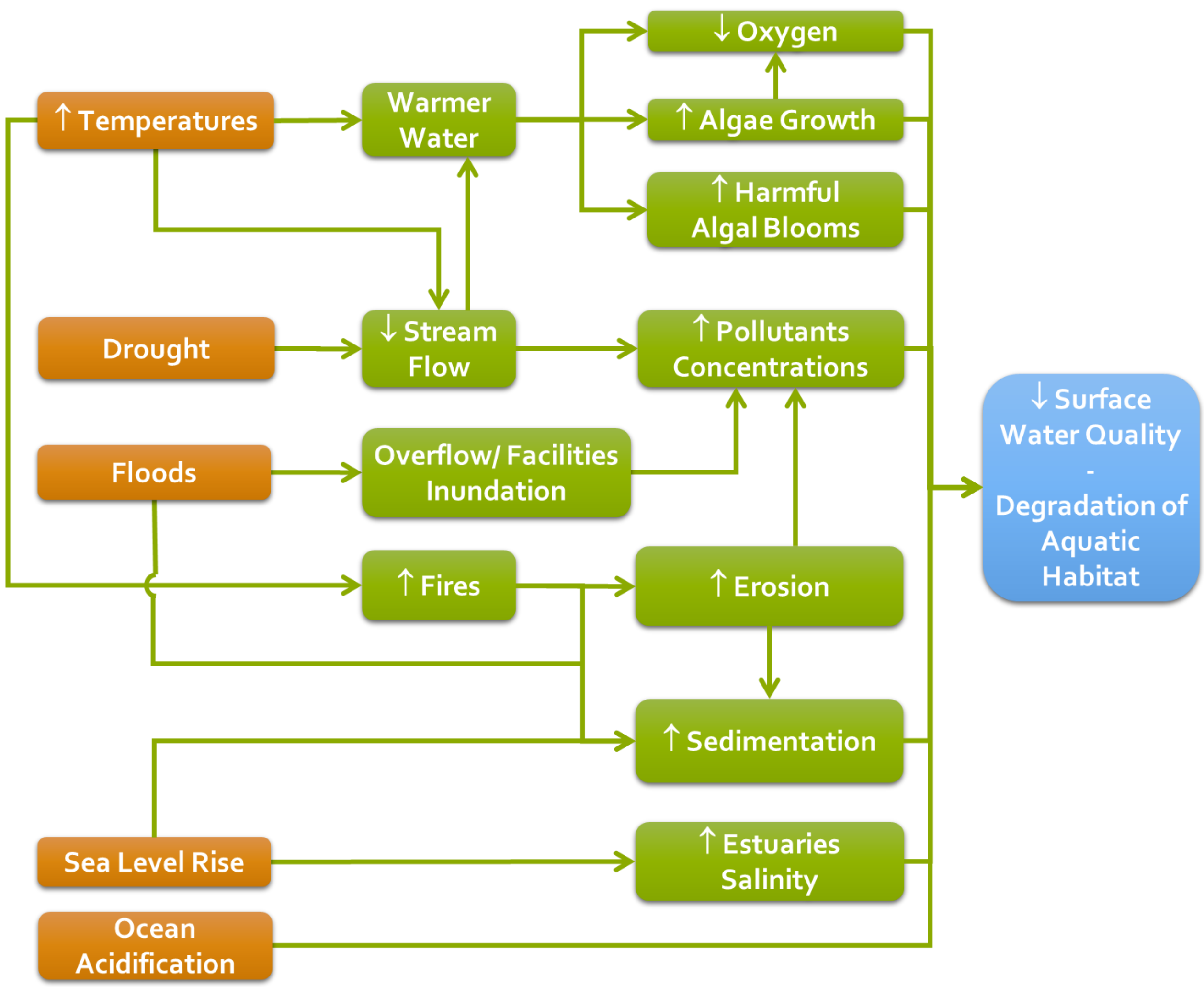
This framework explores the general relationship between climate change, water resources, and water quality and develops a number of considerations and actions for addressing potential impacts on water quality through the Los Angeles Regional Water Board's regulatory programs. This document considers climate change impacts to inland, estuary and coastal surface waters separately from groundwater in different sections of the framework, as they are addressed by different regulatory programs within the Regional Water Board. Within each of these sections, general effects of climate change on water quality are evaluated, followed by a consideration of potential impacts to beneficial uses and water quality objectives, and a reflection on the effects of drought/climate adaptation efforts on water quality. Climate impacts and potential regulatory measures that the Regional Water Board may consider within each of its programs are then explored. Finally, some overarching considerations spanning all programs and water bodies are outlined.

3.1. Inland, Estuary and Coastal Surface Waters

3.1.1. Potential Impacts of Climate Change to Surface Water Quality

The potential impacts of climate change to the physical, chemical and biological characteristics of surface water, and in turn to the quality of aquatic habitats, are numerous (Figure 2).

Figure 2: Simplified schematic of the impacts of climate change on water quality in surface waters.



- Stream flows are expected to drop during drought periods, resulting in a loss of aquatic habitats, increase in water temperature, and concentration of pollutants that may threaten water quality.
- An increase in the number of fires and flash floods, as well as a sea level rise could cause an increased transport of contaminants to surface waters through soil erosion processes, and augmented sedimentation in rivers and estuaries. An increase in the number of fires could

in addition increase the release of toxic chemicals associated with fires or firefighting practices, such as dioxins.

- Heavy rainfall could also overload the loading capacity of sewer systems and treatment plants, leading to overflows that would contaminate natural waters. Septic tanks and leach lines, landfills, and other land treatment units could be inundated and lose function and contaminate adjacent areas.
- Sea level rise could cause a global change of the coastal system's ecology. In particular, as sea water moves inland, the associated increase in salinity would pose a risk to freshwater aquatic communities, the likely outcome being a shift towards more salt tolerant plant and animal species.
- Warmer waters would be conducive to an increase in algae growth. This could result in more harmful algal blooms that would degrade water quality through undesirable color, odor, taste and possible toxicity, and in a decrease of oxygen in surface waters to levels endangering aquatic life. Warmer waters also hold less oxygen, causing stress to aquatic life.
- The decline of pH in seawater, or ocean acidification, caused by the uptake of carbon dioxide (CO_2) from the atmosphere would induce a diminution of the amount of carbonate ions in the water. Because these are used in combination with calcium by marine organisms to build their shells and skeletons, this trend could have major repercussions on ocean ecology.

