Climate Change and Integrated Regional Water Management in California:

A Preliminary Assessment of Regional Approaches

June 2012

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Acknowledgments

This study was carried out with support from the Climate Change Program at the California Department of Water Resources (DWR), under Agreement No. 4600008548 between DWR and the Office of the President, Regents of the University of California. The project was initiated as a result of discussions with John Andrew (DWR) in the interdisciplinary colloquium, "Adaptation to Variability: Water Management in Mediterranean Climates," at the Institute for International Studies, University of California Berkeley, in Spring 2011.

DWR Climate Change Specialists Erin Chappell (North Central Region), Peter Coombe (Northern Region), Lauma Jurkevics (Southern Region), and Michelle Selmon (South Central Region), conducted interviews with IRWM regional representatives. Their efforts, and the thoughtful responses of IRWM regional representatives, are gratefully acknowledged. Joseph Yun and Vivien Masionneuve of the IRWM Program provided access to proposal documents and other information.

The author is a PhD student in the Department of Environmental Science, Policy and Management (ESPM) at the University of California Berkeley, working under the guidance of Professor Jeffrey Romm. Views expressed in this report are those of the author, and do not necessarily represent those of ESPM, the University of California, or the Department of Water Resources. Please contact the author at estherconrad@berkeley.edu with any questions or comments.

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Rolf Frankenbach, Financial Assistance Branch, Division of Integrated Regional Water Management, California DWR
Elissa Lynn, Climate Adaptation Section, Statewide Integrated Water Management, California DWR
Daniel Olstein, Executive Director, River Exchange, on behalf of the Upper Sacramento, McCloud Lower Pit IRWM Region
Andrew Schwarz, Climate Adaptation Section, Statewide Integrated Water Management, California DWR

Cover photos: California Department of Water Resources

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Acronyms

BCSD	bias-corrected statistical downscaling
CABY	Cosumnes American Bear Yuba (Rivers) IRWM region
CALSIM	water resources planning model jointly developed by DWR and USBR to simulate State Water Project and Central Valley Project operations
CAT	California Climate Action Team
CAWWG	(federal) Climate Change and Water Working Group
CCTAG	Climate Change Technical Advisory Group at DWR
CEQA	California Environmental Quality Act
CMIP-3	Climate Model Intercomparison Project Phase 3
CNRM-CM3	global climate model developed by Centre Nationale de Recherches Météorologiques
CNRA	California Natural Resources Agency
DAC	Disadvantaged Community
DOI/LLNL	Department of Interior/Lawrence Livermore National Laboratories
DWR	California Department of Water Resources
EPA	U.S. Environmental Protection Agency
FEP	Functionally Equivalent Plan
IRWM	Integrated Regional Water Management
GFDL-CM2.1	Geophysical Dynamics Laboratory Climate Model 2.1
GHGs	greenhouse gas emissions
MIROC 3.2	Model for Interdisciplinary Research on Climate, developed at University of Tokyo, Japan
MOCASIM	a Monte Carlo analysis simulation tool
MPI-ECHAM5	global climate model developed by Max Plank Institute, Germany
NCAR-PCM	National Center for Atmospheric Research Parallel Climate Model
NCAR-CCSM3	National Center for Atmospheric Research Community Climate System Model
NRC	National Research Council
RAP	Regional Acceptance Process
RWMG	Regional Water Management Group
SAWPA	Santa Ana Watershed Project Authority
SLR	sea level rise
SWRCB	State Water Resources Control Board
VIC	Variable Infiltration Capacity hydrologic model developed at the University of Washington
WEAP	Water Evaluation and Planning system developed by the Stockholm Environment Institute
USBR	U.S. Bureau of Reclamation
USGS	U.S. Geological Survey

Executive Summary

Climate change has serious implications for the management of California's water resources. Increased temperatures, reduced snowpack, changing precipitation patterns, and accelerated sea level rise are already being observed in the state. These impacts vary widely across the state's highly diverse hydrologic, ecological and socio-economic conditions, and need to be accounted for in regional and local-level planning. California's Integrated Regional Water Management (IRWM) process plays an important role in the State's overall water planning, and in its strategy to address climate change impacts on the state's water resources. Established in 2002, IRWM seeks to support collaborative strategies that meet regional water needs while addressing social and environmental objectives. Approved IRWM regions are eligible for funding through the IRWM Program, administered by the California Department of Water Resources (DWR). This program is currently supported by over $1 billion in bond funds through Propositions 84 and 1E, approved by voters in 2006. There are now 48 IRWM regions across the state, which involve diverse stakeholders in developing and implementing Integrated Regional Water Management plans.

This report examines the initial steps that IRWM regions are taking in response to new requirements to address climate change vulnerabilities and consider greenhouse gas emissions in IRWM plans. Given our evolving understanding of climate change impacts and appropriate adaptation strategies, effectively integrating climate change into planning is a challenging task. This report seeks to learn from initial steps by IRWM regions in order to inform future guidance and support. It also identifies key considerations for DWR and IRWM regions in analyzing and adapting to climate change risks within an adaptive management framework. Specifically, this report seeks to:

1. Assess the manner and degree to which the climate change requirements in the 2010 IRWM Guidelines are met in Round 1 Proposition 84 Planning and Implementation grant proposals, and in recently approved IRWM plans
2. Assess current IRWM regional approaches to analyzing and adapting to climate change risks, in light of the overall goal to promote an adaptive management approach
3. Provide recommendations on key steps for DWR and IRWM regions to support the development of informative climate change analyses and mechanisms for adaptive management at regional and state levels

This assessment is based on a review of the current IRWM climate change requirements, existing IRWM plans, and Planning and Implementation grant proposals funded in 2011. It is also informed by interviews conducted by DWR regional climate change specialists with representatives of IRWM regions regarding their plans to address climate change.

Climate change requirements for IRWM regions. In the 2010 IRWM Guidelines, climate change is one of 16 "standards" that IRWM plans must meet in order to receive planning and implementation grant funds through Propositions 84 and 1E. Broadly, the Guidelines

require that IRWM plans evaluate regional climate change impacts, identify adaptation strategies, and consider greenhouse gas emissions reductions in reviewing projects. These efforts are to be undertaken within an adaptive management approach that supports updating knowledge about climate change impacts. The Guidelines also include "Climate Change Response Actions" as a Statewide Priority to be considered in prioritizing regional projects. In December 2011, DWR released draft language for a refined "climate change standard" with respect to climate change adaptation. This draft requires a regional vulnerability assessment, prioritization of these vulnerabilities through an IRWM region's decision-making process, and development of a plan for further analysis of the prioritized vulnerabilities. Also in December 2011, the EPA Region 9 and DWR released the *Climate Change Handbook for Regional Water Planning*, which is intended to help IRWM regions access relevant technical resources and tools to analyze climate change impacts and greenhouse gas emissions. Revised guidelines incorporating the new climate change standard are anticipated in the spring of 2012.

Climate change in existing IRWM plans. Of the 34 existing IRWM plans, 12 contain some discussion of climate change in relation to the management of the region's water resources. Two regions, Cosumnes American Bear Yuba (CABY) and North Coast, established programs to encourage climate change projects in 2009. Four IRWM regions – Coachella Valley, Inyo-Mono, Kern County, and Santa Ana Watershed Project Authority (SAWPA) – adopted IRWM plans after the 2010 Guidelines. These plans seek to follow the climate change requirements in terms of discussing climate change impacts, considering the need for adaptation in the choice of Resource Management Strategies, and in considering greenhouse gas emissions in the project review process. Climate change is not specifically considered in plan evaluations and project monitoring processes, or in data management activities. These plans do not yet incorporate the elements described in DWR's recent draft guidance on the climate change standard, but their approaches are not incompatible with this guidance. This review suggests the need for coordinating mechanisms within a region to develop and implement plan elements related to climate change.

Climate change in Round 1 Planning grants. In early 2011, 30 IRWM regions received Round 1 Proposition 84 Planning grants to update or create IRWM plans according to the 2010 Guidelines. Of the approximately $21 million awarded across all regions, about $1 million is dedicated to analyzing climate change risks and considering adaptation strategies and greenhouse gas emissions (GHGs). Although details are limited for some regions, these proposed analyses appear to follow the 2010 IRWM guidelines. All regions indicated plans to consider GHGs in project selection, and 10 regions mentioned plans to create or participate in a regional GHG inventory. With regard to assessing climate risks and adaptation strategies, regions are taking a wide variety of approaches. Fourteen regions describe plans to conduct quantitative analysis of climate impacts, mostly related to water supply, using downscaled climate model outputs. The three main sources of model outputs are the California Climate Action Team's scenarios, the Coupled Model Intercomparison Project Phase 3 (CMIP-3) archive, and Cal-Adapt, an online tool that includes four climate models. Most regions are planning some means of stakeholder input, and 16 regions indicate that they are considering collaboration with one or more other IRWM regions on climate change analyses. Specifics are limited regarding how IRWM regions plan to

implement an "adaptive management" approach with respect to climate change. Discussion of climate change is also relatively limited with respect to data collection and management. The draft guidance for a revised climate change standard suggests a focus on regional characteristics in assessing climate risks. This approach is complementary to the review of climate change projections and impact studies that is proposed in many regions.

Climate change in Round 1 Implementation grants. In August 2011, 25 IRWM regions were awarded a total of approximately $205 million in Round 1 Proposition 84 Implementation grant funds, supporting projects that address objectives such as water supply reliability, water quality, improved water use efficiency, flood management, and ecosystem protection. IRWM regions consider Statewide Priorities laid out in the 2010 Guidelines in prioritizing implementation projects, and one of these priorities is Climate Change Response Actions. Of the 192 projects funded in this round, 140 (73%) were described by IRWM regions as addressing the Climate Change Statewide Priority, either through promoting adaptation or reducing GHGs. While 60-70% of all projects were also described as meeting priorities related to drought preparedness, water quality, water use efficiency, and environmental stewardship, less than 30% of all projects were listed as meeting the Statewide Priority for Integrated Flood Management. A comparison of the 140 projects categorized as addressing climate change with the overall portfolio of 192 projects shows that a greater proportion of climate change projects address drought preparedness and water use efficiency than in the overall portfolio. This may be related to the fact that projects addressing these issues can contribute to both adaptation and GHG reductions. An analysis of the types of climate change response actions undertaken in these projects shows that conjunctive water management and improving water use efficiency are the most common adaptation strategies, and improving water efficiency is the most common approach to reducing GHGs. Although most IRWM regions have not yet analyzed climate change vulnerabilities, six Implementation grant proposals discussed climate change as a factor in determining the need for the proposed projects.

Considerations for analyzing and adapting to climate change risks in IRWM regions. Managing regional water resources for an uncertain climate requires an adaptive management approach that integrates the study of climate change risks with decisions regarding project priorities and design, and builds in opportunities for learning over time. A critical first step is identifying and prioritizing key vulnerabilities. IRWM regions appear to be using one or more of three strategies for this: considering how climate change may affect central water management objectives, conducting a broad review of potential vulnerabilities to regional water resources, and engaging stakeholders. All of these elements are valuable, but conducting a periodic, broad vulnerability assessment may be particularly important in an adaptive management approach since it can promote awareness over time of emerging risks. The vulnerability assessment described in the December 2011 draft of a revised climate change standard might play this role. At least 14 IRWM regions have developed plans for further analysis of climate impacts using downscaled climate model outputs. These analyses are primarily focused on impacts to water supply and demand, and most make use of downscaled climate models. In considering the type and level of analysis that would be appropriate in IRWM regions, it is useful to first identify the kinds of decisions that the analysis is intended to inform.

Quantitative analyses at an IRWM regional level may be useful in some cases, but there are also situations in which studies conducted at a larger scale may be sufficient or more appropriate. Some IRWM regions may need technical support for identifying appropriate approaches, which the Climate Change Handbook can help to provide. Certain risks, such as flooding and ecosystem impacts, may need particular attention since methods for using downscaled climate models in these settings may be less well established or less accessible. Finally, adaptation strategies need to be informed not only by the results of impact analyses, but also by consideration of costs, co-benefits, partnerships, and potential adverse impacts. On-going evaluation of adaptation strategies at regional and state levels will require a clear identification of projects that are intended to reduce regional vulnerabilities.

Recommendations. The following recommendations support the development of robust analyses in IRWM regions to understand and plan for climate change impacts on the State's water resources through an adaptive management approach. These include steps on the part of DWR to provide appropriate guidance and support, and on the part of IRWM regions to organize their efforts to address climate change. These recommendations raise issues that should be further explored by DWR's Climate Change Technical Advisory Group (CCTAG).

<u>Developing informative climate change analyses in IRWM regions to support adaptation strategies:</u>

- DWR could provide support to specific IRWM regions in identifying appropriate resources in the Climate Change Handbook as well as other sources
- Particular support may be needed for analysis of flooding and ecosystem impacts in IRWM regions that identify these as vulnerabilities
- DWR should consider whether more specific guidance on the use of particular downscaled climate models would be useful
- DWR should support the development of inter-regional collaborations to plan for climate change
- Climate Change Priority Projects should address the vulnerabilities identified in each region's vulnerability assessment

<u>Mechanisms at regional and state levels to enable adaptive management:</u>

- Successful adaptive management with respect to climate change at the regional level will likely require a mechanism within the IRWM region for on-going coordination
- Periodic regional vulnerability assessments could be used as a process for routinely updating knowledge and monitoring project priorities
- Further attention is needed at the regional level to developing methods for evaluating progress over time toward addressing climate change impacts
- At the state level, use the Climate Change Statewide Priority projects to track responses to regional vulnerabilities
- A separate Statewide Priority for projects that reduce GHG emissions could support on-going evaluation of these measures across IRWM regions

1. Introduction

In 2002, California initiated the Integrated Regional Water Management (IRWM) planning process to support collaborative strategies that meet regional water needs while addressing social and environmental objectives. IRWM plays an important role in the State's overall water planning process, and in its strategy to address climate change. According to the 2009 Water Plan Update, "IRWM provides an effective forum and a critical framework for actions to address the uncertainties presented by climate change as well as other risks to California's water future," (DWR, 2009, Highlights, p. 20). In 2010, DWR issued new guidelines requiring that climate change be addressed in the IRWM process. This study examines the initial steps IRWM regions are taking in response to these requirements, and identifies key considerations for DWR and IRWM regions in analyzing and adapting to climate change risks within an adaptive management framework.

1.1. Climate change and water management in California

Climate change has serious implications for the management of California's water resources. Increased temperatures, reduced snowpack, changing precipitation patterns, and accelerated sea level rise are already being observed in the state (Moser et al., 2009). Potential impacts of these changes for water management are wide-ranging, including threats to water supply reliability and quality, increased risks from flooding and storm surges, and effects on ecosystems (DWR, 2008). Water resources are also important with regard to greenhouse gas emissions that lead to climate change. While hydroelectricity is an important source of clean energy, water management activities also require significant amounts of energy, contributing to greenhouse gas emissions.

California is taking steps to address the risks and mitigate its contributions to climate change. Executive Order S-13-08 instructed the California Natural Resources Agency (CNRA) and other agencies to assess the risks of sea level rise, and to develop a multi-sector adaptation strategy. The California Department of Water Resources (DWR)'s 2008 white paper, *Managing an Uncertain Future*, laid out an approach for addressing climate change impacts on water management, which was incorporated into the California Climate Adaptation Strategy (CNRA, 2009) and into the California Water Plan Update 2009 (DWR, 2009). With regard to climate change mitigation, the 2006 California Global Warming Solution Act (AB 32) requires the reduction of statewide GHG emissions to 1990 levels by 2020, and SB 97 updates the California Environmental Quality Act (CEQA) to require consideration of climate change in public projects.

1.2 Considering climate change in water planning

In light of the above, DWR and other agencies involved in managing California's water resources have begun to consider climate change risks in water planning. This requires a shift from water management practice that has typically relied upon the assumption that future climate patterns will be similar to those of the past (Milly et al., 2008). Although there are still uncertainties in climate change projections, they need to be considered in planning, just as water managers must take into account other sources of non-stationarity, such as changing water use patterns (Hirsch, 2011). Climate change also requires decision-making

approaches that anticipate change, with the flexibility to adjust strategies as information improves (Brekke et al., 2009, DWR, 2009). A recent DWR study shows that a diversity of approaches have been employed to consider climate change in statewide and local water planning studies in California (Khan and Schwarz, 2010). DWR has established a Climate Change Technical Advisory Group to provide guidance on its approaches to considering climate change in planning and decision-making to meet California's water needs.

The manner in which climate change will impact water resources depends heavily upon the regional and local context. For example, climate change poses very different risks for a region dependent upon water supply from snowpack in the Sierra Nevada, compared to those faced by a region relying primarily on groundwater and where large populations and infrastructure are located in low-lying coastal areas. Given California's highly diverse hydrologic, ecological and socio-economic conditions, it is crucial to consider climate change risks in regional and local-level planning processes. DWR's 2008 white paper and the Water Plan Update 2009 both emphasize the need to consider climate change in integrated regional water planning efforts underway across the state.

In compliance with legislative mandates, DWR is also seeking to mitigate GHG emissions resulting from water management activities by reducing energy consumption and converting to cleaner energy sources. Projects funded through DWR's grant programs must follow CEQA requirements for a GHG emissions analysis. Meeting AB 32 goals for GHG reductions will require finding the best opportunities to reduce energy consumption and shift to cleaner energy sources, while meeting local water management objectives. Considering GHG emissions in regional and local planning is critical to achieving this.

1.3 Integrated Regional Water Management and climate change

Integrated Regional Water Management (IRWM) promotes a collaborative approach to regional water planning to address multiple objectives, including a reliable water supply, improved water quality, flood management, and environmental stewardship (DWR, 2009). Given the diverse water portfolios across the State, IRWM seeks to enable local stakeholders to define a comprehensive approach to meeting regional water needs, and to improve long-term reliability of water supply while meeting other environmental and social objectives (DWR, 2010a). Beginning with the Water Plan Update 2005, IRWM has been increasingly emphasized as a core element of a statewide water management strategy. This is likely to continue in Water Plan Update 2013.