3.1.2. Potential Impacts of Climate Change to Beneficial Uses and Water Quality Objectives

3.1.2.1. Evaluation of Impacts to Surface Water Beneficial Uses

The effects of climate change on water quality will potentially impact numerous existing and designated beneficial uses of waters in the Los Angeles region (Table 1).

Inland Waters

- The expected increase in water temperatures may endanger fish populations that thrive in cold waters, such as trout, and impact the COLD (Cold Freshwater Habitat) designations.
- The combination of lower flows, increasing pollutant and sediment loadings and increasing algae growth (which could bring a decrease in oxygen levels) could potentially affect the hydrological and chemical quality of the region's streams, lakes and wetlands. These changes would impact multiple beneficial uses designated to protect the ecological integrity of inland waters, such as COLD, WARM (Warm Freshwater Habitat), WET (Wetland Habitat), WILD (Wildlife Habitat), BIOL (Preservation of Biological Habitats), RARE (Rare, Threatened, or Endangered Species), SPWN (Spawning, Reproduction, and/or Early Development), and MIGR (Migration of Aquatic Organisms).

- The potential ecological changes mentioned above could in turn affect COMM (Commercial and Sport Fishing) uses.
- Increasing algae growth and potential harmful algal blooms and decreasing flow resulting in shallower water depth could impact recreational uses in the region, such as REC-1 (Water Contact Recreational Use), LREC-1 (Limited Water Contact Recreational Use) and REC-2 (Non-contact Recreational Use) beneficial uses.
- Warmer temperatures, changes in water circulation patterns resulting from lower flows and sewer overflows resulting from flood events may favor bacteria growth, and impact REC-1, LREC-1 and REC-2 recreational uses.
- Increasing pollutant and sediment loadings and increasing algae growth could affect beneficial uses designated to protect human activities that rely on water quality, such as PROC (Industrial Process Supply), GWR (Ground Water Recharge), FRSH (Freshwater Replenishment), MUN (Municipal and Domestic Supply), AGR (Agricultural Supply) and AQUA (Aquaculture).
- Decreasing flows could result in water depths that no longer support NAV (Navigation) uses.

Coastal and Estuary Waters

- The increasing salinity induced by sea level rise, combined with lower stream flows limiting the amount of freshwater coming to coastal zones may cause conversions of habitat types (e.g., estuarine habitats to marine habitats)and/or loss of coastal and wetland habitats. These ecological changes could impact beneficial uses such as EST (Estuarine Habitat), WET, MAR (Marine Habitat), WILD, BIOL, RARE, SPWN and MIGR.
- Increasing sediment loadings and algae growth (which could bring a decrease in oxygen levels) could affect the hydrological and chemical quality of the coastal and estuary waters, and impact EST, WET, MAR, WILD, BIOL, RARE, SPWN and MIGR uses.
- Coastal lagoons with sand bars that naturally open and close seasonally may be disrupted, affecting aquatic life, including many endangered species, that are supported by EST, WET, MAR, WILD, BIOL, RARE, SPWN and MIGR uses.
- These potential ecological changes could in turn affect COMM uses.
- Ocean acidification in seawater induces a diminution of the amount of carbonate ions in the water, which are used by a variety of marine organisms to build their shells and skeletons in combination with calcium. As a result, ocean acidification hinders the building of shells, and also leaves the existing shells susceptible to erosion. This phenomenon threatens non only shellfish populations, but also fish populations that consume those shellfish. As a result, it could affect the EST, WET, MAR, WILD, BIOL, RARE, SPWN and MIGR beneficial uses.
- These potential ecological changes resulting from ocean acidification could in turn affect SHELL (Shellfish Harvesting), COMM and AQUA beneficial uses.

Table1. Potential Beneficial uses impacted by climate change in inland, estuarine and coastal waters

Beneficial Use	Inland Water						Estuarine and Coastal Water							
	stream flow	flood	temperature	pollutant	sediment	algae	sea level rise	acidification	stream flow	flood	temperature	salinity	sediment	algae
MUN				x	x	x								
AGR				x	x	x								
PROC				x	x	x								
IND														
GWR				x	x									
FRSH				x	x									
NAV	x						x		x					
POW														
REC-1	x	x	x			x	x		x	x	x			x
LREC-1	x	x	x			x				x	x			
REC-2	x	x	x			x	x		x	x	x			x
COMM	x			x	x	x	x	x	x			x	x	x
AQUA	x			x	x	x		x						x
WARM	x			x	x	x	x		x			x		x
COLD	x		x	x	x	x								
SAL														
EST							x	x	x			x	x	x
WET	x			x	x	x	x	x	x			x	x	x
MAR							x	x					x	x
WILD	x			x	x	x	x	x	x			x	x	x
BIOL	x			x	x	x	x	x	x			x	x	x
RARE	x			x	x	x	x	x	x			x	x	x
MIGR	x			x	x	x	x	x	x			x	x	x
SPWN	x			x	x	x	x	x	x			x	x	x
SHELL								x						x

*Shaded areas indicate beneficial uses that are listed as existing, potential or intermittent in water bodies in the Los Angeles Region. An unshaded area means that no water body is listed for this beneficial use in the region. For example, no inland water body is listed for the MAR beneficial use, as it applies to coastal waters.

[§] Consideration of the effects of pollutants and sedimentation loads include results from multiple factors, including wildfires and overflow/facilities inundation.

- Sea level rise and the associated potential loss of beaches and recreational areas, decreasing flow resulting in shallower water depth in some estuaries and coastal wetlands, as well as increasing algae growth and potential harmful algal blooms could all impact REC-1 and REC-2 recreational uses.
- Warmer temperatures, changes in water circulation patterns resulting from lower flows and sewer overflows resulting from flood events may favor bacteria growth, and impact REC-1, LREC-1 and REC-2 recreational uses.
- Decreasing flows in estuaries could result in water depths that do not support NAV uses.