The IRWM process was established by the 2002 Integrated Regional Water Planning Act, which was updated in 2008. A key element of the process is the development of Integrated Regional Water Management plans, which are collaborative strategies for regional water management over a period of at least 20 years. IRWM plans are developed by Regional Water Management Groups (RWMGs), which formally consist of at least three local agencies, two of which must have statutory authority for water management. The boundaries of IRWM Regions, which are intended to maximize integrated water management opportunities, are proposed by RWMGs and approved by DWR through the Regional Acceptance Process (RAP). Following the 2011 RAP, there are now 48 IRWM regions (see map). Once approved through the RAP, an IRWM region is eligible to apply for project

funding through several grant programs administered by DWR, which are currently supported by bond funds approved by voters in 2006 through Propositions 84 and 1E.[1]

The California Water Code lays out the requirements that IRWM plans must meet in order to be eligible for funding, such as identifying regional water management objectives, following an integrated and multi-benefit approach, and consideration of the water needs of disadvantaged communities. In 2008, the updated Integrated Water Management Planning Act, CWC §10530 *et seq*., revised these requirements to include consideration of greenhouse gas emissions and the adaptability to climate change of water management systems. In August 2010, DWR issued new guidelines for IRWM grants under Propositions 84 and 1E, including, among other things, new requirements to address climate change in IRWM plans.

RWMGs are now in the process of updating their IRWM plans to reflect these new requirements, with support from planning grants awarded in 2010 through the IRWM Grant Program administered by DWR. In 2011, one round of implementation grants was also awarded, providing funds for water management projects consistent with IRWM plans. Implementation grant proposals included projects addressing adaptation or mitigation as specified under a new Statewide Priority for Climate Change Response Actions.

2. Report Purpose, Objectives and Structure

Given the importance of IRWM for the State's water management, and the role it can play in addressing climate change risks, this study examines the initial steps IRWM regions are taking to incorporate climate change into their planning. DWR recognizes that knowledge is evolving about the effects of climate change and needed adaptation measures, and that tools for assessing impacts are still being developed. This preliminary assessment of how IRWM regions are meeting the IRWM climate change requirements can help inform DWR's future guidance and support to regional water planning. It can also serve as a baseline for later evaluations of progress toward addressing climate change. Finally, this report serves to share information about regional-level activities related to climate change, which can help inform the 2013 Water Plan Update process.

The report addresses the following specific objectives:

1. Assess the manner and degree to which the climate change requirements in the 2010 IRWM Guidelines are met in Round 1 Proposition 84 Planning and Implementation grant proposals, and in recently approved IRWM plans

[1] Proposition 84, the Safe Drinking Water, Water Quality, and Supply, Flood Control, River and Coastal Protection Bond Act, authorized the appropriation of $1 billion for projects following IRWM plans. An additional $300 million for IRWM was authorized through Proposition 1E, the Disaster Preparedness and Flood Prevention Bond Act. Initial IRWM funding of $500 million came in 2002 through Proposition 50, which was administered jointly by DWR and the State Water Resources Control Board (SWRCB).

2. Assess current IRWM regional approaches to analyzing and adapting to climate change risks, in light of the overall goal to promote an adaptive management approach
3. Provide recommendations on key steps for DWR and IRWM regions to support the development of informative climate change analyses and mechanisms for adaptive management at regional and state levels

The report is structured as follows. After a brief discussion of data and methods, Section 4 provides an overview of the climate change requirements in the 2010 IRWM Guidelines, and anticipated refinements to these requirements. Section 5 summarizes how climate change is addressed in current IRWM plans across the state, especially those adopted after the 2010 Guidelines were issued. Section 6 provides an overall assessment of how IRWM regions responded to the climate change requirements in Round 1 Planning grant proposals. Section 7 surveys the climate change elements of Implementation grant proposals, and analyzes the set of projects identified by IRWM regions as meeting the Climate Change Statewide Priority. Section 8 assesses the current plans of IRWM regions to analyze climate risks and identify adaptation strategies. These efforts are placed in the context of the broader goal of establishing an adaptive management approach to managing water in an uncertain climate. Finally, Section 9 summarizes key findings and offers recommendations.

3. Data and Methods

This analysis was conducted primarily as a desk study during the period of June – December 2011. The review of documents was supplemented by results from a set of interviews conducted by DWR regional climate change specialists with representatives of IRWM regions. Discussions with DWR Climate Change and IRWM Program staff also contributed substantively to this report. Attendance at two meetings of the Bay Area IRWM Coordinating Committee in August and September 2011 helped provide some basic background to the functioning of one RWMG. The author also attended two IRWM regional workshops focused on climate change: one hosted by the Santa Ana Watershed Protection Authority (SAWPA) in February 2012, and one hosted by the Watershed Coalition of Ventura County (WCVC) in March 2012.

Documents reviewed include IRWM plans, Round 1 Planning and Implementation grant proposals, IRWM Guidelines, Proposal Solicitation Packages, proposal evaluations, resources prepared by DWR's Climate Change Program, other DWR reports, and relevant academic and gray literature. All IRWM documents consulted for this report are publicly available via DWR's website, or websites of RWMGs. Appendix A lists resources consulted.

Recognizing that the content of grant proposals may not be fully comprehensive in describing the work to be undertaken related to climate change, DWR's regional climate change specialists reached out to representatives of IRWM regions to learn more about their plans. Regions were contacted via phone or email during the months of October and November 2011. Responses were received from 20 IRWM regions (see Appendix A for a

list). Information from these responses was considered in the analysis, as referenced throughout this report.

The content of IRWM plans and grant proposals was reviewed for discussion of climate change and plans to address it. Word searches such as "climate," "climate change," and "global warming" were used to identify relevant sections of these lengthy documents. In order to summarize each region's plans with respect to climate change, categories were created to reflect key elements of the climate change requirements, and other common themes that appeared in proposals (see categories in Tables 2, 4 and 8). Every effort was made to select categories against which IRWM regional plans could be evaluated consistently, based on the information available in documents and interviews. Inevitably, there are some instances in which the categories do not adequately reflect a particular IRWM region's plans. In addition, given the diversity among descriptions in proposals and interview results, subjective judgment was sometimes involved in placing proposals in particular categories, although every effort was made to be consistent.

It should be noted that this report analyzes *planned* efforts to address adaptation and mitigation in IRWM plans, for which implementation is currently underway. At the time of writing, some IRWM regions were still developing the specifics of their climate change analyses. It is recognized that regional approaches to addressing climate change may evolve from what was presented in Planning grant proposals and communicated in interviews.

4. IRWM Guidelines and new climate change requirements

In 2010, DWR issued the *Proposition 84 and Proposition 1E Integration Regional Water Management Guidelines* (hereafter referred to as the Guidelines), to be consistent with these two propositions and other legislative requirements. This included 2008 legislation that updated the requirements that IRWM plans must meet in order to qualify for funding through DWR and other grant programs. The 2010 Guidelines lay out 16 "standards" specifying the content and sections that IRWM plans should contain.

This report focuses on funding through Proposition 84, which authorized the appropriation of $1 billion for projects consistent with IRWM Plans.[2] These funds are being disbursed through the following grant types:

- Planning grants are intended to "develop, update or improve an IRWM Plan" such that it meets IRWM Plan standards (Guidelines, p. 16). Funding cannot exceed $1 million for each region, and grants are awarded through a statewide competition.
- Implementation grants fund projects that are consistent with IRWM Plans, and which yield specific types of multiple benefits (Guidelines, p. 17). Implementation grant proposals compete for funding within each funding area (see map of IRWM regions).

[2] The 2010 Guidelines also guide funding for Proposition 1E, which authorized $300 million for Stormwater and Flood Management (SWFM) grants. These grants are not considered in this report.

Round 1 Prop 84 Planning and Implementation grants proposals were the first set considered under the new Guidelines, and awards for both were finalized in 2011. Submissions for Round 2 Planning grants were submitted in March 2012 (these are not considered in this report). Rounds 2 and 3 of Implementation grants are anticipated for 2013-14.

4.1 Climate Change Standard for IRWM Plans

The requirement to address climate change is based on the California Water Code, amended in 2008 by the Integrated Regional Water Management Planning Act to require that IRWM plans include:

- CWC §10541(e)(9): "consideration of greenhouse gas emissions of identified programs and projects"
- CWC §10541(e)(10): "evaluation of the adaptability to climate change of water management systems in the region"

Following these provisions, the 2010 Guidelines include climate change as one of the 16 standards for IRWM plans. The Guidelines state that "the intent of the Climate Change Standard is to ensure that IRWM Plans, through existing plan standards, describe, consider, and address the effects of climate change on their regions and disclose, consider, and reduce when possible GHG emissions when developing and implementing projects" (p. 68).

Appendix C of the Guidelines provides details of the requirements for what must be included in an IRWM plan. The Climate Change Standard requires consideration of climate impacts, adaptation strategies, and GHG emissions. Table 8 in Appendix C (p. 74) specifies which sections of the plan must contain this information, and how requirements for meeting the standard may increase over time. Key elements are summarized below.[3]

- Evaluate regional climate change impacts. An IRWM plan must describe the "likely Climate Change impacts on their region" in the Region Description section. Over time, the "descriptions should be updated to become more region-specific as vulnerability analysis tools become available" and in the future, these tools should be quantitative (Tables 7 and 8, p. 74).
- Develop adaptation strategies. This relates to multiple sections, including Plan Objectives, Resource Management Strategies, Project Review Process, Relation to Local Water Planning, and Relation to Local Land Use Planning. Initially, IRWM regions should pursue "no-regrets" strategies, and several examples are offered, including water use efficiency, integrated flood management, and enhancing ecosystems. In the future, plans should "identify and implement, using vulnerability assessments and tools, adaptation strategies that address region-specific climate change impacts" (Table 8, p. 74). Adaptation strategies also must be considered in the IRWM plan's project review process.
- Consider greenhouse gas emission (GHG) reductions. GHG reductions need to be considered in the project review process, but as a "secondary criterion" (p. 72). In

[3] This summary is intended to highlight key features for the purposes of this report, and is not comprehensive.

order to receive funding, projects must contain a GHG emissions analysis following CEQA requirements, and the Guidelines suggest that IRWM regions may wish to follow a similar procedure for project selection. The Guidelines indicate that GHG emissions analyses should be quantitative, and several emissions reporting protocols are referenced as possible tools. IRWM plan participants are encouraged to join the California Climate Action Registry (now The Climate Registry).

- Adaptive management. As noted above, the Guidelines emphasize that RWMGs must continue to update their analyses of climate change impacts. "IRWM Plans should contain policies and procedures that promote adaptive management. As more effects of Climate Change manifest, new tools are developed, and new information becomes available, RWMGs must adjust their IRWM plans accordingly" (Guidelines, Table 8). This is to be reflected in the Plan Performance and Monitoring section.

The Guidelines also include "Climate Change Response Actions" as a Statewide Priority. IRWM Program Preferences and Statewide Priorities are considered in each IRWM plan's project review process. In addition, Implementation projects that meet Preferences or Priorities receive greater weight according to DWR's proposal ranking criteria. Climate Change Response Actions are defined as projects that include activities that address: 1) climate change adaptation, 2) reduction of GHG emissions, and 3) reduction of energy consumption (Guidelines, Table 1, p. 13).

Finally, the Guidelines contain several statements indicating that additional guidance on climate change can be expected in the future. In particular, the Guidelines indicate that in the future, the Climate Change Standard would require IRWM regions to use "quantitative tools for vulnerability analysis, specific actions identified for adaptation to effects of Climate Change with performance measures, and disclosure and consideration of quantitative analysis of project GHG emissions" (p. 74). The process of refining the Climate Change Standard has begun, and a preliminary draft was shared during the Process Improvement Workshops in December 2011. This draft describes three elements that must be included in an IRWM plan:

- A climate change vulnerability assessment for the region, which at a minimum should follow a qualitative checklist outlined in the Climate Change Handbook (discussed in the following section)
- A list of prioritized climate change vulnerabilities based on the assessment
- A plan, program or process for gathering data and analyzing prioritized vulnerabilities

These steps specify the level of analysis of climate change risks that an IRWM plan will be expected to contain in order to be eligible for Rounds 2 and 3 Implementation Grant funding. The other components of the 2010 Guidelines still apply, including the need to integrate climate change adaptation and GHG emissions into the project review process and to employ adaptive management strategies. These steps will be incorporated into a revised set of IRWM Guidelines, anticipated to be available for public comment in March 2012.

4.2 Resources for IRWM regions in meeting the Climate Change Standard

In order to assist regions in meeting the Climate Change Standard in their Round 1 Planning and Implementation grant proposals, DWR's Climate Change Program developed several resources on climate change science and risks with regard to water management. Available on the DWR Climate Change website, these included a Climate Change Document Clearinghouse containing brief summaries of climate change literature relevant to IRWM practitioners, a Climate Change Vulnerability Matrix which summarizes key impacts based on the 2009 California Climate Adaptation Strategy, and a Frequently Asked Questions document compiled in response to climate change questions during the Planning grant application process. An informal guidance document for DWR grantees on GHG analyses for projects under the California Environmental Quality Act (CEQA) was also created.

DWR's Climate Change Program includes four regional climate change specialists, based in the Southern, South Central, North Central and Northern DWR regions. The specialists provide assistance on climate change-related concerns in water management processes at a regional level, including the IRWM process. They are available to assist IRWM regions in addressing climate change in the context of IRWM plans, such as in accessing regional climate data and other resources, and providing presentations on climate change to RWMGs. However, based on discussions with Climate Change Program staff, only a limited number of IRWM regions sought out such assistance during the Round 1 proposal processes.

The *Climate Change Handbook for Regional Water Planning* (Climate Change Handbook) was prepared by the U.S. Environmental Protection Agency (EPA) Region 9 and DWR, in partnership with the US Army Corps of Engineers and the Resources Legacy Fund. Released in December 2011, the Handbook provides overall guidance for the consideration of climate change in regional water planning, drawing upon current best practice and case studies from California and elsewhere in the United States. While it targets a broader water management audience, the Handbook uses the IRWM process to illustrate how analyzing climate change risks can inform planning. The Handbook was in development at the time the Guidelines were issued, and was discussed during proposal preparation workshops. A draft outline of the handbook was circulated during a conference call of the Roundtable of Regions, an informal network of IRWM regions. The Handbook was also discussed during a special session at the Integrated Regional Water Management Conference held in Sacramento in May 2011. The December 2011 draft language for the Climate Change Standard references the vulnerability assessment tool contained in the Climate Change Handbook (see Section 4 and Appendix B) as the basic type of vulnerability assessment that IRWM plans will be expected to contain in order to be eligible for Rounds 2 and 3 of Implementation grant funding.

5. Consideration of climate change in existing IRWM plans

The Proposition 84 IRWM Planning grant process is intended to update existing IRWM plans and develop new ones to follow the Guidelines. Before reviewing how climate change is being addressed in the update process, it is useful to understand what attention IRWM

regions have already given to climate change. This section provides an overview of the current status of IRWM plans, and summarizes how climate change is considered in existing IRWM plans and programs.

Table 1 provides an overview of IRWM regions and existing IRWM plans. Following the completion of the second Regional Acceptance Process in August 2011, there are now 48 IRWM regions in California (see map).[4] Of these, 34 have created and formally adopted an IRWM or "Functionally Equivalent Plan." Table 1 also shows which regions applied for Proposition 84 Round 1 Planning or Implementation grants, or both. Of these 34 existing plans, 12 contain some discussion of climate change in relation to the management of the region's water resources. Table 2 summarizes the climate change content of these plans, as discussed below.

5.1 Pre-2010 plans and programs

Of the 12 IRWM regions with plans that contain discussion of climate change, seven were adopted prior to the 2010 Guidelines. Two regions, North Coast and Cosumnes American Bear Yuba (CABY), have been quite active with regard to climate change, even though this is not yet formally reflected in their IRWM plans. In 2009, the North Coast region established its Energy Independence and Emission Reduction Program, encouraging projects addressing climate change adaptation and mitigation. Under the program, the North Coast has conducted several studies on climate change concerns, developed a list of 21 strategies for addressing climate change, and identified and pursued funding opportunities. A map on the North Coast website lists 31 projects that reduce GHGs in the region. Similarly, CABY established climate change as one of four programs in 2009, as reflected in an "interim update" to their 2007 IRWM Plan. (Appendix I, 2009). Both the North Coast and CABY appear to have developed their climate change programs with input and support from stakeholders. These regions have received Planning grant awards to update their plans to formally incorporate climate change.

Five pre-2010 IRWM plans mention climate change as a general concern for water management. San Francisco Bay Area (2006), Antelope Valley (2007) Upper Santa Clara River (2008) and San Diego (2007) discuss general impacts of climate change in their descriptions of regional water resources. Antelope Valley and Upper Santa Clara River focus primarily on the potential impacts of climate change on the reliability of supply from the State Water Project. The Upper Santa Margarita IRWM region's Plan (2007) includes consideration of climate change risks to water supply as a sub-objective, and mentions GHG reduction efforts in its discussion of resource management strategies.

5.2 Post-2010 plans

Four IRWM plans – Coachella Valley, Inyo-Mono, Kern County, and Santa Ana Watershed ("SAWPA")– were prepared after DWR issued the August 2010 guidelines. Greater Monterey County has not yet completed its plan, but has formally adopted plan Goals and Objectives, which include climate change. The four completed plans broadly seek to follow the new

[4] Two regions, Tule and Kaweah River Basin, are "conditionally approved," meaning that the boundaries of the region are not fully agreed upon between the RWMG and DWR.

Table 1. Status of IRWM Plans and Round 1 Prop 84 Proposals, December 2011

Funding Area	IRWM Region	IRWM Plan Adoption Date	Round 1 Planning Funds?	Round 1 Implementation Funds?
North Coast	North Coast	2007	Yes	Yes
Sacramento River	American River Basin	2006	Yes	Yes
	Cosumnes American Bear Yuba	2007 (interim update 2009)	Yes	Yes
	Northern Sacramento Valley Four County Group	In development	Yes	Did not apply
	Upper Feather River	2005	Did not apply	Did not apply
	Upper Pit River Watershed	In development	Yes	Did not apply
	Upper Sacramento-McCloud-Lower Pit	In development	Yes	Did not apply
	Westside	2007	Yes	Did not apply
	Yuba County	2008	No	Did not apply
San Francisco Bay	San Francisco Bay Area	2006	Yes	Yes
San Joaquin	East Contra Costa County	2005 (FEP)	Yes	Yes
	East Stanislaus	In development	Did not apply	Did not apply
	Eastern San Joaquin	2007	Yes	Yes
	Madera	2008	No	Did not apply
	Merced	In development	Yes	Did not apply
	Mokelumne/Amador/Calaveras	2006	Yes	Yes
	Toulumne-Stanislaus	In development	Yes	Did not apply
	Westside-San Joaquin	2006	No	No
	Yosemite-Mariposa	In development	No	No
Lahontan	Antelope Valley	2007	Yes	Yes
	Fremont Basin	In development	Did not apply	Did not apply
	Lahontan Basins	In development	Did not apply	Did not apply
	Inyo-Mono	2011	Yes	Yes
	Tahoe-Sierra	2007	Did not apply	Yes
Central Coast	Greater Monterey County	2006 FEP (Salinas Valley)	Yes	Yes
	Monterey Peninsula, Carmel Bay, So. Monterey Bay	2007	Yes	No
	Santa Barbara County	2007	Yes	Yes
	San Luis Obispo	2007	Did not apply	Yes
	Santa Cruz	2005	Yes	Did not apply
	Pajaro River Watershed	2007	Yes	Did not apply
Tulare Lake	Kaweah River Basin (conditionally approved)	2008 (FEP)	Did not apply	Yes
	Kern County	2011	Did not apply	Did not apply
	Poso Creek	2007	Did not apply	Yes
	Southern Sierra	In development	No	Did not apply
	Tule (conditionally approved)	In development	Did not apply	Did not apply
	Upper Kings Basin	2007	Yes	Yes
Los Angeles-Ventura	Gateway	In development	Yes	Did not apply
	Greater Los Angeles County	2006	Yes	Yes
	Upper Santa Clara River	2008	Yes	Yes
	Watersheds Coalition of Ventura County	2006	Yes	Yes
Santa Ana	Santa Ana Watershed Project Authority	2010	Yes	Yes
San Diego	San Diego	2007	Yes	Yes
	South Orange County	2006	Yes	Yes
	Upper Santa Margarita Watershed	2007	No	Yes
Colorado River	Anza Borrego	In development	No	Did not apply
	Coachella Valley	2010	Yes	Yes
	Imperial	In development	Yes	Did not apply
	Mojave	2005	Did not apply	Yes

This table is up to date as of December 2011, based on information on IRWM regional websites and some 2011 Regional Acceptance Process Summaries. Some IRWM regions fall within two funding areas. Regions are listed only once, in the funding area in which it has received the most Prop 84 funding.

"Conditionally Approved" means that the region's boundaries are not yet fully agreed upon with DWR.
A Functionally Equivalent Plan (FEP) is one accepted by DWR in place of an IRWM plan.

Table 2. Current IRWM plans containing discussion of climate change.

Funding Area	IRWM Region	Date	IRWM Plan sections containing discussion of climate change			
			Regional Description/Needs and Challenges	***Plan Objectives and Resource Mgmt Strategies***	***Climate Change Section***	***Project Prioritization***
North Coast	North Coast	2007				Although it is not yet formally included in the IRWM Plan, the 2009 North Coast Energy Independence and Emission Reduction Program promotes adaptation/mitigation. It will be formally included as part of the current IRWM plan update process.
Sacramento River	CABY	2007 (interim update 2009)		Objective 12 (2007 Plan) is: "investigate effects of drought and climate change and the need for water management strategies" (Section 8.3)		2009 Interim Update includes climate change as one of four Programs under which projects are prioritized (Appendix I). This will be included in the overall plan as part of the plan update process.
San Francisco Bay	San Francisco Bay Area	2006	Brief description of main features of climate change, and the range of possible impacts in Northern California. Indicates that impacts in the Bay Area are uncertain (Section B3).			
Lahontan	Antelope Valley	2007	General discussion of CC impacts in CA, and potential effects on Antelope Valley due to dependence on State Water project and local surface water sources. Reviews 2005 CA Water Plan Update and 2006 DWR document on incorporating climate change into CA water resources mgmt. (Section 3.1.9). Impact of cllimate change on agricultural water demand also mentioned (Section 3.1.3).			
	Inyo-Mono	2011	Describes knowledge about CC impacts in California and anticipated impacts in the Eastern Sierras. (Ch. 3)	Objective 5 is: "address climate variability and reduce GHG emissions". Resource mgmt strategies include: understanding water-related GHG emissions; manage/modify systems to address increasing climate variability; cleaner energy sources to move/treat water (Ch. 6)	Overview of anticipated climate change impacts, anticipated GHG reduction efforts, and adaptation strategies. Analysis will be expanded through work under the Planning grant award. (Ch. 4)	Meeting IRWMP objectives (including climate change) is considered in project review. Adaptation and GHG reductions were included in ranking criteria for Round 1 implementation projects (Ch. 7).
Central Coast	Greater Monterey County	2011 (Goals and Objectives)		Although the plan is not complete, the IRWM region adopted Goals and Objectives in Sept. 2011. These include a climate change goal: "Adapt the region's water management approach to deal with impacts of climate change using science-based approaches, and minimize the regional causal effects." Goal includes 7 objectives, covering adaptation, mitigation, and outreach efforts.		
Tulare Lake	Kern County	2011	Reviews climate change impacts relevant to the region, particularly effects on snowpack and water supply through the State Water Project. Draws upon 2005 and 2009 Water Plan Update, and 2006 DWR document on incorporating climate change into CA water resources mgmt. Discusses relevance of CA Adaptation Strategy to the region. (Section 2.10.11)	IRWM Plan Objectives (increase supply, improve efficiency, improve quality, promote land use planning/stewardship, and improve flood mgmg) are described as "no-regrets" adaptation strategies. Table 10.2 specifies the kind of adaptation/mitigation promoted by each sub-objective. The Climate Change Handbook was used as a guide.		Climate change is not specifically discussed. The project prioritization process includes consideration of Statewide Priorities, of which one is climate change. There does not appear to be a specific means by which a project's particular benefits in terms of adaptation/mitigation would be identified/prioritized.

Funding Area	IRWM Region	Date	IRWM Plan sections containing discussion of climate change			
			Regional Description/Needs and Challenges	***Plan Objectives and Resource Mgmt Strategies***	***Climate Change Section***	***Project Prioritization***
Los Angeles-Ventura	Upper Santa Clara River	2008	General discussion of CC impacts in CA, and potential effects in Santa Clara River area due to dependence on State Water Project. Reviews 2005 CA Water Plan Update and 2006 DWR document on incorporating climate change into CA water resources mgmt. (Section 2.2)			
Santa Ana	Santa Ana Watershed Project Authority	2010	Climate change is included as one of four key threats to water resources in the region. Findings of DWR's Managing an Uncertain Future are discussed. (Ch. 1)	Climate change is included as one of 10 "pillars" guiding management strategies (Ch. 1). Reducing GHGs is included as sub-objective under "promote sustainable water solutions" objective (Ch. 6).	Describes study undertaken with the RAND Corporation to evaluate CC vulnerabilities in the Santa Ana Watershed. Outlines a set of CC mgmt strategies, and how climate change is considered for project ranking. Indicates plans to expand climate analysis under the Planning grant, following the Handbook (Section 5.9)	GHG scoring is included in project ranking criteria. In the weighting system for 11 project criteria, climate change is the smallest at 2%. (Ch. 6)
San Diego	San Diego	2007	Reviews 2005 CA Water Plan Update and 2006 DWR document on incorporating climate change into CA water resources mgmt (Section B.2)			
	Upper Santa Margarita Watershed	2007		Climate change included as a sub-objective ("consider climate change in evaluating future water supply options") under the goal of achieving a more reliable supply (Section 3.3). GHG reduction efforts are discussed as part of resource management strategies (Section 4).		
Colorado River	Coachella Valley	2010	Includes a legislative summary, overview of DWR's Managing an Uncertain Future, and a discussion of research on CC impacts, particularly effects on supply through the State Water Project. (Section 2.8)	Objective 4 ("maximize local supply") indicates that this is the RWMG's primary CC adaptation strategy, which also helps reduce GHGs. CC also mentioned in Objective 8 (flood risk), and Objective 9 (onjunctive water use) (Ch. 4). CC is discussed as part of certain Resource Mgmt Strategies (Ch. 6), including system reoperation, ecosystem restoration, forest mgmt, and recreation. Section 6.5 discusses adaptation strategies, listing possible "no-regrets" strategies for the region.		Climate change actions are considered separately from other state priorities in project review. Developing local water supply is the primary adaptation strategy for the region and is considered in project prioritization, along with GHG reduction strategies (Ch. 7). Describes strategies for reducing GHGs and specifies that project proponents must consider GHG reductions and adaptation strategies (Section 9.2 of Ch. 9, Framework for Implementation).

Information in this table is based upon IRWM Plans available on the websites of Regional Water Management Groups as of December 2011, and information contained in Round 1 Planning grant proposals.
A blank box means that section of the Plan did not discuss climate change.

Guidelines, and therefore offer initial examples of the interpretation of the Guidelines with respect to incorporation of climate change. It should be noted that except for Kern County, these regions were also awarded Round 1 Planning grants to further update their plans, including climate change components.

Table 2 indicates the sections of the IRWM plans in which climate change is discussed. These include many of the sections required in Table 8 of the Guidelines, although for the most part the plans do not address climate change in the Relation to Local Water Planning, Relation to Local Land Use Planning, Plan Performance and Monitoring, and Coordination sections. However, some of the issues relevant to these sections are discussed elsewhere in the plans, such as in specific climate change sections in the SAWPA and Inyo-Mono plans.

The following is a summary of how these plans respond to the following broad elements of the Guidelines: 1) assessing climate change impacts; 2) identifying adaptation strategies; 3) considering GHG reductions; and 4) monitoring and updating for adaptive management.

5.2.1. Assessing climate change impacts. All four plans include a discussion of anticipated climate change impacts in the region. In the Inyo-Mono, Coachella, and Kern County plans, these descriptions are drawn from DWR and other studies of climate change impacts in California, and focus largely on anticipated changes in snowpack and impacts on water exports (for Inyo-Mono) and on water imports (Coachella Valley and Kern County). Santa Ana Watershed's plan draws upon a specific study undertaken by the RAND Corporation (Groves et al., 2008a) of the watershed's key climate vulnerabilities under several different future climate scenarios. The SAWPA Plan reviews possible regional impacts, and highlights a conclusion in the RAND study that a critical vulnerability is reliance on imported water (SAWPA Plan, Section 5.9). The Inyo-Mono, Coachella and SAWPA plans indicate that further climate change analysis will be conducted with support of Planning grant funds, and all four indicate that these descriptions will be revised as tools and knowledge improve.

5.2.2. Identifying adaptation strategies. Addressing adaptation in an IRWM plan not only involves discussion of relevant adaptation strategies, but also the inclusion of adaptation in the Plan's objectives, resource management strategies, and project prioritization.

a. *Discussion of adaptation:* All four plans contain general discussions of climate change adaptation strategies. Inyo-Mono's plan lists the 10 adaptation strategies from the 2008 DWR *Managing an Uncertain Future* white paper (Plan Chapter 4), while Coachella Valley and Kern County list a set of "no-regret" strategies for the region, using California's Adaptation Strategy as a guide (Plan Sections 6.5 and 2.10.11, respectively). SAWPA lists a set of "management strategies for a changing climate" that appear to be principles emerging from SAWPA stakeholder discussions (Plan Section 5.9).
b. *Inclusion in objectives/resource management strategies:* Inyo-Mono and Coachella include adaptation in plan objectives and the selection of resource management strategies. Inyo Mono's Objective 5 is to "address climate variability and GHG emissions." Coachella Valley's Plan specifies that "maximizing local supply

opportunities is the primary climate change adaptation strategy being employed by the CVRWMG" (Objective 4, p. 4-3). Greater Monterey County's recently adopted goals include one dedicated to promoting adaptation to climate change. Kern County's plan describes each of its five goals as promoting "no-regrets" strategies (Table 10.2), but does not specifically include climate change as a goal. SAWPA does not explicitly include adaptation in its objectives or discussion of resource management strategies. However, SAWPA's management strategies appear to address reducing reliance on imported water, the critical vulnerability identified in the climate change study conducted for the Santa Ana Watershed.

c. *Inclusion in project prioritization:* Inyo-Mono's plan considers IRWM Plan objectives in prioritizing projects, and therefore considers adaptation because addressing climate variability is included in Objective 5. In addition, Inyo Mono indicates that adaptation was a factor in the review for Round 1 Implementation grants (see discussion in Section 7.3 of this report). Coachella Valley's project review process considers climate change actions as separate from other Statewide Priorities, and requires that project proponents consider adaptation strategies. Kern County's process does not specifically consider adaptation, although Statewide Priorities are considered, of which climate change is one. SAWPA's project review process does not explicitly include adaptation.

5.2.3. Consideration of greenhouse gas emissions. All four completed plans discuss the need to reduce GHGs, but implement this to varying degrees in the project review process. Inyo-Mono's Plan indicates that currently, GHG accounting does not take place for water management in the region, and most water districts do not have the resources to do so. The project review process formally includes consideration of GHG emissions, and planning grant funds will be used to begin to quantify regional energy use and assess methods to reduce it (Chapter 7). Coachella Valley's Plan includes a discussion of GHG reduction opportunities for each resource management strategy (p. 6-36). In Coachella Valley's project review process, project proponents must include an analysis of GHG emissions, as required by CEQA (p. 9-11). SAWPA's plan includes GHG emissions as one of 11 project criteria. The GHG criterion receives the smallest weighting, at 2%. The GHG score of a project is calculated based on a ranking from 1-5, which evaluates the degree of quantification of GHG emissions for a project, with 1 being no information, 5 being a numeric estimate plus specific reduction actions (Chapter 7). Finally, in Kern County's plan, projects are ranked according to the degree to which they meet IRWM objectives, Program Preferences, and Statewide Priorities. The process does not include a specific criterion for GHG reductions, although it is noted that certain kinds of projects are expected to provide GHG reduction benefits (Section 12.4.1).

5.2.4. Monitoring and updating for adaptive management. The Plan Performance and Monitoring sections in these plans discuss general methods for monitoring project performance, such as quarterly reviews of progress (Inyo-Mono), annual reports (Coachella Valley), and plan evaluations every two years (SAWPA). Kern County's plan is to be updated every five years, although there is a provision for more frequent updates if new information about watershed conditions becomes available (Section

14.6). Although climate change is not mentioned, presumably updates of the climate analysis would be included in these processes. These plans do not identify specific project or performance indicators related to climate change, except for a project-level indicator for GHG emissions in the SAWPA plan (see Chapter 9). Data management chapters for each plan discuss efforts to pool a wide range of datasets for the region, such as ground and surface water quantity and quality, flooding, habitat, and demographics (see Coachella Valley plan, Section 9.3). Climate data, such as precipitation, temperature, or climate model projections, are not among the datasets mentioned in these plans.

5.3. Summary and Discussion

At least two IRWM regions, North Coast and CABY, were already engaging on climate change through programs developed prior to the 2010 Guidelines. In the four plans formally adopted after the 2010 Guidelines – Coachella Valley, Inyo-Mono, Kern County, and SAWPA – most of the elements of the 2010 climate change requirements are addressed, at least to a degree. All four discuss how climate change may affect the region. SAWPA's plan draws upon a specific study of regional climate change risks, and the other three rely upon a literature review. Adaptation strategies are generally discussed in all plans, and are included in project review processes for Inyo-Mono and Coachella Valley. The Coachella, Inyo-Mono, and SAWPA plans consider GHG emissions as part of the project review process. The plans do not discuss a specific process for updates based on continual monitoring or new knowledge about climate change risks. These plans do not yet incorporate the elements described in DWR's recent draft guidance on the climate change standard, which include a vulnerability assessment, prioritization of vulnerabilities, and a plan for further analysis. However, the literature reviews presented in these plans are complementary to these steps. These and other elements related to climate change may be addressed under the Round 1 Planning grants received by three of these regions.

Two key issues emerge from this review. First, it suggests that attention is needed not only to the discussion of climate change in an IRWM plan, but also to the process used to generate it. Two regions that began to address climate change before the 2010 Guidelines did so through stakeholder engagement and creation of coordinating mechanisms within the region to support integrating climate change priorities into projects. Other RWMGs also have such mechanisms. For example, SAWPA's structure includes climate change as one of 10 "pillar groups," which represent critical issues for the watershed. Each "pillar" has an assigned leader who helps integrate efforts to address this issue across program activities (SAWPA Plan, Executive Summary). As a topic that cuts across so many aspects of water management, meaningful efforts to integrate climate change are likely to require coordinating mechanisms of some kind. A formal inclusion of climate change in the project prioritization process needs to be supported by efforts within a RWMG to work with project proponents on ways to incorporate climate change into project design.

Second, the four IRWM plans adopted after the Guidelines do not offer many clues as to what a process of "adaptive management" for addressing climate change might entail. They generally indicate that the analysis of climate change impacts will be updated, and presumably would figure in regular plan evaluations, but it is unclear how the IRWM

region's efforts to addressing these impacts would be monitored and assessed. Evaluating adaptation efforts is a considerable challenge globally, and efforts to develop appropriate metrics are only just beginning (Preston et al., 2009). The Climate Change Handbook provides some guidance on this issue (Section 6). Questions remain about the kinds of data and information should be tracked about climate impacts and adaptation measures at the regional level, and these will likely need to be region-specific. Coordinating mechanisms for climate change at the RWMG level could help support addressing monitoring and evaluation needs over time.

6. Climate change in Round 1 Planning grant proposals

In September 2010, 39 IRWM regions submitted applications for Proposition 84 Round 1 Planning grant funds. Each approved IRWM region is eligible for up to $1 million, to be used to update an existing IRWM plan or develop a new one in accordance with the Guidelines. Final awards were announced in early 2011, with 30 out of 39 proposals receiving funding, totaling $21,046,952.

This review draws upon information in Round 1 Planning grant proposals to make an overall assessment of how regions are responding to the climate change requirements in the Guidelines. It focuses on two questions:

- How do IRWM regions plan to address climate change, and are these plans broadly consistent with the main elements of the 2010 Guidelines?
- What are expectations about future guidance on climate change, and how do current plans compare with draft language for a revised climate change standard?

Planning grant proposals describe how the region intends to update its IRWM plan to meet the new Guidelines. The Proposal Solicitation Package for Planning grants indicates that the explanation should include "sufficient detail such that the reviewer understands the work to be performed and is able to evaluate the adequacy of the proposal," (p. 15). This report is not seeking to assess the adequacy of these descriptions. This determination was part of the proposal review process conducted by DWR, reflected in the Proposal Evaluations available on the DWR IRWM website. All but five of the 37 proposals included in this review were deemed to have described climate change elements adequately. These five proposals did not receive funding, although not solely on the basis of how climate change was addressed.

It is recognized that information in the Planning grant proposals may not fully reflect existing plans for addressing climate change, and that these plans may evolve as work begins. When available, information from interviews conducted by DWR climate change specialists was used to confirm the current status of these plans.

6.1. Climate Change Discussion in Planning Grants

Climate change is referenced in multiple parts of the workplan component of Planning grant proposals, indicating how climate change will be integrated in various sections of the IRWM

plan update. All but two proposals include a specific climate change task description, ranging from a paragraph to several pages, describing plans for analyzing climate impacts, adaptation strategies, and GHG emissions. In some cases, this section only indicates that an analysis will be undertaken, but does not provide details of the approach.