<u>Questions to consider:</u>

- What is the degree of impact of climate change to each beneficial use?
- How will the impacts manifest with time?
- How will beneficial uses be impacted spatially within the region?
- What type of monitoring and research is needed to evaluate these impacts?
- How can potential changes to beneficial uses impact the Regional Water Board's programs?
- Should the Regional Water Board consider the application of conditional beneficial uses dependent on weather conditions (e.g., drought or storm event), or increased application of the "Intermittent" label?
- What long term strategies should be considered to mitigate impacts where beneficial uses are at risk?
- Other considerations to be developed

3.1.2.2. Impacts to Reference Conditions

Establishing reference conditions is a crucial tool for the development of water quality regulations. Reference conditions provide a basis for comparison of an impaired water body to one that has been untouched by human activity, and can be used to set objectives for system recovery. Finding unperturbed water bodies can be challenging in urban southern California, and it may become even more so as climate conditions change, regardless of local anthropogenic perturbations. In addition, as climate change progresses, the definition of reference conditions themselves may change as ecological, physical and chemical conditions evolve in unperturbed systems.

<u>Questions to consider:</u>

- How will ecological, physical and chemical conditions change in unperturbed systems as climate change progresses?
- Since climate change effects are expected to progress over an extended period of time, when would a steady state be reached, if any?
- What type of monitoring and research is needed to evaluate these impacts?
- As conditions change as a result of climate change, would current established reference conditions still be relevant to the Regional Water Board's decision making?
- How could these considerations impact the Regional Water Board's programs?

- Other considerations to be developed

3.1.2.3. Water Quality Standards Considerations

Increase of Pollutant Levels over Water Quality Objectives

As mentioned earlier, increasing pollutant and sediment loads may be observed in waters as a result of climate change. These increases could bring pollutant levels above existing water quality objectives.

Questions to consider:

- What pollutants may see their levels increase above water quality objectives?
- Would those effects be localized?
- How would those effects progress with time, and would they eventually stabilize?
- What levels are these pollutants expected to reach?
- What type of monitoring and research is needed to evaluate these impacts?
- How could these considerations impact the Regional Water Board's programs?
- What long term strategies should be considered to mitigate the increase of pollutants where beneficial uses are at risk?
- Other considerations to be developed

Changes in Critical Levels of Pollutants

Physical and chemical alterations of the natural systems associated with climate change may, in turn, alter the critical levels of a pollutant that impair beneficial uses. For example, most toxicants (metals, organic pollutants) see their toxicity level rise with temperature. The predicted increase in water temperatures may therefore intensify the level of toxicity for some pollutants, for which water quality objectives may need to be reconsidered.

Questions to consider:

- What are the pollutants that are likely to see their critical levels change (in the example above, a specific metal or organic pollutant)?
- How will the triggering factor (in this example temperature) change with time as climate change progresses?
- What would be the new critical levels of pollutant (in this example what would be the new critical toxicity level for a specific metal or organic pollutant at a corrected ambient temperature)?
- How could these considerations impact the Regional Water Board's programs?
- Should the Regional Water Board consider more protective water quality objectives to address new local conditions?
- Other considerations to be developed

3.1.2.4. Consideration of the Need for New Quality Objectives

In addition to a reconsideration of existing standards, the need for the development of new standards may be heightened by the new environmental conditions. As mentioned above, drops in precipitation could mean a decrease in water quantity and quality. This will possibly raise the concentrations of pollutants that to date have not been identified at levels of concern to spur development of a water quality objective. This may be an issue particularly for constituents of emerging concerns (CECs) that are present in effluents from publicly operated treatment works (POTWs) for which standards have not yet been developed.

Questions to consider:

- For which pollutants that do not currently have a water quality standard may levels increase to levels of concern?
- What levels are these pollutants expected to reach following climate change?
- What type of monitoring and research is needed to evaluate these impacts?
- How could these considerations impact the Regional Water Board's programs?
- What can be done on the regional level to support the development of new water quality criteria, or to establish water quality objectives?
- Other considerations to be developed

3.1.2.5. Consideration of the Added Complexity in the Development of Numeric Objectives

For some water quality objectives expressed as narratives, the change in conditions may make the development of numeric objective more difficult. This is the case for biostimulatory substances (including nutrients), whose water quality objective in the Los Angeles Region Water Board's Basin Plan reads as: "*Waters shall not contain biostimulatory substances in concentrations that promote aquatic growth to the extent that such growth causes nuisance or adversely affects beneficial uses.*" The USEPA has identified the development of numeric objectives for nutrients a high priority, and the State Water Board is developing a statewide nutrient control program. It is an especially complicated task because aquatic growth is influenced not only by nutrients, but by multiple factors such as sunlight and water temperature. Climate change will exacerbate these factors, and make the task even more complex.

Questions to consider:

- What narrative objectives may be impacted by climate change?
- How will these impacts manifest (for example, how much more aquatic growth is expected)?
- What triggering factors may be impacted by climate change, and what is the extent of this modification (for example, for aquatic growth, triggering factors includes nutrients, sunlight/shading and temperature)?
- How are changes expected to progress with time?

- What type of monitoring and research is needed to evaluate these impacts?
- How can climate change be included in ongoing efforts to develop numeric objectives?
- How could these considerations impact the Regional Water Board's programs?
- Other considerations to be developed

3.1.3. Potential Effects of Drought/Climate Adaptation Efforts on Water Quality

An added complication to the estimation of impacts of climate change on water quality standards is the need to consider changes deriving from measures taken to fight the decrease of water resources or protect infrastructure. These efforts may in turn have water quality impacts of their own.

3.1.3.1. Water Conservation Efforts

Water conservation efforts have already led to a rise in pollutants concentrations in waste water as the region's population uses less water. Even after treatment, Public Owned Treatment Works (POTWs) effluents released to receiving waters may show rising concentrations leading to an exceedance of existing water quality objectives. Such effects are already observed locally, and will likely intensify as climate change progresses, more water is conserved, and as stream flows decrease.

Questions to consider:

- What other effects could conservation efforts have on beneficial uses?
- What pollutants will be more likely to present a risk to beneficial uses as their concentrations rise in effluents?
- How much will concentrations rise as conservation efforts progress?
- What type of monitoring and research is needed to evaluate these impacts?
- How could these considerations impact the Regional Water Board's programs?
- Would Waste Load Allocations (WLAs) be affected by this phenomenon?
- Will compliance be affected by these increases?
- How could these effects be mitigated?
- Other considerations to be developed

3.1.3.2. Efforts to Increase Water Supply

Desalination projects that convert ocean water to potable water are often considered as a potential remedy for water supply shortage. However, the desalination process produces reject water, or brine, that contains high concentrations of salts that were removed from the source water. Brine discharges coming from those facilities can degrade water quality and affect aquatic life. As more desalination facilities are built as a result of climate change, so may the potential adverse effects to water quality and beneficial uses.

Other efforts to increase local water supplies can have impacts to water quality as well. Recycled water offsets potable water use and provides a much needed source of water in southern California. Recharge with stormwater is another emerging source of local water which is incentivized under regional municipal stormwater permits. Monitoring of these projects, as well as basin-wide efforts like Salt and Nutrient Management Planning, can ensure that these projects continue to provide expected benefits while ensuring that water quality is protected as well.

Questions to consider:

- What other efforts to increase water supply could impact beneficial uses?
- What type of monitoring and research is needed to evaluate these impacts?
- What measures can we take to minimize water quality impacts from these efforts?
- How could these considerations impact the Regional Water Board's programs?
- How could these effects be mitigated?
- Other considerations to be developed

3.1.3.3. Efforts to Protect Infrastructure

Efforts undertaken to protect our infrastructure against the effects of climate change could also have significant impacts on beneficial uses. For example, the construction of sea walls to fight sea level rise could result in a loss of beaches and associated habitats (e.g., dune habitat, rocky intertidal habitat that is already limited in the region). This could impact both recreational uses (REC-1 and REC-2) and ecological uses as habitat is lost (WARM, EST, MAR, WILD, BIOL, RARE, MIGR, SPWN, SHELL).

Questions to consider:

- What other efforts to protect infrastructure could impact beneficial uses?
- What type of monitoring and research is needed to evaluate these impacts?
- How could these considerations impact the Regional Water Board's programs?
- How could these effects be mitigated?
- What provisions can be included in permits to avoid or remedy these impacts?
- Other considerations to be developed

3.1.4. Potential Regulatory Adaptation Measures

As discussed previously, a variety of the Water Board's programs will be affected by the aforementioned effects on water resources and water quality deriving from climate change. On a regional level, each of the Regional Water Board's programs should identify the specific challenges caused by climate change within their activities, and develop and implement specific actions to address them. Addressing the questions defined for each program, in combination with the Regional Water Board's participation in regional projects (e.g., Southern California Wetland Recovery Project) and watershed initiatives will contribute to ensuring the general protection of watersheds and wetlands of the region.

Questions to consider for each program:

- What would be the specific impacts of climate change to the program?
- What type of adaptation/mitigation measures can be developed?
- What type of monitoring and research is needed?
- What requirements might be needed in the Regional Water Board's permits or other regulatory actions?
- How can the Regional Water Board's programs coordinate with other agencies that regulate inland and coastal waters (e.g., USEPA, Fish and Wildlife, California Department of Water Resources, California Coastal Commission) to assess and solve problems related to climate change?
- Other considerations to be developed

For inland, estuary and coastal waters, the programs that will potentially be impacted and some preliminary specific considerations for each of them are outlined below.

3.1.4.1. Standards

The Standards Program is charged to update and develop Water Quality Standards, and develops plans and policies designed to protect water quality in the region. Naturally, considerations for this program are closely related to those outlined in Section 3.1.2.

Questions to consider:

- Should the Regional Water Board consider the application of conditional beneficial uses dependent on the weather conditions (e.g., drought or storm event), or increased application of the "Intermittent" label?
- As conditions change as a result of climate change, would current established reference conditions still be relevant to the Regional Water Board's decision making?
- Should the Regional Water Board examine water quality objectives for water bodies undergoing changes due to climate impacts to 1) try to restore water quality if possible and 2) ensure protection of beneficial uses?
- How can climate change be included in ongoing efforts to develop numeric objectives?
- How could antidegradation policies be used to manage a potential increase in pollutant loads deriving from climate change?
- What long term strategies should be considered to mitigate impacts where beneficial uses are at risk?
- Other considerations to be developed

3.1.4.2. Total Maximum Daily Loads

Total Maximum Daily Loads (TMDLs) are developed to address water quality, sediment quality, fish tissue or other impairments of beneficial uses. They specify the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and allocate pollutant loading to point and non-point sources. Those allocations are later incorporated into permits.

Questions to consider:

- Should potential climate change effects be considered in TMDL development?
- How would climate change effects impact Waste Load Allocations (WLA) and Load Allocations (LA)?
- Should monitoring requirements included in TMDLs take into account climate change?
- Should climate change be taken into consideration when contemplating implementation measures?
- Should special studies include the evaluation of climate change effects?
- Other considerations to be developed

3.1.4.3. Control of Non-Point Source Pollutants

The Non-Point Source program manages measures to control pollutants originating from diffuse sources. Those include agricultural sources (e.g., irrigated agriculture land, grazing), forestry (silviculture), equestrian facilities, and marinas. Extreme weather effects can increase effects from erosion from land used for these activities.

Questions to consider:

- What will be the effects of climate change on each program area that addresses the various non-point source pollutant categories?
- How can these effects be taken into account in the Regional Water Board's actions?
- Should monitoring requirements for these activities/discharges take into account the potential effects of climate change?
- Should mitigation measures associated with permits, waivers, and other actions include climate change adaptation and effects?
- Other considerations to be developed

3.1.4.4. Regulation of Dredge and Fill Activities

The Clean Water Act Section 401 Water Quality Certification program regulates activities that result in dredge or fill to Waters of the U.S. and state.

Questions to consider:

- What will be the effects of climate change on the scope, frequency and nature of dredge and fill activities?
- How can these effects be taken into account in the Regional Water Board's actions?
- Should monitoring requirements for these activities/discharges take into account the potential effects of climate change?

- Should mitigation measures associated with certifications and permits include climate change adaptation and effects?
- Should planning for compensatory mitigation, mitigation banks and in-lieu fee programs consider climate change adaptation?
- Other considerations to be developed

3.1.4.5. Stormwater Permitting

The Stormwater Permitting program regulates storm water discharges from industrial facilities, construction sites, and municipal systems by issuing National Pollutant Discharge Elimination System (NPDES) permits and Waste Discharge Requirements (WDRs).