Most proposals included a specific budget for the climate change task. Table 3 shows the amounts requested from DWR for climate change work, matching funds, and total climate change budgets for Planning grants awarded. The total amount of DWR funds dedicated to climate change analyses in Round 1 awards was $1,004,636, which represents about 5% of the total funds awarded.[5]

Table 3. Climate change task budgets in Round 1 Planning grant awards.

	Request to DWR for climate change work†	Matching funds††	Total climate change task budget
Average	$35,880	$41,328	$77,208
Range	$0 - $101,482	$0 - $583,000	$5,000 - $583,000
Total (27 awards)†	$1,004,636	$1,157,185	$2,161,821

† Unfunded proposals and 3 funded proposals without separate climate change budgets were excluded.
†† SAWPA's match of $583,000 is significantly higher than others. If this is excluded, the average match is $21,266.

This section summarizes the discussion of climate change in the 37 single-region Planning grant applications with respect to the climate change requirements.[6] The first three elements described below are reflected in Table 4, which provides an overview of the aspects discussed in each proposal and mentioned in interview results where available. Page numbers cited in this section refer to the workplan component of the Planning grant proposals, unless otherwise specified.

6.1.1. Assessing climate change impacts and identifying adaptation strategies (blue columns in Table 4). This element of the climate change standard involves three broad aspects: assessing key vulnerabilities, modeling to measure impacts, and identifying adaptation strategies. Using quantitative models to measure impacts was not required at this stage by the Guidelines, but it is included on Table 4 since some proposals covered this. These approaches are discussed further in Section 8, and in Table 9.

a. *Discussion of key vulnerabilities to climate change.* Most regions (31 out of 37) included some discussion of the kinds of climate change risks the region plans to investigate, or described a process by which those would be identified. For example, the Mokelumne/Amador/Calaveras (MAC) proposal indicates plans to "document the anticipated impacts of climate change on water supply" (p. 50).

[5] This is an underestimate, since three proposals did not include specific climate change budgets.
[6] Two inter-regional proposals, which were not funded, are not included because they did not directly address updating IRWM Plans to meet the new climate change standard.

Table 4. Overview of Round 1 Planning Grant Climate Change Task Elements

Adaptation to Climate Change

Climate Change Mitigation

Elements of regional process for climate change analysis

Funding Area	IRWM Region (1)	Discussion of vulnerability priorities	Model climate impacts	Discussion of adaptation strategies	Project-level GHG assessment	Regional GHG inventory	Stakeholder/public involvement	Partnerships/collaborations	Plans for inter-regional collaboration	Request for CC work, $ (2)	Matching funds, $	Total CC Budget, $	Total Planning Grant Award, $ (3)
North Coast	North Coast	•		•	•		•	•		47,000	53,000	100,000	1,000,000
Sacramento River	American River Basin	•	•	•	•		•			80,278	0	80,278	403,848
	Consumnes American Bear Yuba (CABY)	•	•	•	•		•	•	•	26,480	0	26,480	647,593
	N. Sacramento Valley Four County Group				•					37,700	8,800	46,500	900,000
	Upper Pit River Watershed	•	•	•	•		•	•	•	25,380	0	25,380	649,713
	Upper Sacramento-McCloud-Lower Pit	•		•	•		•	•	•	0	169,300	169,300	592,470
	Westside-Sacramento	•			•					64,000	14,400	78,400	1,000,000
	Yuba - NOT FUNDED	•			•		•	•	•	*13,440*	*720*	*14,160*	*0*
San Francisco Bay	San Francisco Bay Area	•	•	•	•			•		44,280	53,960	98,240	842,556
San Joaquin	East Contra Costa County				•		•			--	--	--	449,843
	Eastern San Joaquin	•	•		•		•			78,225	26,075	104,300	545,925
	Madera - NOT FUNDED	•					•	•		*24,150*	*0*	*24,150*	*0*
	Merced	•		•	•	•	•	•		79,200	173,493	252,693	719,010
	Mokelumne/Amador/Calaveras (MAC)	•			•					--	--	--	250,909
	Toulumne-Stanislaus	•			•					9,314	1,380	10,694	636,380
	Westside-San Joaquin- NOT FUNDED									--	--	--	*0*
	Yosemite/Mariposa - NOT FUNDED				•		•			--	--	--	*0*
Lahontan	Antelope Valley	•		•	•	•	•			51,222	0	51,222	472,919
	Inyo Mono	•	•	•	•	•	•	•	•	10,000	1,000	11,000	237,615
Central Coast	Greater Monterey County	•		•	•		•	•	•	10,000	0	10,000	755,264
	Monterey Penninsula	•			•			•		5,000	0	5,000	995,000
	Pajaro River Watershed	•	•	•	•		•	•		25,840	1,560	27,400	996,170
	Santa Barbara County	•		•	•		•		•	44,964	7,035	51,999	555,737
	Santa Cruz	•	•	•	•			•	•	31,500	22,992	54,492	999,750
Tulare Lake	*Southern Sierra - NOT FUNDED*	•	•		•		•	•		*44,900*	*50,000*	94,900	*0*
	Upper Kings Basin	•			•		•		•	24,000	3,440	27,440	236,890
Los Angeles-Ventura	Gateway	•			•		•		•	22,340	0	22,340	950,000
	Greater Los Angeles County			•	•					--	--	--	1,000,000
	Upper Santa Clara River	•	•	•	•				•	77,250	25,750	103,000	266,250
	Watersheds Coalition of Ventura County	•		•	•	•	•	•	•	10,320	0	10,320	485,694
Santa Ana	Santa Ana Watershed Project Authority	•	•	•	•	•	•	•	•	0	583,000	583,000	1,000,000
San Diego	San Diego	•	•	•	•	•	•	•	•	63,840	0	63,840	1,000,000
	South Orange	•			•	•	•		•	30,000	10,000	40,000	457,416
	Upper Santa Margarita - NOT FUNDED	•	•		•	•	•		•	*101,482*	*0*	*101,482*	*0*
Colorado River	*Anza Borrego Desert - NOT FUNDED*				•					*4,875*	*1,500*	*6,375*	*0*
	Coachella Valley	•			•	•				56,503	0	56,503	1,000,000
	Imperial Valley	•	•	•	•	•		•		50,000	2,000	52,000	1,000,000
									Totals (excluding unfunded proposals):	**1,004,636**	**1,157,185**	**2,161,821**	**21,046,952**

This table is based on information from Round 1 Planning Grant proposals and 20 interviews conducted by DWR with IRWM regions.

1. Of the 39 Planning Grant proposals submitted in September 2010, 37 are analyzed here (30 funded, 7 unfunded). Unfunded proposals are in italics. Two unfunded inter-regional proposals are not included, since they are not intended to address integrating climate change into IRWMPs.

2. Figures reflect specific budgets for climate change analysis. A few proposals did not include separate line items for climate change; these are indicated by "--"

3. Total award amounts are the same as the amounts requested except for North Sacramento Valley (award was $100,000 less than requested). Award figures do not include matching funds. The total of all awards and matching funds for accepted proposals is $32,665,731.

Several proposals discuss plans to use the vulnerability matrix created by DWR regional climate change specialists based on the 2009 California Adaptation Strategy, as a starting point for their analysis. Many regions are conducting a review of existing climate change studies to identify vulnerabilities. A number of proposals, such as San Diego, Upper Pit River Watershed, CABY and others, emphasize stakeholder input in this process. For example, the San Diego IRWM region plans to form a workgroup to review the analysis and rank vulnerabilities (San Diego interview, November 8, 2011).

b. *Quantitative analysis of climate impacts.* The majority of proposals do not describe additional analysis of climate vulnerabilities beyond the general assessment mentioned above. However, based on information from proposals and interview results, at least 14 regions (including one unfunded proposal) have developed plans to use climate models or scenarios, along with specific hydrologic, vegetation, or other resource models, to more specifically analyze certain climate impacts. Most of these analyses focus on impacts to water supply and demand. A few of these regions, such as American River Basin, CABY, Inyo-Mono, and Eastern San Joaquin, appear to be undertaking this modeling themselves or with support from consultants, while others are collaborating with agencies such as the US Bureau of Reclamation (SAWPA and Imperial Valley), and US Geological Survey (Santa Cruz). Some regions are basing their analysis upon existing studies that incorporate climate change projections, such as DWR's State Water Project Delivery estimates (DWR, 2010b) and US Bureau of Reclamation's recent West-Wide Climate Risk Assessments (USBR, 2011). Three regions (the Bay Area, Pajaro River Watershed, and San Diego) discuss plans to use Cal-Adapt, an online tool that enables users to visualize downscaled climate projections and access model data. Participation in the climate change workshop hosted by the Watersheds Coalition of Ventura County suggested that Cal-Adapt is also being used by some other IRWM regions as well. Further details on these approaches and the specific climate and hydrologic models being used can be found in Section 8 and Table 9 in this report.

c. *Identifying adaptation strategies.* The Guidelines indicate that initially, regions should consider "no-regrets" strategies, defined as "those that make sense in light of the current water management context for a region and also help in terms of effects of Climate Change" (p. 71). The Guidelines mention specific examples, including water use efficiency, integrated flood management, and sustaining and enhancing ecosystems. "Next steps" should be to use vulnerability assessments to develop "adaptation strategies that address region-specific climate impacts," (p. 74).

Nineteen proposals discuss specific adaptation strategies or describe an approach for identifying them. About half of these indicate that "no-regrets" adaptation strategies will be employed, often citing examples from the Guidelines. Some proposals describe a process or principles to guide the selection of adaptation strategies. For example, the Greater Monterey County region plans to use the results of the vulnerability assessment in a stakeholder workshop to help select

appropriate strategies (p. 21). The North Coast plans to pursue "climate adaptation strategies that integrate ecosystem resiliency with human community resiliency and disadvantaged communities (DACs)," (p. 30). A few proposals identify plans to undertake specific adaptation strategies. For example, Antelope Valley anticipates that the climate change analysis will "confirm importance of groundwater banking initiative in adapting to climate change and support other water resources management activities, including flood management planning," (p. 9).

6.1.2. Considering greenhouse gas emissions (green columns in Table 4). The 2010 Guidelines indicate that the project review process for IRWM plans must consider the "contribution of the project in reducing GHG emissions as compared to project alternatives," (Guidelines, p. 75). Projects that are eventually funded by DWR under the IRWM Plan must conduct a CEQA analysis, and the Guidelines suggest (but do not require) that it may be helpful to use a similar process in project selection. The Guidelines do not require creating a regional inventory, although these are discussed in Section 3 of the Climate Change Handbook. Since some proposals discuss regional inventories, these are included in Table 4.

a. *Project-level GHG assessments*. Except for two that were not funded, all proposals state that GHG emissions will be integrated into the project review process. A few proposals contain language suggesting a somewhat tentative commitment to this. For example, Santa Barbara's workplan states that they "will consider the benefit of using a project-level analysis as a means of disclosing and evaluating GHG emissions for project alternatives," (p. A3-55). However, proposals with this language are reflected in Table 4 as addressing this element.

   Very few proposals describe how they will implement this. Two that include some detail are Imperial Valley and Eastern San Joaquin. Imperial Valley discusses a number of factors to be considered in estimating project emissions, such as identifying the marginal energy source for water supply projects, seasonal differences in GHG emissions, and future changes in energy supply. The proposal indicates that each project will be ranked on a 1-5 scale, with 1 corresponding to a low ability to reduce GHGs, and that this ranking will be considered in the project review (Section 9.7). Eastern San Joaquin's proposal indicates plans to calculate potential reductions in GHG emissions for projects that generate renewable energy or reduce energy use. Energy use data would be obtained from PG&E to calculate "relative and absolute GHG emissions" (p. 31-32).

b. *Regional GHG inventories.* Ten proposals describe plans to create or participate in a regional GHG inventory. The Watersheds Coalition of Ventura County (WVCC) and the Merced IRWM region indicate plans to integrate their GHG reduction efforts with county and city Climate Action Plans, including participation in regional inventories. The South Orange proposal states that it will create a "gross GHG inventory of the water management systems in the region," which "will be a useful tool for the Region in understanding the regional baseline and in selecting IRWM projects that reduce regional emissions" (p. 1). All three of the IRWM regions in

the San Diego Funding Area discussed the creation of, or participation in, a regional inventory, and indicate that they will coordinate across their Funding Area on this effort.

6.1.3. Process for implementing the climate change analysis (gray columns in Table 4). The Guidelines do not specify how IRWM regions should organize the integration of climate change into the IRWM plan and RWMG decision-making processes. Most regions rely in some way upon consultants to write or update IRWM plans. Out of the 20 interview results received, 16 indicated that a consulting firm or team is involved conducting the climate change analysis and incorporating it into the IRWM plan. A number of proposals and interview results also indicate specific stakeholder involvement, partnerships, and inter-regional collaborations as part of the process for carrying out the analysis.

a. *Stakeholder/public involvement*. 24 regions indicate some plans for involving stakeholders and/or the general public in pursuing their climate change analysis. This might be a specific Technical Advisory Committee or workgroup composed of IRWM region stakeholders with relevant interests and expertise, a public workshop focused on climate change, or other kinds of public outreach. Specific examples are discussed in Section 8.

b. *Partnerships/collaborations.* Proposals and interview results reflect that 18 regions plan to implement their climate change analysis in partnership with a specific outside agency, bringing technical expertise, matching funds, or both. These partnerships involve the following types of agencies:
   - Federal agencies (US Bureau of Reclamation, US Geological Survey, US Forest Service)
   - Local or county governments (City of Merced, Ventura County)
   - Universities (University of California San Diego, UC Merced, UC Davis, University of Nevada Reno)
   - Foundations (San Diego Foundation)
   - Local networks (i.e., North Bay Climate Adaptation Initiative)
   - Non-governmental and local community groups (Cal-Trout, a climate change community group in Mariposa)

c. *Inter-regional collaborations.* Based on proposals and interview results, at least 16 IRWM regions have initiated or plan to explore collaborating with one or more neighboring IRWM regions. In most cases these are regions in the same funding area, but not always. Details about the nature of these collaborations are not yet available. Information sharing appears to be one aspect. For example, the Watersheds Coalition of Ventura County's climate change workshop also involved two neighboring IRWM regions in order to share ideas and promote collaboration. CABY hopes to develop an approach to analyzing climate impacts in the Sierra Nevada that could be used in other regions (CABY interview, October 19, 2011). All three regions in the San Diego funding area plan to coordinate their analyses to develop a "shared understanding of

the funding area's vulnerability to climate impacts," (San Diego workplan, p. 34, and San Diego interview, November 8, 2011).

6.1.4. Coordination with land use planning processes. The Guidelines require a new section in IRWM plans on the Relation to Local Land Use Planning, specifying that plans should "demonstrate information sharing and collaboration with regional land use planning in order to...adapt water management systems to climate change, and potentially offset climate change impacts to water supply in California" (Guidelines, p. 75).

Most proposals mention that climate change will be considered in the IRWM plan section on relations with land use planning, but do not provide specifics. The following are two examples from those that do:

- Bay Area: coordinate with Regional land use planning under SB 375, the California Sustainable Communities Planning Act (p. 13-2)
- Southern Sierra (not funded): coordinate with the planned Southern Sierra Conservation Cooperative (SSCC), a collaborative group of federal land management agencies to develop an information clearinghouse to improve land use decisions in light of climate change (p. 20).

6.1.5. Adaptive Management. The Guidelines emphasize the need to take an "adaptive management" approach in the consideration of climate change, such that new information and tools can be integrated into IRWM Plans as they emerge (Guidelines, p. 71). Most proposals acknowledge the need for regular Plan updates as knowledge about climate change improves. However, few proposals include details on how this will be done. A few examples from the more explicit descriptions are provided below.

The Greater Monterey County proposal states that, "The IRWM Plan Coordinator will identify policies and procedures that promote adaptive management at the project level for the planning region, including a feedback loop for project sponsors on projects implemented and projects proposed with regards to required changes or adaptation actions needed, based on available climate change data and predictions" (p. 21). The Upper Kings Basin proposal focuses on procedures for updating the Plan: "Climate change is a dynamic science. As a result, the IRWMP will be fashioned to allow frequent updates to accommodate the frequent changes to climate change research and guidelines." (p. 3-22). The Pajaro River Watershed group plans to identify "triggers" for updating the plan: "The RWMG recognizes that the IRWM Plan will need to be updated as more effects of climate change manifest, new tools are developed, and new information becomes available. The RWMG will identify triggers for considering plan changes or amendments. These triggers will be incorporated into the Plan Performance and Monitoring section," (p. 30).

6.1.6. Discussion of data related to climate change. As noted in the previous section, IRWM plans include efforts to consolidate relevant data for water resources management in each region. To understand the impacts of climate change, long-term monitoring of climate variables and impacted features of water systems is critical (Brekke et al.,

2009). The Guidelines do not specifically mention such data, but it is clearly needed for the study of climate impacts, and to support an adaptive management approach.

Relatively few Planning grant proposals discuss plans for collecting or managing climate or other data for impacts studies. Where this is mentioned with respect to climate change analyses, the discussion usually refers to collecting existing climate change studies and downscaled climate change projections relevant to the region. For example, the Data Collection task of the Westside-Sacramento River IRWM region's proposal includes collection of data for the analysis of climate change impacts, and states, "For example, obtaining and mapping sea level rise and evapotranspiration projections for the Westside region may be conducted under this subtask," (p. 25). CABY and Upper Pit River Watershed's proposals include a subtask to "collect and synthesize region-specific climate change data" which includes collecting relevant studies, policy statements and other documents (p. 57 and p. 38, respectively). The Bay Area IRWM region also plans a clearinghouse of climate change studies as part of its plan update (Bay Area interview, October 19, 2011).

Proposals from a few regions contain activities that relate to long-term monitoring of climate impacts. The Upper Sacramento-McCloud-Lower Pit IRWM region's climate change study builds upon several existing projects in the region that involve creating or using long-term monitoring datasets for critical climate impact variables. For example, the Castle Lake Environmental Research and Education Program involves "building a 52-year monitoring dataset on biological, physical, and water quality parameters in small watersheds within the Sacramento Headwaters," (p. 42). The IRWM region's climate change study will consolidate data from these and data from other studies related to critical climate impacts (p. 43). South Sierra's proposal (not funded) included participation in a proposed Climate Change Information Clearinghouse for the Southern Sierra Conservation Cooperative, a collaborative effort between federal land management agencies and other partners (p. 20). One goal of the clearinghouse is to enable participants to share data for understanding long-term climate impacts, as part of a broader adaptive management approach (Attachment 4 to Workplan).