Questions to consider:

- What will be the effects of climate change on the permitted systems' operations and, in turn, discharge quality?
- How can these effects be taken into account in the Regional Water Board's stormwater permits (industrial, construction, and municipal)?
- Should permits consider the potential impacts of pollutants contained in their discharge on climate change? For example, nutrients and organic carbon inputs in the coastal zone favor algae growth, and in turn harmful algal blooms and a decrease in oxygen levels in the water. Increases in water temperature also exacerbate effects on aquatic life. This makes local ecosystems more vulnerable, and less able to naturally adapt to climate change.
- Should monitoring requirements take into account the potential effects of climate change?
- Other considerations to be developed

3.1.4.6. Watershed Regulatory

The Watershed Regulatory Section issues NPDES permits and water recycling requirements (WDRs and WRRs) to dischargers that release pollutants from any point source into surface waters of the region. The section includes Municipal Permitting (Publicly Owned Treatment Works - POTWs), Industrial Permitting (e.g., refineries, power plants, manufacturing, desalination plants) and General Permitting/Special Projects programs.

Questions to consider:

- What will be the effects of climate change on the permitted facilities' operations and in turn on discharge quality?
- How can these effects be taken into account in the Regional Water Board's permits?
- Should the effects of conservation measures (e.g., the increase of pollutants in facilities' effluents resulting from the decrease in water use) be taken into account when setting effluent limits?
- Should monitoring requirements take into account the potential effects of climate change?
- Other considerations to be developed

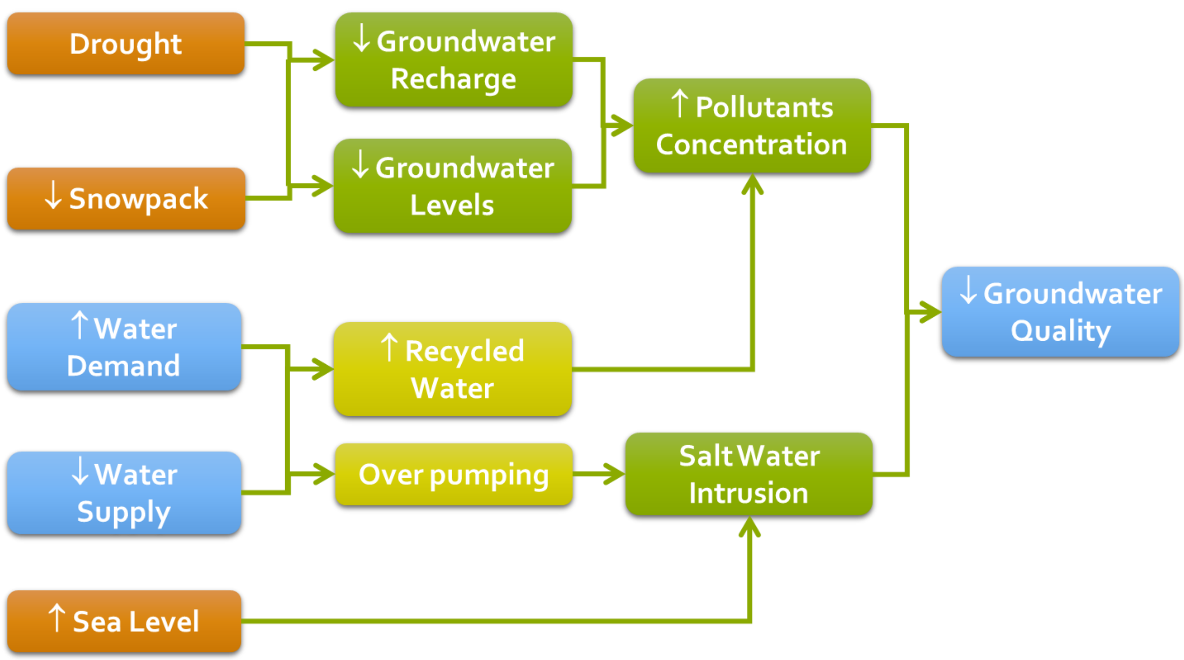
3.2. Groundwater

3.2.1. Potential Impacts of Climate Change to Groundwater Quality

Water quality in ground waters could be affected by climate change in a few direct and indirect ways (Figure 3).

- Low precipitation periods and smaller snowpack could affect natural groundwater recharge and result in a drop of water levels, which in turn could increase the levels of pollutants in groundwater.
- In order to offset deceasing levels of water and increasing demand, recycled water could be used to supplement water recharge. However recycled water, depending on the type and level of treatment used, could improve the water quality of a groundwater basin or worsen it.
- Finally, potential over-pumping of local aquifers, combined with sea level rise, could increase salt water intrusion problems in coastal areas, further threatening groundwater quality. Land subsidence can also occur as a result of over-pumping.

Figure 3: Simplified schematic of the impacts of climate change on groundwater quality.



3.2.2. Potential Impacts of Climate Change to Beneficial Uses and Water Quality Objectives

3.2.2.1. Evaluation of Impacts to Groundwater Beneficial uses

Groundwater in the Los Angeles region can be designated for MUN (Municipal and Domestic Supply), AGR (Agricultural Supply), PROC (Industrial Process Supply), IND (Industrial Service Supply) or AQUA (Aquaculture) beneficial uses. All of these uses except for IND are dependent on water quality. Therefore, the potential increase of pollutant loads and intrusion of salt water in coastal basins associated with climate change could impact MUN, AGR, PROC and AQUA uses (Table 2).

Table 2. Potential impacts of climate change factors on beneficial uses in groundwater

Beneficial Use	Groundwater	
	Pollutant Loads	Salt Water Intrusion
MUN	x	x
AGR	x	x
PROC	x	x
IND		
AQUA	x	x

Questions to consider:

- What is the potential degree of impact of climate change to each beneficial use?
- How will the impacts manifest with time?
- What type of monitoring and research is needed to evaluate these impacts?
- How could these considerations impact the Regional Water Board's programs?
- How should the Water Board's regulatory programs prevent the loss of beneficial uses as a result of climate change or related mitigation measures?
- What would be long term strategies to mitigate impacts where beneficial uses need to be protected?
- Other considerations to be developed

3.2.2.2. Consideration of the Potential Effect of Increased Pollutant Load on Water Quality Objectives

As mentioned above, changes in climate patterns and sea level rise may lead to an increase of pollutant loads in groundwater basins. The range and magnitude of these impacts need to be assessed, and potential strategies to cope with these changes should to be developed.

Questions to consider:

- What pollutants may see their levels increase above water quality objectives?
- Would those effects be localized?
- How would those effects progress with time, and would they eventually stabilize?
- What levels are these pollutants expected to reach?
- What type of monitoring and research is needed to evaluate these impacts?
- How could these effects be mitigated?
- How could these considerations impact the Regional Water Board's programs?

- Should the Regional Water Board consider a reevaluation of groundwater water quality objectives in areas impacted?
- How should antidegradation policies be used to manage impacts from climate change?
- Other considerations to be developed

3.2.3. Effects of Drought/Climate Adaptation Efforts on Water Quality

Similarly to what can be observed in surface waters, adaptation efforts to fight the decrease of water resources may have some unintended consequences on groundwater quality. Such efforts include the use of recycled water to irrigate and replenish groundwater basins. Because recycled water, depending on treatment, can contain high levels of salts, nutrients and CECs and disinfection byproducts, this type of effort to increase water supply could result in a degradation of water quality in groundwater basins. In particular, because water quality standards have not been developed yet for most CECs and disinfection byproducts, this could potentially create risks to beneficial uses. Despite these shortcomings, recycled water is an important resource, especially during drought periods, and impacts can be managed through salt and nutrient management planning efforts. Infiltration with stormwater and other sources of water can also be used to replenish groundwater basins, but they have to be monitored and managed as well, such that they do not cause water quality impacts. Both of these efforts to increase water supply have the potential to bring more pollutants into the region's groundwater basins if not managed properly.

Questions to consider:

- What other effects could conservation efforts have on beneficial uses in groundwater?
- What pollutants will be more likely to present a risk to beneficial uses as their concentrations rise in effluents?
- How much will concentrations rise as conservation efforts progress?
- What pollutants should we monitor to examine changes over time to basin quality?
- What type of monitoring and research is needed to evaluate these impacts?
- How could these effects be mitigated?
- How could these considerations impact the Regional Water Board's programs?
- What can be done on the regional level to help with the development of new water quality standards?
- Other considerations to be developed

3.2.4. Potential Regulatory Adaptation Measures

A variety of the Water Board's programs will be affected by the aforementioned effects on water resources and water quality deriving from climate change. On a regional level, each of the Water Board's programs should identify the specific challenges caused by climate change within their activities related to groundwater, and develop and implement specific actions to address them.

Questions to consider for each program:

- What would be the specific impacts of climate change to the program?
- What type of adaptation/mitigation measures can be developed?
- What type of monitoring and research is needed?
- What requirements might be needed in the Regional Water Board's permits or other regulatory action?
- How can the Regional Board's programs coordinate with other agencies that regulate groundwater?
- Other considerations to be developed

The groundwater programs that will potentially be impacted and some preliminary specific considerations for each of them are outlined below.

3.2.4.1. Standards

Questions to consider:

- How could antidegradation policies be used to manage a potential increase in pollutant loads deriving from climate change?
- What long term strategies should be considered to mitigate impacts where beneficial uses are at risk?
- Other considerations to be developed

3.2.4.2. Groundwater Permitting and Land Disposal

The Groundwater Permitting and Land Disposal programs issue waste discharge requirements (WDRs) to regulate discharges of waste to land and groundwater. These include, but are not limited to, discharges from small POTWs that discharge to ponds, onsite wastewater treatment systems (OWTSs, commonly known as septic systems), direct discharges to land, landfills, soil treatment units, and dredge sediment disposal.

Questions to consider:

- What will be the effects of climate change on the permitted systems' operations and in turn discharge quality?
- How can these effects be taken into account in the Regional Water Board's actions?
- Other considerations to be developed

3.2.4.3. Underground Tanks

The Underground Storage Tank (UST) Program addresses contamination due to petroleum products (e.g. gasoline and diesel fuel) and other hazardous substances leaking from USTs. Leaking USTs can cause soil, groundwater, and surface water contamination and present a fire or explosion hazard.

The UST program directs responsible parties to carry out corrective actions to mitigate unauthorized release from leaking USTs.

Questions to consider:

- What will be the potential effects of climate change on the USTs operations and in turn discharge quality?
- What effects could the increased recharge of various waters have on UST sites?
- How can these effects be taken into account in the Regional Water Board's actions?
- Other considerations to be developed

3.2.4.4. Remediation

The Remediation section of the Regional Water Board investigates unauthorized releases of pollutants to the environment, including soil, groundwater, surface water, and sediments. Upon confirming that an unauthorized discharge is polluting or threatens to pollute regional waterbodies, the Regional Water Board oversees site investigation, monitoring, and cleanup actions. Because remediation efforts, especially for groundwater contamination, can span long periods of time, it is relevant to consider the effect of climate change on these projects.

Questions to consider:

- What could be the effects of climate change on contaminated sites?
- What could be the effects of climate change on remediation efforts?
- What effects could the increased recharge of various waters have on remediation sites?
- How can these effects be taken into account in the Regional Water Board's actions?
- Other considerations to be developed

3.3. Overarching Considerations

3.3.1. Regional Monitoring and Research Needs

Although monitoring and research needs should be evaluated carefully for each program, and specific projects can be tailored to particular issues, there is also a need to consider monitoring and research projects that would inform our decision making on a region-wide basis. Those efforts should help track the progress and effects of climate change in the region, and assist the Regional Water Board in prioritizing its actions. Examples of areas of interest for such projects include:

- ***Regional monitoring of surface and ground water quality and quantity***

As our environment evolves as a result of climate change, it is imperative to monitor changes to stream flow and groundwater levels, as well as modifications in water quality. In particular, historic and current "baseline" stream measurements are needed to measure changes against (i.e., flow measurements, mapping, satellite imagery). Several State and Regional Water Board monitoring, assessment, and tracking programs, as well as multi-agency programs contribute to the available pool of data in the region. Among them are notably the Surface Water Ambient Monitoring Program (SWAMP), a statewide effort designed to monitor and assess the conditions of surface waters throughout the state of California, and the Groundwater Ambient Monitoring and Assessment (GAMA) Program, California's comprehensive groundwater quality monitoring program. However, even if they monitor trends in water quality, so far none of these programs specifically includes tracking climate change impacts in their mandate.