6.2. Expectations regarding future guidance and draft language for a revised Climate Change Standard

As discussed in Section 4, the 2010 Guidelines indicated that the requirements related to climate change would be further clarified. The anticipation of future guidance seems to have affected how some RWMGs approached their plans for climate change analysis. For example, Eastern San Joaquin's proposal states, "As the DWR has not yet published its recommended approach, this Task must be flexible for potential changes…DWR is expected to refine the IRWMP climate change analysis standards shortly," (p. 32).

Some proposals also reflect anticipation of the Climate Change Handbook, which had been shared as a draft and discussed in Planning grant workshops in the fall of 2010. In some proposals and interview results, some IRWM regions appear to have interpreted the Handbook as a "guidance document" or "recommended approach." However, as noted in

Section 4, DWR does not intend the Handbook to represent a required "recommended approach" to analyzing climate change in IRWM plans. Rather, it is intended to provide resources to aid regional water planners, including those involved in IRWM plans, in identifying the most appropriate approach to meet regional needs. This has been clarified in the recent set of Process Improvement workshops held by DWR in December 2011, in which the final version of the Climate Change Handbook was presented.

During the December 2011 workshops, DWR discussed draft language for a revised climate change standard. This specifies the level of analysis of climate change impacts that would be expected for updating an IRWM Plan such that a region would be eligible for Rounds 2 and 3 Implementation Grant funding. When viewed in light of this draft guidance, the current plans of some IRWM regions may require some adjustment with regard to how vulnerabilities are assessed. The vulnerability assessment checklist in the Climate Change Handbook, which is referred to in the new draft guidance as the minimum expectation, examines specific regional characteristics to identify potential vulnerabilities. Some regions propose different approaches to identifying vulnerabilities, such as beginning with a review of climate change projections relevant to the region. Examining regional characteristics is complementary to this, providing a sense of the degree of impact the region is likely to experience as a result of such projections, and identifying critical infrastructure or areas that may be most vulnerable.

Interviews conducted by DWR with IRWM representatives suggest concern on the part of some regions about the level of detail that may be required in the future for climate change analyses, based on indications in the Guidelines and the Handbook. Interview results with Upper Pit River Watershed, CABY, and Santa Clara expressed concern about requirements for highly detailed analyses, which could be beyond the capacity of some IRWM regions. One particular concern relates to whether in the future DWR would expect all IRWM regions to conduct quantitative analyses of climate change impacts, as suggested on p. 74 of the Guidelines. The recent draft guidance requires developing a plan for further analysis of prioritized vulnerabilities, but at present, does not specify whether that analysis must be quantitative. Issues related to the appropriateness of quantitative analyses are discussed in Section 8 of this report.

6.3. Summary and Discussion

This review indicates that for the most part, the plans described by IRWM regions for addressing climate change meet the basic elements of the 2010 Guidelines. Plans to analyze vulnerability and impacts and identify adaptation strategies vary across regions in the extent of their analyses and use of region-specific studies and models. The majority of regions appear to be developing an approach to assessing vulnerabilities in the region, and 14 out of 37 regions have planned some quantitative modeling of climate impacts. All funded proposals indicate that project-level assessments of GHG emissions will be undertaken, and 10 proposals also discuss plans to develop or participate in a regional GHG inventory. At least 24 regions plan to involve stakeholders and/or the public in aspects of the climate change analysis, 18 describe specific collaborations to carry out this work, and 16 mention plans to coordinate with other IRWM regions. The need to engage with land use planning processes is generally acknowledged, and a few proposals include specific plans

for this. The proposals note the need for continual monitoring and updating of their consideration of climate change, but with limited specifics. Discussions of data related to climate change analyses largely focus on the collection of information and studies on regional climate impacts. Finally, IRWM regions have anticipated further guidance from DWR on how to approach the climate change analysis, and the Climate Change Handbook has been perceived by some as providing this. Some concern has been expressed in interviews regarding the level of detail that the Guidelines and Handbook appear to suggest is required. In light of the recently released draft guidance for a Climate Change Standard, plans in some IRWM regions may require some adjustment with regard to how vulnerabilities are assessed, but planned efforts appear largely compatible with the draft guidance.

These results show a large diversity of approaches to assessing climate change vulnerabilities, reflecting relatively broad guidance in this respect, as well as the wide range of possible approaches to assessing these risks. While the flexibility to pursue locally appropriate approaches is useful, more specific guidance on the steps involved, as provided in the draft for a revised climate change standard, will likely be helpful. In addition, the technical resources in the Climate Change Handbook may help reduce the burden on IRWM regions to investigate and select analytical approaches from among the many possibilities. Section 8 discusses some additional considerations. By comparison, the response to the requirement to include GHGs in the project review process is quite consistent, although limited information is available about exactly how each group will comply. Regions that create or participate in regional GHG inventories, although not specifically required in the Guidelines, will be better placed to demonstrate measurable progress toward emissions reductions over time.

7. Climate Change in Round 1 Implementation Grant Proposals

The aim of IRWM plans is to enable a coordinated approach to water management, leading to integrated projects that meet multiple water management objectives. Implementation grants provide funding for projects that follow IRWM plans, selected through project review processes. With respect to climate change, the analyses undertaken through Planning grants would ideally inform how Implementation projects are prioritized so as to reflect the best current understanding of regional vulnerabilities. This might mean increasing the emphasis on certain types of projects, focusing on specific locations at risk from flooding, sea level rise or other impacts, or perhaps adjusting the design of certain projects to account for anticipated changes.

Most IRWM regions are just beginning to integrate climate change in their plans. Therefore, it is not expected that Implementation grants be informed yet by regionally specific analyses. However, the Guidelines introduced a Statewide Priority for funding projects that address climate change. With respect to Round 1 Implementation grant proposals, this review seeks to answer the following questions:

- What is the nature of the portfolio of projects funded under the Climate Change Priority?
- To what degree has climate change been included in the rationale for prioritizing Implementation projects?

7.1. Overview of Funded Implementation Grant Proposals

In January 2011, 28 IRWM regions submitted applications in Round 1 of Prop 84 Implementation grant funding. In August 2011, final awards were announced to 25 IRWM regions, totaling $204,922,248. The projects funded through these awards address a range of objectives, including water supply reliability, improved water use efficiency, water recycling, water quality, flood management, and watershed protection.

These projects were identified through each IRWM plan's project review process, which typically involves consideration of IRWM plan objectives, IRWM Program Preferences, and Statewide Priorities laid out in the 2010 Guidelines. DWR's scoring criteria to rank Implementation grant proposals assigns points for meeting these Preferences and Priorities (Implementation Grant PSP, 2010, p. 28-29). In Attachment 11 of the proposal, the IRWM region must provide a description of how each project meets the Preferences and Priorities. Most projects fall into multiple categories, especially since the intent of the IRWM program is to promote integrated projects addressing multiple benefits.

Table 5 indicates the number of projects in each funded proposal, and how many are described by IRWM regions as meeting the Climate Change and other Statewide Priorities or Preferences. Out of a total of 192 projects, 140 are described as addressing the Climate Change Priority, making it the most frequently cited priority. The table also shows that overall, implementation projects are much more focused on managing water supply and quality issues than on flood management. This limited emphasis on flood management may reflect the availability of other funding sources to address flooding, such as Proposition 1E, or challenges involved in quantifying benefits for flood management projects. Two columns in Table 5 relate to projects addressing the needs of disadvantaged communities (DACs).[7] Each proposal indicates whether a project meets the IRWM Program Preference for addressing water supply and quality issues for (DACs); about half of all projects were included in this category. If approved by DWR, the 25% matching funds requirement is waived for these projects. In Round 1, DWR approved about half of the DAC projects put forth as such by IRWM regions.

It should be noted here that Program Preferences and Statewide Priorities are not the only way DWR's IRWM Program might track the key purposes of projects. The online component of the implementation grant application includes a section entitled, "Project Benefits Information." Here, applicants list anticipated Primary, Secondary and lower-degree benefits of each project. One benefit category included in the drop-down menu is "Climate Change Impacts." A word search was conducted of the PDF files of the online portion of each proposal, and this search found only 17 projects listing "Climate Change Impacts" as a

[7] A "disadvantaged community" is a community with a median household income of less than 80% of the statewide average.

Table 5. Round 1 Prop 84 Implementation Grants: Funded Projects by Statewide Priority and DAC Preference

IRWM Region	Total Funded Projects (1)	Statewide Priorities (2)								DAC Preference (3)		Total Award, $
		CC Response Actions	Drought	Water Quality	Water Use/Reuse Efficiency	Env. Stewardship	Integrated Flood Mgmt	Equitable Distrib. of Benefits	Tribal Resources	DAC Water Project	DWR Approved DAC Project	
North Coast	19	15	6	11	7	19	8	14	10	7	5	8,221,061
American River Basin	15	13	11	4	6	14	5	2	0	2	0	16,030,766
Cosumnes American Bear Yuba	16	16	16	1	16	16	0	16	0	13	13	3,197,503
San Francisco Bay Area	5	5	3	5	3	5	3	3	0	2	1	30,093,592
East Contra Costa County	2	2	1	1	1	1	0	1	0	0	0	1,775,000
Madera	4	2	4	4	2	3	4	0	0	0	0	9,413,947
Mokelumne/Amador/Calaveras	4	4	4	0	3	0	0	4	0	2	2	2,298,000
Antelope Valley	1	1	1	1	1	1	0	1	0	0	0	5,400,000
Inyo-Mono	15	12	10	13	12	5	1	15	1	4	2	1,075,000
Tahoe-Sierra	10	3	5	10	8	9	7	6	0	6	0	1,437,000
Greater Monterey County	7	2	3	6	4	4	2	5	0	2	2	4,139,000
Santa Barbara County	7	7	6	4	5	3	1	6	0	5	3	3,000,996
San Luis Obispo	3	2	2	1	1	2	1	3	0	2	0	10,401,000
Kaweah River Basin	5	3	3	1	3	3	3	2	0	1	1	4,643,000
Poso Creek	8	5	7	6	6	3	1	7	0	4	3	8,215,000
Upper Kings Basin	6	5	5	6	4	1	0	3	0	3	2	8,496,000
Greater Los Angeles County	13	0	11	10	9	1	5	5	0	2	0	25,600,000
Upper Santa Clara River	5	3	3	5	4	2	2	5	5	5	0	6,931,000
Watersheds Coalition of Ventura County	8	8	6	8	6	8	2	1	0	1	1	17,510,599
Santa Ana Watershed Project Authority	13	13	13	12	6	6	4	10	0	5	1	12,660,004
San Diego	11	8	5	10	6	2	4	4	1	3	1	7,900,000
South Orange County	3	3	3	3	3	3	3	3	3	3	1	2,316,780
Upper Santa Margarita Watershed	5	4	4	4	3	2	0	1	1	5	1	2,167,000
Coachella Valley	4	2	1	3	3	2	0	2	2	4	1	4,000,000
Mojave	3	2	3	2	2	3	3	4	0	3	1	8,000,000
TOTALS	**192**	**140**	**136**	**131**	**124**	**118**	**59**	**123**	**23**	**84**	**41**	**204,922,248**

1. The number of funded projects is based on List of Awarded Projects posted on the IRWM website. However, the Bay Area's projects are counted differently here. The Bay Area's proposal includes multiple projects under five programs. Although the projects are listed separately on the Awarded Projects list, in this table the programs are counted as 5 projects, because this is how Attachment 11 described Preferences/Priorities.
2. These numbers were gathered from Attachment 11 in each Implementation proposal. All proposals indicated specifically which projects met which priorities, except for CABY. The description in this proposal was more general, but was interpreted to mean that all projects were related to climate change. Some proposals specified whether priorities are met directly or indirectly. Both are included here. It should be noted that these numbers represent each region's interpretation of how projects meet certain Statewide Priorities, and these interpretations may differ across regions.
3. The first column shows the projects listed in Attachment 11 as addressing the Program Preference for projects addressing water supply and quality issues in Disadvantaged Communities (DAC). The second column lists those approved by DWR for a matching funds waiver. In the case of the Bay Area, it is 1 rather than 2 projects because here, the Bay Area's programs were considered as projects.

Primary, Secondary, or lower-degree benefit. This is significantly lower than the figure of 140 projects listed under the Climate Change Priority. The difference may be indicative of the challenges involved in developing systems for gathering reliable information about project purposes and benefits that are not burdensome to IRWM regions. It may also reflect the difficulty of defining adaptation measures that address climate change impacts.

7.2. Climate Change Response Actions

Table 6 provides the definition of the Climate Change Response Actions Statewide Priority. Preferred types of water management actions are organized under three areas: 1) Climate change adaptation, 2) Reduction of GHG emissions, and 3) Reduction of energy consumption. Many of the Adaptation actions are similar to those included under other Statewide Priorities for Drought Preparedness, Use and Reuse Water More Efficiently, Environmental Stewardship, and Integrated Flood Management. The Reduction of GHG Emissions and Reduction of Energy Consumption categories are also related to other Priorities, since water efficiency, conjunctive water management, and water quality improvement projects can be associated with reduced energy use and/or reduced GHG emissions.

Table 6. Statewide Priority for Climate Change Actions, 2010 IRWM Guidelines, p. 13.

Component of Climate Change Priority	Project types mentioned in the Guidelines
Climate change adaptation	▪ Advance and expand conjunctive management of multiple water supply sources ▪ Use and reuse water more efficiently ▪ Water management system modifications that address anticipated climate change impacts, such as rising sea-level, and which may include modifications or relocations of intakes or outfalls ▪ Establish migration corridors, re-establish river-floodplain hydrologic continuity, re-introduce anadromous fish populations to upper watersheds, and enhance and protect upper watershed forests and meadow systems
Reduction of GHG emissions	▪ Reduce energy consumption of water systems and uses ▪ Use cleaner energy sources to move and treat water
Reduction of energy consumption	▪ Water use efficiency ▪ Water recycling ▪ Water system energy efficiency ▪ Reuse runoff

It is possible to learn about the nature of projects included under the Climate Change Priority by examining how many of them were also classified under other priorities. Table 7 shows the percentages of Climate Change Priority projects also addressing other Statewide Priorities, and compares this to the percentages for the overall set of funded projects. It shows that in the overall portfolio, projects addressing Drought Preparedness, Ground/Surface Water Quality, and Efficiency of Water Use/Reuse are the most frequent, and Integrated Flood Management projects are the least frequent. In large part, Climate Change projects reflect this overall pattern, except that drought preparedness and water use efficiency projects are more common among climate change projects than in the overall portfolio. It is possible that in assigning projects to Priorities, IRWM regions were more

likely to view drought preparedness and water use efficiency actions as addressing the potential vulnerabilities of climate change. However, another reason for this may be the fact that improving water efficiency and drought preparedness offer both adaptation and GHG reduction opportunities, making it even easier to justify their inclusion under the Climate Change Priority.

Table 7 also shows that there is no difference between the overall portfolio and the Climate Change Priority projects with respect to projects addressing DAC water quality and supply issues. Climate Change Projects were equally likely to be classified by IRWM regions as addressing the DAC Program Preference as compared to the overall set of projects, and were also equally likely to be considered by DWR as meeting the criteria for the matching funds waiver. As regions begin to identify and prioritize climate change vulnerabilities, it may be useful to track how these vulnerabilities are addressed through DAC projects. The types of climate change impacts may differ among DAC communities in different parts of California. For example, in rural areas of the state, climate change might exacerbate already existing problems with water supply and quality for DAC communities by increasing severity of droughts. These types of risks coincide with the requirement that DAC projects receiving a matching fund waiver must address critical water supply or quality needs. However, in urban areas, flooding in low-lying DAC areas may be a more important climate vulnerability, and this may be less easy to address directly under current DAC waiver requirements.

Table 7. Comparison of Climate Change Priority to all Round 1 Implementation Projects.

Statewide Priority or IRWM Program Preference†	Freq. among all funded projects (N=192)	Freq. among Climate Change Priority projects (N=140)
Drought Preparedness	71%	82%
Efficiency of Water Use/Reuse	65%	70%
Surface/Groundwater Quality	68%	64%
Environmental Stewardship	61%	64%
Integrated Flood Management	31%	28%
Equitable Distribution of Benefits	64%	68%
Tribal Water/Natural Resources	12%	10%
DAC Water Supply/Quality Pref.	44%	43%
DWR-approved DAC Project	21%	22%

† These percentages are based on the data for all projects in Table 5, and on data for Climate Change Priority projects in Appendix B.

Attachment 11 of the Implementation grant proposals also provides information about the ways in which Climate Change Priority projects address climate change adaptation or mitigation. Table 8 summarizes this for each IRWM region. The blue and green columns refer to water management actions indicated in the Guidelines as Climate Change Response Actions (as listed in Table 6), while the gray columns represent additional ways in which IRWM regions described projects as addressing climate change. Most proposals provided sufficient information about projects to classify them in this manner. Appendix C provides some examples of the descriptions of climate change project elements and how they were classified in order to create Table 8.

Table 8. Types of Climate Change Response Actions, by IRWM Region (1)

Adaptation to Climate Change	
Reduce GHGs Reduce Energy Consumption	
Other (not specified in Guidelines)	

Funding Area	IRWM Region (2)	Conjunctive management	Use/reuse water more efficiently	System modifications to address CC	Migration corridors, floodplain/watershed protection	Reduce energy consumption	Cleaner energy sources	Water use efficiency	Water recycling	Water system energy efficiency	Reuse runoff	Carbon sequestration	Tidal marsh restoration (SLR)	Reduce wildfire potential	Increase local water supply/reduce import dependence	Reduce water pollution as ecosystem stressor	Sewer system repair to reduce flood risk
North Coast	North Coast		•	•	•	•		•		•		•					
Sacramento River	American River Basin	•	•	•	•			•									
	Cosumnes American Bear Yuba		•												•		
San Francisco Bay	San Francisco Bay Area		•	•	•			•	•			•	•				
	East Contra Costa County							•	•								
San Joaquin	*Eastern San Joaquin - NOT FUNDED*	•															
	Madera									•				•			
	Mokelumne/Amador/Calaveras	•						•									
	Westside-San Joaquin - NOT FUNDED																
Lahontan	Antelope Valley	•	•			•		•							•		
	Inyo-Mono	•	•				•	•									
	Tahoe-Sierra				•			•				•					
Central Coast	Greater Monterey County						•	•	•			•	•				
	Monterey Peninsula - NOT FUNDED	•			•												•
	Santa Barbara County	•	•		•	•	•										
	San Luis Obispo	•	•														
Tulare Lake	Kaweah River Basin	•	•														
	Poso Creek	•															
	Upper Kings Basin	•				•		•									
Los Angeles-Ventura	Greater Los Angeles County																
	Upper Santa Clara River		•					•	•						•		
	Watersheds Coalition of Ventura County	•	•	•	•	•		•	•		•	•					
Santa Ana	Santa Ana Watershed Project Authority					•			•						•		
San Diego	San Diego	•	•			•	•					•			•	•	
	South Orange County		•			•		•	•		•						
	Upper Santa Margarita Watershed		•		•	•		•		•	•					•	
Colorado River	Coachella Valley		•			•											
	Mojave	•	•														

Information in this table is based primarily on Attachment 11 - Program Preferences, which describes how projects included in a proposal meet Statewide Priorities. The table only reflects activities that were specifically described as addressing the Statewide Priority for Climate Change Response Actions. See Appendix C for examples of how Attachment 11 descriptions were interpreted to place them in these categories.

1. The Climate Change Response Actions listed in blue and green are described in Table 1 - Statewide Priorities, p. 13, IRWM Guidelines, Aug. 2010. Actions listed in gray are additional ways the applicants related their activities to the Statewide Priority on climate change. A dot means that at least one project included in a proposal was described as contributing toward a particular adaptation or mitigation strategy.

2. Table includes only regions that submitted applications for Prop 84 Round 1 Implementation Grants. Proposals from American River Basin, CABY, E. Contra Costa County, Westside-San Joaquin, and Mojave cover two funding areas. They are listed here in the funding area from which the largest portion of funding was awarded.

The results indicate the following patterns:

- Climate change adaptation (blue columns): conjunctive water management and the efficiency of water use/reuse are most common, each occurring in over half the proposals. Fewer proposals include water system modifications to address climate change or floodplain protection.
- Reducing energy consumption/GHGs (green columns): improving water efficiency is again the most common, followed by reducing energy consumption, which overlaps somewhat with water efficiency but also includes projects that reduce energy consumption through more energy-efficient groundwater pumping, for example. A smaller number of proposals use cleaner energy sources, improve water system energy efficiency, or re-use runoff.
- Other measures (gray columns): carbon sequestration is the most common additional way in which RWMGs describe projects as addressing climate change. The North Coast IRWM region particularly emphasizes carbon sequestration, and supports the formal inclusion of this approach in the Climate Change Statewide Priority (North Coast interview, Jan. 18, 2012). Improving the reliability of local water supply is mentioned in five proposals. Although this overlaps with some of the adaptation measures above, it is included here because this is one common articulation of an adaptation strategy in water management, appearing, for example, in Coachella Valley's IRWM plan. Tidal marsh restoration, reducing wildfires, reducing water pollution, and sewer repair to reduce flood risk were also mentioned as climate change response actions.

Thus, the majority of projects under the Climate Change Priority involve efforts to improve the efficiency of water supply and use, which is viewed as both an adaptation and mitigation strategy. This supports the finding in Table 7 that drought preparedness and water use efficiency projects are more frequent among Climate Change projects than among all projects. Flood management projects, on the other hand, do not receive the same emphasis. Like the overall portfolio of Implementation projects, less than one-third of Climate Change Priority projects address integrated flood management.

7.3. Consideration of Climate Change in Project Selection

The analysis above suggests that Climate Change Priority projects are largely "low-regrets," addressing climate change while meeting other water management priorities. Given that climate change projects are similar to the overall portfolio of projects, and that most RWMGs are still in the initial stages of developing their climate change analyses, it would not be expected that climate change actually figured in how these projects were prioritized.

A brief examination of Implementation grant workplans largely confirms this. In most proposals, the workplan, which contains extensive details regarding each project's purpose and implementation, does not mention climate change. However, there are a few exceptions. Six IRWM regions –North Coast, Bay Area, CABY, Inyo-Mono, Greater Monterey County, and SAWPA – do mention climate change in their workplans, either in the context of defining the need for the projects or in the overall proposal goals. For example, in the Bay Area's proposal, implementing climate change adaptation strategies is a core objective. Climate

change is integrated throughout the proposal's five proposed programs, which address water recycling, conservation, green infrastructure, ecosystem restoration, and flood management. CABY's proposal contains 16 projects that undertake "infrastructure improvements and long-range conservation planning as a strategy for responding to future climate change, water shortages and/or drought conditions" (Workplan, p. 3). The North Coast's proposal seeks to advance the IRWM region's overall goals, which include "energy independence and climate change mitigation and adaptation," and describes how this is integrated into certain projects (Workplan, p. 3). Similarly, the Inyo-Mono, Greater Monterey County, and SAWPA proposals mention climate change because it is part of the overall IRWM region's objectives. In these regions, climate change appears to have figured in the rationale for projects, although of course these projects might have been undertaken anyway based on other regional priorities. These six regions account for nearly half of all Climate Change Priority projects (63 out of 140 projects).

Two proposals mention using the climate change studies supported by Planning grants in shaping the selection or design of Implementation projects. CABY's proposal indicates that climate change projections for the region will be integrated into the long-range planning for drought preparedness that is the focus of their Implementation grant proposal (Attachment 11, p. 7-8; see Table 10). Upper Santa Clara River's proposal mentions that the study of climate change vulnerability being undertaken through the Planning grant will inform future integrated flood management efforts: "The projects in this proposal are near-term approaches to addressing integrated flood management. However, the commitment to integrated flood management is also long-term. The IRWMP is undertaking a Climate Change Study that will greatly inform the description of future flood vulnerabilities and identify adaptation strategies. The Climate Change Study will provide a means to consider uncertainty and risk not only for water management but specifically for flood management" (Attachment 11, p. 9).

7.4. Summary and Discussion

Among funded Round 1 Implementation grant projects, 140 out of 192 (73%) are included under the Statewide Priority for Climate Change Response Actions, making it the most frequently cited Statewide Priority. Drought Preparedness, Improving Efficiency of Water Use/Reuse, and Water Quality are almost as common, but only one third of projects address Integrated Flood Management. The Project Benefits Information section of the online Implementation grant application provides a different picture, with only 17 projects classified as addressed "Climate Change Impacts." Statewide Priorities are used in this report to understand the key purposes of Implementation projects, since this information is likely to be more complete. The difference between these two numbers may reflect both the challenges involved in defining responses to climate change, as well as in developing systems to manage project information in the IRWM program.

The Climate Change Statewide Priority includes both adaptation and mitigation-related measures, which overlap with other Statewide Priorities. Climate change projects are for the most part similar to the overall portfolio of 192 projects, except that drought preparedness and water efficiency efforts are more frequent among Climate Change Priority projects. On the other hand, flood management projects, which constitute only 31% of the overall

portfolio, do not receive additional emphasis in Climate Change Priority projects. A review of the specific types of climate change adaptation and mitigation efforts undertaken in Climate Change Priority reveals that efforts to improve the efficiency of water supply and use are most frequent, addressing both adaptation and GHG emissions reductions. Finally, a review of proposal workplan content related to climate change indicates that six IRWM regions have included climate change in the rationale for projects.

The patterns found in this review reflect the challenges involved in describing and evaluating responses to climate change, particularly with respect to adaptation. Many kinds of activities can be viewed as addressing potential impacts of climate change, but these efforts are often primarily undertaken for other reasons. Such "low-regrets" strategies seem appropriate under the current Guidelines, and given that efforts to analyze region-specific vulnerabilities are still preliminary. However, these adaptation efforts can be difficult to distinguish from other water management interventions, making it challenging to evaluate progress on adaptation.

However, as regions begin to identify more specific regional vulnerabilities, it may be possible for climate change projects to become more targeted toward these vulnerabilities. Such projects can still be "low-regrets" in that they also contribute other regional water management objectives, but they would also relate to specific vulnerabilities prioritized by an IRWM region. For example, a region might identify a specific area vulnerable to increased flooding due to sea level rise, and propose flood management projects in that location. In the future, it may be useful to define the Climate Change Priority to focus only on those projects that respond to vulnerabilities identified at the regional level. This would likely lead to a smaller set of Climate Change Priority projects, but it would allow some way to track how IRWM regions are identifying and responding to specific regional vulnerabilities. This could help facilitate an adaptive management approach, both at regional and state levels. Since the Climate Change Priority would no longer include projects reducing GHGs, a separate priority could be established for projects and programs to reduce emissions. This would also help facilitate the tracking of climate change mitigation efforts.

8. Considerations for analyzing and adapting to climate change risks in IRWM regions

Addressing climate change risks ultimately means managing water resources in a way that anticipates change (DWR, 2009, 2008). We can develop estimates of climate change risks, but must remain aware that their patterns and magnitudes will change over time, and that new kinds of risks may emerge. In order to manage in the face of such uncertainty, an on-going process is needed to integrate analysis of climate risks into decisions, and to update choices as knowledge improves (NRC, 2010a, p. 105). The 2010 Guidelines capture this in their emphasis on the need for an adaptive management approach with respect to climate change.

The IRWM Program presents both opportunities and challenges in doing this. The regional structure enables approaches that fit local needs, and provides ways for diverse stakeholders to engage in the process. However, analyzing climate risks is a broadly defined and sometimes complex task, and capacity and resources at the regional level may be limited. In addition, some vulnerabilities may be best understood at a scale larger than a particular IRWM region, for example in areas that depend upon the Colorado River for their water supply. These analyses must be linked with decisions regarding project priorities and design, within a process of monitoring and updating to enable learning. Finally, processes need to be in place for evaluating adaptation strategies. In addition to assessing progress at the regional level, an understanding of the nature of vulnerabilities and adaptation responses may also be needed at the state level. Such knowledge may be important for the California Water Plan Update process, given its emphasis upon IRWM as a key avenue for addressing climate change.

This section examines how current plans for identifying key vulnerabilities, modeling climate change impacts, and defining adaptation strategies in IRWM regions may contribute within an adaptive management framework.[8] It places these current efforts in the context of relevant risk assessment and adaptation planning literature in order to identify issues that may need further consideration in light of the overall goal of managing climate uncertainties in a way that promotes learning over time.

8.1. Regional approaches to evaluating climate risks

8.1.1. Identifying key vulnerabilities. Climate change may affect many aspects of water management, and a critical first step is identifying the set of key vulnerabilities for further analysis and action. The first two elements of the draft language for the revised climate change standard reflect this: a vulnerability assessment, and a process of prioritizing which are most critical for the region (see Section 4). In general, the process of identifying vulnerabilities involves examining regional characteristics in the context of general knowledge about impacts of climate change. This is the approach taken by the vulnerability assessment tool in the Climate Change Handbook (Section 4 and Appendix B), which includes a 40-question checklist highlighting regional characteristics that suggest potential vulnerabilities related to water supply, quality, flooding, and habitat. This is similar to the "vulnerability-based" approach discussed in adaptation literature (Mastrandrea et al., 2010, Moser et al., 2009), which begins with information about regional characteristics, rather than relying primarily on information about projected changes in climate features based on climate models (although these are also incorporated, usually through a review of existing studies).

Based on Round 1 planning grant proposals and DWR interview results, the climate change analyses of many IRWM regions incorporate some means of identifying and

[8] The term "adaptive management" is used here in a broad sense, similar to the usage in *America's Climate Choices* (NRC, 2010b) as referring to "an iterative process in which decisions are based on evolving understanding of the underlying natural and social science and the observed success (or failure) of programs and policies that have been implemented," (p. 125).

prioritizing vulnerabilities. The following three strategies appear to be represented, with some regions pursuing more than one.

a. Identify risks to main water management priorities. IRWM regions develop goals that take into account regional circumstances as well as statewide water management priorities expressed in the California Water Plan Update and requirements in IRWM Guidelines. Clearly, regions need to examine factors presenting risks to achieving these goals, including climate change. Maintaining reliable water supply is of primary importance at state and regional levels, and there is also substantial evidence that climate change poses risks in this regard (DWR, 2009). Investigating this is justifiably a critical concern for all IRWM regions, and a number of proposals, particularly the American River Basin, Mokelumne/Amador/Calaveras (MAC), Antelope Valley, Upper Kings, Anza Borrego (not funded), Coachella Valley and Imperial Valley, indicate that their vulnerability assessments will be primarily focused on anticipating impacts to water supply.

b. Assess a range of vulnerabilities through a literature review and vulnerability assessment tools. Some IRWM regions propose to begin with a broad review of possible areas of vulnerability to climate change impacts. Four regions – Upper Santa Clara River, Gateway, Eastern San Joaquin, and Yuba (not funded) – indicated plans to start with the vulnerability matrix developed by DWR climate change specialists based on the 2009 California Climate Adaptation Strategy. This matrix links specific climate change drivers – temperature increase, changes in snowmelt, more prolonged drought periods, and more – with a range of possible impacts across sectors such as water management, agriculture, ecosystems, public health, and others. Others, such as the Bay Area, Greater Monterey, Pajaro River Watershed, and Monterey Peninsula, proposed to review a range of existing studies and then prioritize critical vulnerabilities. This approach is similar to that proposed in the draft climate change standard in that it requires a review of risks to all aspects of water resources in a region. The vulnerability checklist in the Handbook, referenced in the draft standard, adds the consideration of specific regional features in deciding whether certain types of impacts are likely.

c. Engage stakeholders. As discussed in Section 6, most IRWM regions are involving stakeholders and/or the general public in the process of identifying vulnerabilities, such as through a Technical Advisory Group, a workgroup composed of RWMG members, or a workshop. A few specifically identify a role for stakeholders in shaping how climate change is studied. For example, the Upper Pit Watershed has established a Technical Advisory Committee that will include representatives from public agencies with technical expertise in this area, whose knowledge will be important for interpreting how statewide climate change studies apply to the region. In addition, the TAC will include stakeholder groups such as agricultural representatives, whose interests may be affected but who may not be comfortable with the issue (Upper Pit River Watershed interview, October 3, 2011).

All of the above are important elements of a vulnerability assessment. Understanding how climate change will affect regional or state water management objectives is obviously critical, and may be the primary focus. However, an assessment of a broad range of possible impacts is also important, in that it can help regions identify less obvious risks that could affect water management objectives. This is particularly relevant given the integrated nature of IRWM plans. With respect to adaptive management, repeating the assessment periodically may help regions track emerging risks that may become important in the future. This is a relatively common risk management practice, and many studies of adaptation planning processes emphasize this (NRC, 2010a, p. 106). For example, New York City's adaptation planning process involves periodic reviews of potential risks to critical infrastructure using checklists (NPCC, 2010). The vulnerability assessment checklist in the Climate Change Handbook may serve this purpose, accompanied by a review of literature discussing the latest climate projections for the region.

Risk management and adaptation literature also emphasizes the importance of stakeholder involvement. A 1996 National Research Council study describes risk characterization as an "analytic-deliberative process" that should include broad stakeholder representation (NRC, 1996, p. 6). Involving stakeholders early in the process of adaptation planning can not only help prioritize areas for investigation, but also may improve the acceptability of the results of the analysis (NRC, 2010b, p. 125, CAWWG, 2010). The IRWM process already emphasizes stakeholder engagement, and as noted above, the majority of regions are already incorporating stakeholder engagement into the climate change analysis.

8.1.2. Analysis of climate change impacts. Once critical vulnerabilities are identified, further study may be needed to gain a more specific understanding of possible impacts, such as the magnitude, timing, location, and thresholds of tolerance. Such analyses, discussed in Section 5 of the Climate Change Handbook, may be quantitative or qualitative depending upon the purpose and data available. Developing a plan for further analysis is the third step in the draft of the revised climate change standard.

At least 14 regions plan to undertake some kind of analysis using downscaled climate projections. These are summarized in Table 9, based on planning grant proposals and information from DWR interviews with regional representatives. As the table indicates, the majority of quantitative analyses focus on understanding impacts to water supply and demand, using downscaled climate model outputs in conjunction with a hydrologic model. A few regions mention analysis of impacts on habitat or sea level rise, but with less specificity about the methods to be used.

Among the 14 regions, three main sources of downscaled climate model outputs are being used. American River Basin, CABY, Upper Pit River Watershed, Inyo-Mono, and Upper Santa Clara River plan to use scenarios selected by the Climate Action Team (CAT) or the State Water Project Reliability Report 2009, which also relies the CAT scenarios (Khan and Schwarz, 2010, DWR, 2010b).

Table 9. Overview of quantitative approaches to assessing climate impacts proposed by IRWM regions under Round 1 Planning Grants.