- ***Development of models that can predict and verify climate change impacts to water quality***

There are numerous models that examine the impacts of climate change on a global and regional scale. Though extremely useful, these studies tend to consider impacts to climate variables such as temperature, snowfall/snowpack, precipitation or sea level rises, and when examining impacts related to water, generally focus on water resources. Local models are now needed that link those impacts to water quality and biological indicators for both surface water and groundwater.

- ***Development of indicators of climate change impacts to water quality***

There are well-known indicators of climate change effects, such as temperatures, sea level or snow cover that are monitored to follow the progress of climatic change and validate and improve predictive models. In California, indicators of climate change impacts have also been developed for physical and biological systems, including humans, vegetation and animals.[14] Such indicators provide information on the status and trends of environmental conditions. In addition to documenting the ongoing impacts of climate change, they help assess the efficiency of mitigation and adaptation strategies, and can inform decision makers who need to plan further actions. There needs to be a similar effort to identify a set of indicators reflecting the impacts of climate change on water quality.

- ***Identify and map surface and ground waters whose beneficial uses are the most vulnerable***

In order to efficiently mitigate the impacts of climate change in the region, the areas that are most vulnerable to specific impacts need to be identified and mapped. For example, mapping the streams that are the most vulnerable to dry out would allow us to prioritize actions to protect fisheries, including endangered species.

- ***Research and policy development on unregulated pollutants***

Finally, it is vital to continue research to understand the impacts and distribution of unregulated pollutants such as CECs. This information is necessary to the development of water quality

[14] Office of Environmental Health Hazard Assessment, California Environmental Protection Agency (2013) Indicators of Climate Change in California, http://www.oehha.ca.gov/multimedia/epic/2013EnvIndicatorReport.html

standards for those chemicals whose occurrence and amount will likely increase as a result of climate change, as discussed in previous paragraphs.

Questions to consider:

- What other type of monitoring and research development is necessary to understand the effects of climate change on water quality and develop appropriate regional adaptation and mitigation measures?
- What Regional Water Board programs or other sources of funding could be leveraged to support those projects?
- How could these efforts be coordinated with other entities, such as regulatory institutions, local governments, research centers, etc.?
- Other considerations to be developed

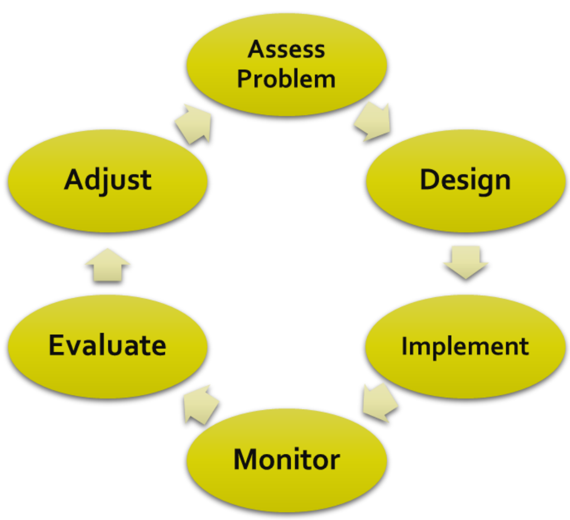
3.3.2. Regulatory Adaptation and Mitigation Measures

Although regulatory adaptation and mitigation measures should be considered for each regional program, some overarching considerations should apply and more global actions could be contemplated.

3.3.2.1. Adaptive Management

Because climate change is an ongoing process which still bears a lot of uncertainties in terms of the magnitude and timing of its effects, adaptive management will be essential to the success of the regulations and policies put forth by the Regional Water Board. Strategies developed to address impacts to beneficial uses should include regular monitoring to assess the outcome of adopted measures, and updates of these measures as needed based on new information and monitoring results (Figure 4).

Figure 4: Adaptive management process



3.3.2.2. Integration of Actions

Because there is a strong link between water conservation and water quality, actions preserving water quality need to be integrated in the various conservation measures put forth by the Water Board. In addition, actions of the Water Board should encourage integrative approaches to compliance that would induce multiple benefits, including those related to climate change adaptation and mitigation. This means developing mechanisms that would for example promote integrated watershed approaches, encourage a balance of waste water loading with stormwater recharge where appropriate, or support habitat creation.

3.3.2.3. Use of Antidegradation Policies to Manage the Degradation of Water Quality

Even though our use of local water will likely increase as a result of climate change, and adaptation efforts could increase the load of pollutants to our waters, mechanisms need to be in place to manage this degradation, and preserve the quality of waters present in the region. A potential mechanism do so is provided by state and federal antidegradation policies. The *Statement of Policy with Respect to Maintaining High Quality of Waters in California,* or "California's Antidegradation Policy," (State Water Board Resolution No. 68-16) ensures that water quality is adequate to protect all beneficial uses and provides a framework to protect surface water and groundwater from degradation. This policy protects waterbodies where existing quality is higher than necessary for the protection of beneficial uses by considering the "buffer" capacity of a water body, which is the difference between the current water quality and the water quality objective. Under the Policy, any action that can adversely affect water quality in all surface waters and groundwater, in other words any action that would utilize some of this this "buffer" capacity, must be consistent with the maximum benefit to the people of the state, must not unreasonably affect present and anticipated beneficial use of such water, and must not result in water quality less than that prescribed in water quality plans and policies. Furthermore, any actions that can adversely affect surface waters are also subject to the federal Antidegradation Policy (40 C.F.R. §131.12) developed under the Clean Water Act.

The State Water Board is currently considering revising the California's Antidegradation Policy with respect to groundwater, possibly adopting an additional policy, and/or issuing guidance regarding implementation of the policy. This climate framework will facilitate critical thinking on ways to improve the usefulness of the Antidegradation Policy as a tool for making informed decisions regarding discharges that affect groundwater under increasing effects from climate change. Such efforts to improve the application of the policy are especially important because the quality of our waters needs to be preserved to ensure a long term use of the region's resources.

The Federal and State Antidegradation policies will be especially important in the future, as climate change and conservation measures may affect water quality. As we will be relying more and more on local water supplies, it is now more than ever essential to implement those policies with care and to ensure they are efficiently protecting both surface and ground waters in our region.

Questions to consider:

- How to best implement antidegradation policies in surface and goundwaters to manage a potential increase in pollutant levels deriving from climate change?
- How could these considerations impact the Regional Water Board's programs?
- Other considerations to be developed

3.3.2.4. Climate Change Policy Development

Consideration of all the elements described previously could be applied to the development of a climate change policy that would guide the Regional Water Board's actions. Such policy could define the overall strategy of the Regional Water Board to address climate change impact on water quality by outlying specific goals and define recommended procedures to be used for adaptation and mitigation.