IRWM Region	Overview of approach	Climate models	Hydrologic or other resource models	Collaborators
American River Basin	Assess future reliability of surface and groundwater for the American River Basin by comparing two future water supply/demand scenarios that include climate change with a baseline scenario that assumes no climate change.	MPI-ECHAM5 under A2 emissions scenario (one of the six CAT models used in 2029 CALSIM State Water Project delivery estimate) (2)	Sacramento Integrated Water Resources Model (SacIWRM), with CALSIM 2029 delivery estimates	Not specified
CABY (1)	Assess how climate change will affect temperature, precipitation, base flow, and runoff, and examine likely changes in vegetation under multiple scenarios. Scenarios to be selected in discussion with stakeholders to represent "best," "worst", "middle range" and "no change". 20-year planning horizon of greatest interest but longer-range, as well as modeling over past years for comparison, may be undertaken. In addition, CABY plans to use the WEAP model to assess impacts to water supply and hydroelectric power.	Six models selected by the Climate Action Team, under two scenarios (3)	Variable Infiltration Capacity (VIC) model, Water Evaluation and Planning System (WEAP)	UC San Diego
Upper Pit River Watershed (1)	Proposal describes a similar process to CABY's (see above) but also includes the use of GIS-based vegetation maps in an iterative process with stakeholders to develop agreement about future scenarios. However, a Technical Advisory Committee will guide decisions about this approach based on an initial review of studies combined with technical expertise from TAC members.	Six models selected by the Climate Action Team, under two scenarios (3)	Variable Infiltration Capacity (VIC) model, GIS vegetation maps (depends upon Technical Advisory Committee decision to use them)	UC San Diego
San Francisco Bay Area (1)	The study will include use of specific climate change projections, following guidance in the Handbook. The proposal discusses plans to use mapping tools available to locate areas of vulnerability to impacts such as flooding related to sea level rise, and identify specific communities and infrastructure at risk.	Climate model outputs available in mapping tools such as Cal-Adapt (4)	Not specified	Not specified
Eastern San Joaquin	Assess robustness of water supply and flood management systems by integrating climate change scenarios into water management alternatives. The process will include stakeholder and public input.	Unspecified, but 3 scenarios will be considered	MOCASIM	Not specified
Inyo-Mono (1)	Following guidance in the Climate Change Handbook, conducting a vulnerability assessment and using downscaled climate model outputs to understand impacts on water infrastructure, water quality, and watershed health.	Six models selected by the Climate Action Team, under two scenarios (3). Also downloading CMIP3 archive for the watershed (5)	Not specified. Exploring potential use of WEAP.	Not specified
Pajaro River Watershed	Use mapping tools available from federal and state agencies to locate areas of vulnerability to impacts such as flooding related to sea level rise, and identify specific communities and infrastructure at risk	Climate model outputs available in mapping tools such as Cal-Adapt (4)	Not specified	Not specified
Santa Cruz	Assess impacts on local water supply and aquatic habitat using downscaled climate model outputs, and assess the effects of sea level rise	Unspecified (modeling conducted by USGS)	USGS Basin Characterization Model	US Geological Survey
Southern Sierra (NOT FUNDED)	Building upon analysis conducted by NCCSP for the Sierras, develop projections specific to the region to assess likely changes in variables such as precipitation, snowpack, evapotranspiration, runoff, recharge, and soil water storage.	GFDL and PCM, A2 emissions scenarios, downscaled to 270m, through 2100	USGS Basin Characterization Model	National Center for Conservation Science and Policy
Gateway (1)	Assess local impacts of temperature and rainfall change using downscaled climate data, along with results from DWR reports assessing groundwater recharge rates. SLR Interim Guidance will be used for SLR impacts.	CMIP3 archive (DOI/LLNL BCSD dataset)	Not specified	Not specified
Upper Santa Clara River (1)	Using projected changes in temperature and precipitation from multiple downscaled climate change models, develop an array of scenarios for the region to understand impacts on regional water resources.	Will rely primarily on scenarios in DWR reliability reports for State Water Project, which use Climate Action Team scenarios (2)	Not specified; multiple analyses related to water supply/demand, ecological impacts, groundwater, and sea level rise	Not specified
Santa Ana Watershed Project Authority (1)	Evaluate a range of basin-wide climate change impacts on surface and groundwater systems and imported water, as well as sea level rise	Drawing upon USBR's West-Wide Climate Risk Assessment, which uses the CMIP3 archive (DOI/LLNL BCSD dataset) (5)	Variable Infiltration Capacity (VIC) model, 12km spatial resolution	US Bureau of Reclamation
San Diego (1)	In conjunction with results from other studies, use Cal-Adapt to assess climate impacts	Cal-Adapt (4)	Not specified	San Diego Foundation
Imperial Valley (1)	The primary focus will be on climate change impacts to water supply and demand from the Colorado River, the primary water source for the region.	Drawing upon USBR's Colorado River Basin Water Supply and Demand Study, which uses CMIP3 archive (DOI/LLNL BCSD dataset (5)	Variable Infiltration Capacity (VIC) model, 12km spatial resolution	US Bureau of Reclamation

1. The description of the approaches for these regions includes information from a DWR interview with a regional representative, as well as the Planning grant Workplan.
2. See State Water Project Delivery Reliability Report 2009, DWR, 2010b.
3. In 2009, the Climate Action Team (CAT) used downscaled results from the following six models: GFDL-CM2.1, NCAR-PCM1, CNRM-CM3, MPI-ECHAM5, MIROC3.2, and NCAR-CCSM3. These were run under A2 and B1 scenarios, resulting in 12 projections. See Khan and Schwarz, 2010 for a discussion.
4. CalAdapt projections include four models: NCAR-PCM1, NCAR-CCSM3, GFDL-CM2.1, and CNRM-CM3, under A2 and B1 scenarios. See: http://cal-adapt.org/data/sources/
5. The CMIP-3 archive includes 112 projections based on 16 GCMs under A1B, A2, and B1 scenarios, using bias-corrected spatial downscaling (BCSD). See Climate Change Handbook, 2011, p. 2-5.

Three regions – Gateway, Imperial Valley, and SAWPA – are using the Department of Interior/Lawrence Livermore National Laboratory (DOI/LLNL) downscaled dataset of 112 projections from the CMIP-3 archive (as discussed in the Climate Change Handbook, p. 2-5). SAWPA and Imperial Valley are collaborating with the US Bureau of Reclamation, which is using these model outputs in its West-Wide Climate Risk Assessments and studies of Colorado River water supply and demand (USBR, 2011). Finally, three regions – Bay Area, Pajaro River Watershed, and San Diego – mention Cal-Adapt, an online tool that uses downscaled data from four of the six climate models used by the Climate Action Team, assembled by the Scripps Institution of Oceanography. The regions using CAT or DOI/LLNL scenarios plan to link climate model outputs with various hydrologic models, including: Variable Infiltration Capacity (VIC), USGS Basin Characterization Model, and the Water Evaluation and Planning System (WEAP), and MOCASIM, a stochastic analysis tool.

Many regions planning to use downscaled climate data appear to be doing so in partnership with research agencies such as the US Geological Survey, US Bureau of Reclamation, and UC San Diego. Specific statements in grant proposals suggest that regions want to ensure that their choice of models will be considered valid. For example, the Upper Pit River Watershed proposal mentions that the six climate models being used to develop future scenarios are "state-approved" (Workplan, p. 39). The Eastern San Joaquin proposal states that climate change scenarios will be selected based on the "guidance document" being prepared by DWR for such these analyses, likely referring to the Climate Change Handbook (Workplan, p. 32).

While some regions have good access to technical expertise through the staff of participating agencies, partnerships, or consultants, some concern was expressed in DWR interviews with IRWM regions about the technical capacity and resources required to carry out such modeling studies. For regions that do not have such expertise, conducting these studies would require hiring consultants, which adds expense (CABY interview, October 19, 2011). As discussed in Section 6, certain regions appear to be concerned about the prospect of an increasing emphasis on quantitative analysis in future requirements, as expressed in the Guidelines themselves and given the emphasis on such approaches in the circulated draft of the Climate Change Handbook.

In assessing these concerns, it is worth reflecting on the purposes for quantitative analysis of climate impacts in the context of IRWM plans. Risk assessment and adaptation literature emphasizes the importance of designing a risk analysis with a clear understanding of the decisions it is intended to inform (NRC, 1996, p. 16, CAWWG, 2010). Recent work in the context of water management suggests involving stakeholders in identifying specific thresholds of tolerance for risk, and to use models to assess the likelihood of exceeding them (Brown et al., 2011). Broadly, IRWM regions need knowledge of climate change risks to inform their overall water management objectives, and to make decisions about prioritizing and designing projects to reduce vulnerabilities. Since quantitative analyses involving climate models require resources, time, and expertise, it is important to consider how they

will inform their decisions about project prioritization or design to address a certain risk.

There are certainly circumstances in which quantitative analysis is valuable, particularly when long-term infrastructure investments are being considered, and when capacity exists to implement the analysis and evaluate results in a way that takes remaining uncertainties into account. However, some adaptation planning literature suggests that precise impact estimates may not always be needed to justify undertaking certain adaptation strategies (NRC, 2010b, p. 153, CAWWG, 2010, Dessai et al., 2009). This may be the case for many kinds of "low-regrets" strategies, which can be largely justified based on other benefits. In addition, there may be instances in which using climate model projections to estimate climate impacts may be more appropriately carried out at a larger scale than a given IRWM region. In this case, it would make more sense for an IRWM region to rely upon an existing study, or if one is not available, for DWR, or multiple IRWM regions, to conduct a larger-scale analysis. Estimating climate change risks to imported water supplies may fall into this category. Sea level rise might also be considered an example of this, in that the Climate Action Team and other agencies have collaborated to develop guidance with estimates for use in local planning (SLR Task Force, 2010).

IRWM regions may need technical support in developing their plans for further analysis of prioritized vulnerabilities, through quantitative or other means. For those regions with sufficient expertise and resources, the Handbook is likely to be quite useful for identifying the kinds of analyses are appropriate for their particular circumstances and understanding the steps involved. The Bay Area IRWM region is using the Handbook in exactly this manner, by requiring the consultant preparing the IRWM plan update to use the Handbook as a guide for conducting the analysis (Bay Area interview, October 19, 2011). For groups with more limited resources and technical expertise, the Handbook may seem overwhelming. Specific assistance from DWR's regional climate change specialists may be particularly needed in these cases to help them identify the appropriate resources. Finally, particular support may be needed in analyzing flooding or ecosystem impacts, for which quantitative methods of analysis may be less well established, or less accessible. For example, most of the case studies in the Climate Change Handbook focus on quantifying impacts to water supply and demand.

Consideration may also need to be given to whether DWR should recommend a particular set of downscaled climate models for use at the regional level. Currently, regions are relying on at least three different sets of scenarios for their analyses, as described above. Certain scenarios may be more appropriate for some uses than others, and variation across regions is not necessarily undesirable, particularly if there are opportunities for learning. However, consistency across regions and the ability to provide adequate technical support may also be a consideration. Cal-Adapt, which provides a visual interface and access to downscaled data from four climate change models under two different emissions scenarios, may provide an alternative that regions with both low and high levels of capacity could use effectively. DWR's

new Climate Change Technical Advisory Group (CCTAG) may be an appropriate venue for considering whether guidance on the choice of climate models is useful in the context of the IRWM program.

8.2. Identifying adaptation strategies

The assessments and analyses described above are intended to inform selection of adaptation strategies to reduce regional vulnerabilities. However, it is useful to recognize that in addition to such studies, IRWM regions must also consider other factors to identify feasible and appropriate strategies. Literature on approaches to adaptation planning typically point to a range of factors, including: co-benefits in terms of the region's water management objectives, costs of undertaking the strategies, and potential adverse impacts to particular groups (NRC, 2010b, p. 138). Planning grant proposals indicate that regions are considering such factors, with reference to relative costs and benefits (Santa Cruz), possible partnerships (Bay Area, Greater Monterey), and considering views of stakeholders (Upper Pit Watershed). The North Coast's proposal indicates specific priorities aligned with their objectives, seeking "climate adaptation strategies that integrate ecosystem resiliency with human community resiliency & DACs" (Workplan, p. 30). The preference for "low-regrets" strategies, emphasized in the Guidelines and in many proposals, addresses the costs and benefits issue by focusing on steps that can be justified for other purposes while also supporting adaptation.

A criterion often emphasized in studies of adaptation for water management and other sectors is that strategies be "robust" in that they perform well under a range of possible future conditions (Brekke et al., 2009). Given the still considerable uncertainties associated with understanding climate impacts at regional and local levels, this criterion may be particularly important for IRWM regions (Dessai et al., 2009). Research on robust adaptation strategies often relies heavily on statistical analysis of model outputs (Lempert and Collins, 2007, Groves et al., 2008b). The climate change study referenced in SAWPA's 2010 IRWM Plan sought to assess the robustness of water allocation strategies (Groves et al., 2008a). These sorts of analyses may not be appropriate for all IRWM regions, but the larger aim of seeking robust strategies is. Perhaps an effective vulnerability assessment covering a range of possible impacts, combined with targeted quantitative analysis of critical risks, can at least help ensure that regions are considering a wide range of possible future conditions in identifying adaptation strategies.

Finally, IRWM regions, as well as DWR and other state agencies, need ways to evaluate adaptation efforts, and monitor progress toward addressing vulnerabilities within an adaptive management framework. This is a considerable challenge for resource managers around the world, and at this stage there are few clear answers (Preston et al., 2009). The Guidelines call for IRWM regions to establish "performance measures" for adaptation in future grant solicitations (Guidelines, Table 7, p. 74), and Section 6 of the Climate Change Handbook lays out an approach to developing performance metrics and approaches to evaluating how project portfolios are contributing to adaptation. However, a process will need to be in place at the regional level to identify such metrics, assess progress toward addressing key vulnerabilities, and update knowledge about those vulnerabilities over time.

Accomplishing this will likely require a working group or other coordinating mechanism within a region to undertake these activities and ensure learning over time.

Evaluation of progress on adaptation is also important at the state level. This requires a means of identifying those projects in IRWM regions that address regional vulnerabilities. One way to do this is to narrow the Climate Change Statewide Priority to include only those projects that address regional vulnerabilities that have been prioritized by IRWM regions, as laid out in the draft language for a revised climate change standard. This would provide a starting point for the analysis of the statewide portfolio of climate change adaptation projects, and could help encourage IRWM regions to link project priorities with vulnerability assessments.

8.3. Summary

Managing regional water resources for an uncertain climate requires an adaptive management approach that integrates the study of climate change risks with decisions regarding project priorities and design, and builds in opportunities for learning over time. As required in the December 2011 draft language for a revised climate change standard, a critical first step is identifying and prioritizing key vulnerabilities. IRWM regions appear to be using one or more of three strategies for this: considering how climate change may affect central water management objectives, conducting a broad review of potential vulnerabilities to regional water resources, and engaging stakeholders. All of these elements are valuable, but in particular, conducting a periodic, broad vulnerability assessment may play an important role in an adaptive management approach since it can promote awareness over time of emerging risks. This approach matches recommendations in adaptation and risk assessment literature regarding the need for an iterative process that incorporates stakeholder participation.

At least 14 IRWM regions are making use of downscaled climate model outputs in their analyses of climate impacts. These analyses are primarily focused on impacts to water supply and demand, and use model outputs from one of three sources: the Climate Action Team's scenarios, the DOI/LLNL dataset, and Cal-Adapt. Some regions have developed partnerships with government agencies and universities to conduct these analyses. Some have expressed concern about future requirements for quantitative analysis, which can involve significant time, resources and expertise. Adaptation and risk management literature suggests that to ensure that such studies are valuable, it is important to clearly identify the set of decisions they are intended to inform. While quantitative analysis at the regional level is useful in many cases, existing studies conducted at a larger scale may be sufficient for some decisions. Some IRWM regions will likely need technical support for identifying what approaches are appropriate, which the Climate Change Handbook can help to provide. Certain risks, such as flooding and ecosystem impacts, may need particular attention since quantitative methods may be less well established, or less accessible. Consideration may be needed as to whether DWR should provide specific guidance regarding the use of particular climate models and scenarios in assessing future impacts.

The selection of adaptation strategies requires not only an understanding of vulnerabilities and estimates of potential impacts, but also consideration of costs, benefits, partnerships,

and other factors. IRWM regions appear to be taking some of these issues into account already. The criterion of "robustness" for adaptation strategies may be useful to consider. This means that to inform planning, studies of climate change risks should seek to identify the range of possible future conditions that regions may face. Finally, on-going evaluation of adaptation strategies at regional and state levels will require clear identification of projects that are intended to help reduce regional vulnerabilities, and metrics for assessing progress. This could be facilitated by developing working groups or other coordinating mechanisms at the regional level, and by defining the Climate Change Statewide Priority to include those projects that address the vulnerabilities prioritized by each IRWM region.

9. Key Findings and Recommendations

This report draws upon current IRWM plans, Round 1 Planning and Implementation grant proposals, and set of interviews conducted by DWR to understand how IRWM regions are responding to new requirements to address climate change. It identifies general patterns in how regions are meeting specific elements of the Climate Change Standard in the 2010 Guidelines, and discusses implications with respect to the overall goal of building capacity to manage water resources in the face of an uncertain climate. Climate change is one of many risks that must be addressed in managing California's water resources, and our understanding of how to effectively integrate consideration of climate change into planning processes is still evolving. This report seeks to learn from initial steps to address climate change in regional water planning in order to inform future guidance and support for IRWM regions.

This section provides a summary of key findings, and a set of recommendations supporting the development of robust analyses in IRWM regions to understand and plan for climate change impacts on the State's water resources through an adaptive management approach.

9.1. Summary of Key Findings

9.1.1 Recently approved IRWM plans (Section 5)

- Of the 34 existing IRWM plans, four (Coachella Valley, Inyo-Mono, Kern County, and SAWPA) have been adopted under the 2010 Guidelines. They broadly follow the climate change requirements in terms of discussing climate change impacts, considering the need for adaptation in the choice of Resource Management Strategies, and in considering greenhouse gas emissions in the project review process. Climate change is not specifically considered in plan evaluations and project monitoring processes, or in data management activities. These plans do not yet incorporate the elements described in DWR's recent draft guidance on the climate change standard, which include a vulnerability assessment, prioritization of vulnerabilities, and a plan for further analysis. However, the approaches in these plans are not incompatible with this guidance, and may be addressed under the Round 1 Planning grants received by three of these regions.

- Some IRWM regions considered climate change in their plans or programs prior to the 2010 guidelines. At least two regions – North Coast and CABY – have established climate change programs to promote attention to climate change adaptation and mitigation.

9.1.2. Round 1 Planning grants (Section 6)

- The 30 funded Planning grant proposals include plans to incorporate climate change into IRWM plan updates, with a total of $2,161,821 dedicated to this task. This includes approximately $1 million in funds from DWR, amounting to 5% of approximately $21 million awarded.
- The proposed climate change analyses appear that they will broadly meet the 2010 guidelines, although details are limited about the plans of some regions.
- All funded proposals indicated that GHG emissions would be considered in the project review process, and 10 indicated plans to establish or participate in a regional GHG inventory
- All proposals indicated that climate change impacts would be evaluated, demonstrating a wide range of approaches to the analysis.
- 14 regions have indicated plans to conduct an analysis using downscaled climate model outputs, sometimes undertaken in partnership with other government agencies or universities
- 24 proposals mentioned some means of involving stakeholders in the consideration of climate change
- 18 proposals discussed partnerships to help carry out the climate change analysis
- 16 regions are considering collaboration with one or more other IRWM regions on their climate change analyses
- Few proposals discussed details of coordination with land use planning processes
- While proposals acknowledged the need for updating knowledge of climate change impacts over time, proposals do not contain many specifics about a process to enable this and other elements of an adaptive management approach
- Most proposals include data management activities, but data needs for addressing climate change are largely not addressed. Two proposals (one funded) included plans to contribute to long-term monitoring relevant to assessing climate impacts.
- In light of draft guidance for a revised climate change standard, some regions may need to revisit their approaches to assessing and prioritizing vulnerabilities. Questions remain about the level of detail needed in analysis of potential impacts, with some regions expressing concern that highly detailed analyses will require significant resources, and may be beyond the capacity of some IRWM regions.

9.1.3. Round 1 Implementation grants (Section 7)

- Implementation grant awards were made to 25 IRWM regions, totaling approximately $205 million, funding 192 projects addressing regional water management objectives
- 140 out of 192 projects are described as addressing the Statewide Priority for Climate Change Response Actions, including adaptation and mitigation efforts.
- In the "Project Benefits Information" section of the online portion of the Implementation grant application, only 17 projects appear to be classified as

addressing "Climate Change Impacts." The difference between this and the number described as addressing the Climate Change Statewide Priority may be indicative of the challenges involved in tracking project information in the IRWM program, as well as in defining climate change-related efforts.