Questions to consider:

- What other overarching considerations should apply in the development of regional regulatory adaptation and mitigation measures?
- How can each of these ideas be implemented by the Regional Water Board?
- Other considerations to be developed

3.3.3. Stakeholders Engagement

Stakeholders in the region have adopted a proactive approach to climate change, and some are already working on climate change adaptation plans and considering potential measures to adjust to upcoming changes and protect their assets. It is important for the Regional Water Board to encourage these actions, and provide support when needed. It is also essential to encourage the involvement of stakeholders in the development of the Regional Water Board's climate change strategy to protect water quality and beneficial uses.

Questions to consider:

- What are the potential effects of adaptation and mitigation measures considered by the Regional Water Board on the regulated community and regulated facilities?
- Are there any sensitive communities that should be considered when developing adaptation and mitigation measures?
- How can stakeholders be involved in the development of adaptation and mitigation measures?
- What are the local initiatives to address climate change, and how can the Regional Water Board's efforts fit into these initiatives?
- How can the Regional Board's efforts be aligned with the efforts of other public agencies?

4. Conclusion and Next Steps

Overall, the key to successful adaptation to climate change is a long-term vision and strategy. Short-term decision making may solve pressing issues, but it may not be as effective in addressing long-term consequences. The Los Angeles region has been proactive in its early steps toward climate change resiliency, thanks to the promotion of stormwater capture, the support of water recycling, robust salt and nutrient management planning, and involved stakeholders. But there is still much more to be done to protect our waters, and all entities involved should think about lasting solutions that will allow us to thrive and prosper by not only protecting our drinking water supply, but also ensuring that local ecosystems and aquatic habitats are preserved.

This framework constitutes an initial step in the development of a comprehensive climate change adaptation and mitigation strategy within the Regional Water Board's programs. Next steps will include (1) more detailed discussions with the various programs at the Regional Water Board and (2) the presentation of an information item on this issue to our Regional Board, during which we will gather input from stakeholders about issues that they see as high priorities. We will seek input from both the regulated community that will be facing impacts to their operations and environmental and community interests. We will then prioritize projects to be undertaken, and will be working with others to identify research, monitoring, and other contract needs.

5. Resources

- Los Angeles Regional Water Quality Control Board. http://www.waterboards.ca.gov/losangeles/
- Cal-Adapt. http://cal-adapt.org/
- California Air Resources Board. Climate Change Programs. http://www.arb.ca.gov/cc/cc.htm
- California Climate Change Portal. http://www.climatechange.ca.gov/
- California Coastal Commission. http://www.coastal.ca.gov/
- California Department of Water Resources. Climate Change Portal. http://www.water.ca.gov/climatechange/
- California Natural Resources Agency (CNRA). Safeguarding California. http://resources.ca.gov/climate/safeguarding/
- California Natural Resources Agency (CNRA). California Water Action Plan. http://resources.ca.gov/california_water_action_plan/
- Intergovernmental Panel on Climate Change (IPCC). https://www.ipcc.ch/
- Office for Environmental Health Hazard Assessment (OEHHA). Environmental Protection Indicators for California (EPIC). http://www.oehha.ca.gov/multimedia/epic/index.html
- State of California Coastal Conservancy. http://scc.ca.gov/
- State Water Resources Control Board. http://www.waterboards.ca.gov/
- US Environmental Protection Agency (USEPA). Climate Change Portal. http://www.epa.gov/climatechange/

APPENDIX A

Beneficial Use Definitions

Beneficial uses for waterbodies in the Los Angeles Region are listed and defined below.

Municipal and Domestic Supply (MUN)
Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

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

Industrial Process Supply (PROC)
Uses of water for industrial activities that depend primarily on water quality.

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

Ground Water Recharge (GWR)
Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.

Freshwater Replenishment (FRSH)
Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity).

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

Hydropower Generation (POW)
Uses of water for hydropower generation.

Water Contact Recreation (REC-1)
Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs.

Limited Water Contact Recreation (LREC-1)

Uses of water for recreational activities involving body contact with water, where full REC-1 use is limited by physical conditions such as very shallow water depth and restricted access and, as a result, ingestion of water is incidental and infrequent.

Non-contact Water Recreation (REC-2)
Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

High Flow Suspension: The High Flow Suspension shall apply to water contact recreational activities associated with the swimmable goal as expressed in the federal Clean Water Act section 101(a)(2) and regulated under the REC-1 use, non-contact water recreation involving incidental water contact regulated under the REC-2 use, and the associated bacteriological objectives set to protect those activities. Water quality objectives set to protect (1) other recreational uses associated with the fishable goal as expressed in the federal Clean Water Act section 101(a)(2) and regulated under the REC-1 use and (2) other REC-2 uses (e.g., uses involving the aesthetic aspects of water) shall remain in effect at all times for waters where the (ad) footnote appears in Table 2-1a. The High Flow Suspension shall apply on days with rainfall greater than or equal to ½ inch and the 24 hours following the end of the ½-inch or greater rain event, as measured at the nearest local rain gauge, using local Doppler radar, or using widely accepted rainfall estimation methods. The High Flow Suspension only applies to engineered channels, defined as inland, flowing surface water bodies with a box, V-shaped or trapezoidal configuration that have been lined on the sides and/or bottom with concrete. The water bodies to which the High Flow Suspension applies are identified in Table 2-1a in the column labeled "High Flow Suspension".

Commercial and Sport Fishing (COMM)
Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.

Aquaculture (AQUA)
Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.

Warm Freshwater Habitat (WARM)
Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Cold Freshwater Habitat (COLD)
Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

Inland Saline Water Habitat (SAL)
Uses of water that support inland saline water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates.

Estuarine Habitat (EST)
Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).

Wetland Habitat (WET)
Uses of water that support wetland ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants.

Marine Habitat (MAR)
Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).

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

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

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

Migration of Aquatic Organisms (MIGR)
Uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish.

Spawning, Reproduction, and/or Early Development (SPWN)
Uses of water that support high quality aquatic
habitats suitable for reproduction and early development of fish.

Shellfish Harvesting (SHELL)

Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.