- Climate Change Priority projects address other Statewide Priorities as well. A comparison between the 140 Climate Change Priority projects and the entire portfolio of 192 projects shows that Climate Change projects address the Priorities for Drought Preparedness and Improving the Efficiency of Water Use/Reuse more frequently (82% and 71%, respectively) compared to the overall portfolio of projects (70% and 65%, respectively). This may be related to the fact that these types of projects can be considered under the Climate Change Priority as addressing both adaptation and GHG reductions.
- Only 31% of Round 1 Implementation projects address the Integrated Flood Management Statewide Priority. Climate Change Priority projects follow this pattern, with 28% described as addressing flooding.
- An analysis of the types of Climate Change Response Actions in each proposal shows that conjunctive water management and improving water efficiency are the most common adaptation responses, and improving water efficiency is the most frequent approach to reducing GHG emissions.
- Although most IRWM regions have not yet conducted analyses of regional vulnerability to climate change, six Implementation grant proposals discuss climate change as a factor in determining the need for the proposed projects. Two proposals mention that the climate change study in the Planning grant will inform the selection or design of future Implementation projects.

9.1.4 <u>Considerations for analyzing and adapting to climate change risks in IRWM regions (Section 8)</u>

- Given uncertainties in the future climate, an adaptive management approach is needed that integrates the study of climate change risks with project prioritization and design, and enables adjusting strategies as knowledge improves.
- With regard to assessing and prioritizing vulnerabilities, IRWM regions appear to using one or more of the following approaches: considering risks that affect core water management objectives, conducting a broad review of possible vulnerabilities to regional water resources, and engaging stakeholders. These approaches are broadly in line with the recent draft language for a revised climate change standard. The specific approach to assessing vulnerability referenced in this draft language focuses on identifying risks based on regional characteristics, which is complementary to the literature reviews planned by some regions. A broad, periodic review of regional vulnerabilities may be an important tool for remaining aware of emerging risks.
- Analyses using downscaled climate models are being planned in at least 14 regions. Focusing largely on water supply considerations, most of these analyses rely on one of three sources of model outputs: the California Climate Action Team's scenarios, the CMIP-3 archive, and the models included in the online tool Cal-Adapt. Some of these regions are undertaking these analyses in collaboration with agencies such as US Bureau of Reclamation and US Geological Survey.

- In developing plans for further analysis of prioritized vulnerabilities, risk management and adaptation literature suggests that the design of an analysis should be undertaken with a clear sense of the set of decisions that it is intended to inform, as well as available data and methodologies. While quantitative analyses using downscaled climate model outputs at the IRWM regional level may be useful in some contexts, larger scale analyses may be sufficient in others.
- IRWM regions may need support to identify appropriate approaches for impact analyses, particularly related to flooding and ecosystem impacts, for which quantitative methods may be less well established or less accessible. Consideration may also be needed as to whether DWR should provide specific guidance regarding the use of certain models and scenarios.
- Selecting adaptation strategies requires consideration of costs, benefits, partnerships, and other factors in addition to the study of climate change risks. To the extent that IRWM regions are considering adaptation strategies, it appears that such factors are being considered, at least informally.
- "Robustness" to a range of possible future conditions is an important criterion for selecting adaptation strategies, and the analysis of vulnerabilities and impacts should be undertaken in a way that helps regions account for them.
- Defining the Statewide Priority for climate change as the set of projects that are addressing specific vulnerabilities, as prioritized through regional vulnerability assessments, could help in linking the analysis of climate risks with project selection, and would aid in future evaluations of adaptation efforts.

9.2. Recommendations

The following recommendations support the development of robust analyses in IRWM regions to understand and plan for climate change impacts on the State's water resources through an adaptive management approach. These include steps on the part of DWR to provide appropriate guidance and support, and on the part of IRWM regions to organize their efforts to address climate change. These recommendations raise issues that should be further explored by DWR's Climate Change Technical Advisory Group (CCTAG).

These recommendations assume implementation of a revised climate change standard, similar to the draft language put out by DWR in December 2011. In other words, it is assumed that IRWM regions will, at a minimum, be conducting a vulnerability assessment, prioritizing those vulnerabilities within the IRWM region's decision process, and developing a plan for further analysis of these prioritized vulnerabilities.

9.2.1 Developing informative climate change analyses in IRWM regions to support adaptation strategies

- **DWR could provide support to specific IRWM regions in identifying appropriate resources in the Climate Change Handbook and other sources.** This may be particularly important in regions in the early phases of considering climate change, and with more limited resources to dedicate to this issue. In addition to the design of meaningful vulnerability assessments, DWR support may be needed in developing plans for further analysis of prioritized vulnerabilities, as indicated in the

draft language of the climate change standard. Methodologies may differ depending upon the type of climate risk, and targeted assistance can help ensure that regions have access to the most appropriate expertise.

- **Particular support may be needed for analysis of flooding and ecosystem impacts in IRWM regions that identify these as vulnerabilities.** Quantitative approaches to analyzing impacts to water supply and demand are relatively well documented, in the Climate Change Handbook and other sources. Methods to assess changes in flooding patterns and ecological impacts are less well established, and may be less accessible. Yet, these risks may be significant in some regions of the state. The review of Implementation projects suggests that at present, flooding receives much less attention than strategies related to water supply and quality. Since the IRWM program seeks to support integrated approaches to water management, it is crucial that the role of climate change in altering flood risks be considered along with impacts to water supply and demand. Support from DWR in how to analyze flood risks and ecosystem impacts could help IRWM regions develop the expertise and necessary partnerships to address these issues.

- **DWR should consider whether more specific guidance on the use of particular downscaled climate models would be useful.** Currently, most regions undertaking quantitative analyses are relying on three sources for downscaled model outputs: the Climate Action Team's 2009 scenarios, the DOI/LLNL downscaled data from the CMIP3 archive, and Cal-Adapt, which includes four models compiled by Scripps Institute for Oceanography. It may be useful to consider whether there are benefits to using certain models or tools in particular contexts, and whether there is value to using a consistent set of scenarios for certain purposes. Additional support beyond the guidance in the Climate Change Handbook may be needed to support some IRWM regions in using downscaled model outputs. Cal-Adapt may a useful resource, since it is designed to be accessible to users with limited background in climate science, while still enabling advanced users to download model outputs for further analysis. Options for more specific guidance and support to IRWM regions on using climate model outputs should be explored by DWR's Climate Change Technical Advisory Group.

- **DWR should support the development of inter-regional collaborations to plan for climate change.** In some instances, critical climate vulnerabilities may be best understood and addressed at scales beyond individual IRWM regions. This may be the case for IRWM regions that rely upon common water sources, or that face flooding risks that could be addressed through planning at a scale beyond a particular region. Given the small size of some IRWM regions, it may make sense for several neighboring regions to undertake a common analysis using downscaled climate models, which they can each use to plan for their specific vulnerabilities. This report shows that at least 16 IRWM regions are exploring collaboration with one or more other IRWM regions in analyzing climate change impacts. DWR could support these efforts through technical assistance and funding for such inter-regional efforts.

- **Climate Change Priority Projects should address the vulnerabilities identified in each region's vulnerability assessment.** The regional vulnerability assessments and further analysis of climate change impacts need to be integrated with decisions regarding project priorities and design. For example, a region's vulnerability assessment may identify certain areas as increasingly vulnerable to flooding due to sea level rise, or if prolonged drought is a concern, priority might be placed on areas that are heavily reliant on vulnerable water supply sources. Projects included under the Climate Change Priority could be targeted to address these vulnerabilities. Defining the Climate Change Statewide Priority in this manner could provide a clearer way to understand how the assessment and further analysis of vulnerabilities is informing project prioritization and design, and help in evaluating progress over time.

9.2.2 Mechanisms at regional and state levels to enable adaptive management.

As acknowledged in the Guidelines, understanding climate change impacts is a complex task and knowledge is continually evolving, calling for an adaptive management approach. This requires mechanisms that make relevant information and data about climate change risks and adaptation efforts accessible at regional and state levels in a way that can inform next steps. The following are several recommendations to support this:

- **Successful adaptive management with respect to climate change at the regional level will likely require a mechanism within the IRWM region for on-going coordination and action**. While updating IRWM plans to include climate change is a crucial first step, an on-going process is needed for integrating climate change, including adaptation and mitigation efforts. This may involve activities that fall outside of a Plan update process, such as ensuring periodic vulnerability assessments, tracking how proposed projects address these vulnerabilities, interfacing with DWR's regional climate change specialists, and identifying relevant partnerships and funding opportunities. Learning is a critical element of adaptive management, and a process is needed to facilitate this among regional participants and other stakeholders. In regions that rely significantly upon technical expertise of outside consultants, such mechanisms may be particularly important for building and sustaining a knowledge base over time. Some of these mechanisms are already emerging, such as the climate change program in the North Coast, SAWPA's climate change "pillar," and the Technical Advisory Committees in the Upper Pit River Watershed and CABY regions. Establishing a point person among RWMG participants may be sufficient in some cases.

- **Use the regional vulnerability assessment as a process for routinely updating knowledge and monitoring project priorities.** This will help IRWM regions remain alert to potential changes in patterns of vulnerability. Assessments should incorporate updated climate change research as well as changes in regional characteristics affecting vulnerability. Future assessments should also review how funded projects are addressing these vulnerabilities, consider areas that may need further analysis or additional emphasis in project priorities. Stakeholder

participation in this process is important for determining priorities and improving understanding of climate change risks. The Guidelines already indicate that IRWM regions should continually revisit their evaluations of climate impacts. The appropriate frequency needs to be determined. Once every 4-5 years may be appropriate for formal updates, although processes should be in place within an RWMG to access and share updated knowledge more frequently.

- **Further attention is needed at the regional level to developing methods for evaluating progress over time toward addressing climate change impacts.** There are two components to this: continued monitoring and learning about the nature of climate change impacts, and assessment of how projects that include adaptation components are addressing these impacts. At present, IRWM plans and the analyses proposed by IRWM regions under Round 1 Planning grants do not contain many specifics on these elements, crucial to an adaptive management approach. The consolidation of water-related datasets undertaken in many IRWM regions may prove to be a quite valuable resource for assessing climate impacts, and this could be enhanced through long-term monitoring efforts related to the climate change vulnerabilities prioritized by the region. Evaluating progress toward adaptation is a challenging task, and regions may benefit from opportunities to learn from each other's efforts through workshops or webinars.

- **At the state level, use the Climate Change Statewide Priority projects to track responses to regional vulnerabilities**. Defining Climate Change Priority projects as those that respond to vulnerabilities identified at the regional level would provide a clearer basis for understanding the overall set of adaptation measures supported through the IRWM program, and the kinds of vulnerabilities being addressed. By reviewing these projects and the vulnerabilities they seek to address, DWR can identify areas of vulnerability not receiving sufficient attention, and work with IRWM regions to conduct further analysis or address other barriers to implementing appropriate adaptation strategies. DWR's Climate Change Technical Advisory Group could play a role in this.

- **A separate Statewide Priority for projects that reduce GHG emissions could support on-going evaluation of these measures across IRWM regions.** There are many opportunities to reduce energy consumption and GHGs while still meeting the primary water management objectives of IRWM regions and Proposition 84 funds. Currently, the Climate Change Statewide Priority combines GHG reduction efforts with adaptation measures. If projects that reduce energy consumption and GHGs were considered under a separate Priority, this might facilitate tracking these efforts over time. This priority could also be used to encourage elements beyond project-level emissions reduction, such as participation in regional inventories or other GHG monitoring protocols.

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Appendix A. Sources Consulted from DWR's IRWM and Climate Change Programs

IRWM Program

2010 Guidelines

Proposition 84 and Proposition 1E Integrated Regional Water Management Guidelines, August 2010.
http://www.water.ca.gov/irwm/docs/Guidelines/Prop84/GL_Final_07_20_10.pdf

IRWM Plans

See Table A1 for a list of IRWM plans obtained from RWMG websites.

DWR Interviews with IRWM Representatives

20 interviews conducted during October 2011– January 2012. See Table A2.

Grant Proposals

Prop 84 Round 1 Planning Grant Proposals. Submitted on September 28, 2010.
http://www.water.ca.gov/irwm/docs/ResourcesLinks/Submitted_Applications/P84_Round1_Planning/

Prop 84 Round 1 Implementation Grant Proposals. Submitted on January 7, 2011.
http://www.water.ca.gov/irwm/docs/ResourcesLinks/Submitted_Applications/P84_Round1_Implementation/

Proposal Solicitation Packages

Prop 84 Round 1 Planning Grant Proposal Solicitation Package, August 2010.
http://www.water.ca.gov/irwm/docs/Archives/Prop84/Guidelines_PSPs/Final_PLANNING%20PSP_072010.pdf

Prop 84 Round 1 Implementation Grant Proposal Solicitation Package, August 2010.
http://www.water.ca.gov/irwm/docs/Archives/Prop84/Guidelines_PSPs/Imp_PSP_Final_10_7_10_Public_Errata_Addendum.pdf

DWR Proposal Evaluations

Prop 84 Round 1 Planning Grant Proposal Reviews, December 2010.
http://www.water.ca.gov/irwm/integregio_archive.cfm

Prop 84 Round 1 Implementation Grant Proposal Evaluations, May 2011.
http://www.water.ca.gov/irwm/integregio_archive.cfm

Final Awards

Prop 84 Round 1 Planning Grant Final Awards, February 2011.
http://www.water.ca.gov/irwm/integregio_archive.cfm

Prop 84 Round 1 Implementation Grant Final Awards, August 2011.
http://www.water.ca.gov/irwm/integregio_implementation.cfm

Proposition 84 Round 1 Implementation Grants, List of Awarded Projects. August 16, 2011.
http://www.water.ca.gov/irwm/docs/ImplementationGrants/Prop84_Round1/FinalAwardedProjects.pdf

Prop 84 Regional Acceptance Process
2011 RAP Final Decision Map and Regional Acceptance Process Summaries.
http://www.water.ca.gov/irwm/integregio_rap.cfm

Process Improvement Workshops
Process Improvement Workshop Materials, December 2011.
http://www.water.ca.gov/irwm/processimprovement.cfm

Climate Change Program Resources for IRWM Regions

Climate Change Handbook for Regional Water Planning. EPA/DWR, December 2011.
http://www.water.ca.gov/climatechange/CCHandbook.cfm

IRWM Climate Change Document Clearinghouse, June 14, 2010.
http://www.water.ca.gov/climatechange/docs/IRWM-ClimateChangeClearinghouse.pdf

Frequently Asked Questions: Addressing Climate Change in IRWM Planning Grant Applications and IRWM Plan Updates. May 2011.
http://www.water.ca.gov/climatechange/docs/Final_PlanningGrants_FAQs_May2011.pdf

Potential Climate Change Vulnerabilities – Adapted from the CA Climate Adaptation Strategy ("Climate Change Vulnerability Matrix"). 2010.
http://www.water.ca.gov/climatechange/docs/CC%20Vulnerabilities%20Chart%20w%20schematic%20on%20back%2011X17%201-21-11.pdf

Informal Guidance for DWR Grantees: GHG Assessment for CEQA Purposes. February 2011.
http://www.water.ca.gov/climatechange/docs/Guidance%20For%20Grantees-%20Calculating%20GHGs%20for%20CEQA2011.pdf

Table A1. IRWM Funding Areas, IRWM regions, and websites, December 2011.

Funding Area	IRWM Region	IRWM Plan Adoption Date	Website
North Coast	North Coast	2007	http://www.northcoastirwmp.net/
Sacramento River	American River Basin	2006	http://www.rwah2o.org/rwa/programs/irwmp/
	Cosumnes American Bear Yuba (CABY)	2007 (interim update 2009)	http://www.cabyregion.org/
	Northern Sacramento Valley Four County Group	In development	http://www.buttecounty.net/Water%20and%20Resource%20Conservation/NoSacramentoIRWM.aspx
	Upper Feather River Watershed	2005	http://www.featherriverwater.com/regionalplanningirwm.html
	Upper Pit River Watershed	In development	http://upperpit.wordpress.com/
	Upper Sacramento-McCloud-Lower Pit	In development	http://www.riverexchange.org/projects.html
	Westside (Yolo, Solano, Napa, Lake, Colusa)	2007	http://www.yolowra.org/irwmp.htm
	Yuba County	2008	http://www.ycwa.com/projects/detail/7
San Francisco Bay	San Francisco Bay Area	2006	http://bairwmp.org/
San Joaquin	East Contra Costa County	2005 (FEP)	http://www.ccwater.com/
	East Stanislaus	In development	
	Eastern San Joaquin	2007	http://www.gbawater.org/IRWMP/IRWMP.html
	Madera	2008	http://www.madera-county.com/supervisors/water-plan.html
	Merced	In development	http://www.mercedirwmp.org/
	Mokelumne/Amador/Calaveras	2006	http://www.umrwa.org/mac_region_irwm_program.html
	Toulumne-Stanislaus	In development	http://www.tudwater.com/project_development/integrated-regional-water-management-plan.htm
	Westside-San Joaquin	2006	http://www.sldmwa.org/intergrated_resources_plan.htm
	Yosemite-Mariposa	In development	http://mcrcd.net/IRWMP.aspx
Lahontan	Antelope Valley	2007	http://www.avwaterplan.org/
	Fremont Basin	In development	http://www.fremontvalleyirwmp.org/
	Lahontan Basins	In development	
	Inyo-Mono	2011	http://inyomonowater.org/
	Tahoe-Sierra	2007	http://www.stpud.us/plan_documents.html
Central Coast	Greater Monterey County	2006 (FEP, Salinas Valley)	http://ccwg.mlml.calstate.edu/irwmp
	Monterey Peninsula, Carmel Bay, So. Monterey Bay	2007	http://www.mpwmd.dst.ca.us/Mbay_IRWM/Mbay_IRWM.htm
	Santa Barbara County	2007	http://www.countyofsb.org/pwd/pwwater.aspx?id=16852
	San Luis Obispo	2007	http://www.slocountywater.org/site/Frequent%20Downloads/Integrated%20Regional%20Water%20Management%20Plan/index.htm
	Santa Cruz	2005	http://www.santacruzirwmp.org/
	Pajaro River Watershed	2007	http://www.pvwma.dst.ca.us/project_planning/projects_irwmp.shtml
Tulare Lake	Kaweah River Basin (conditionally approved)	2008 (FEP)	http://www.kdwcd.com/index.html
	Kern County	2011	http://www.kernirwmp.com/
	Poso Creek	2007	http://www.semitropic.com/PubsArchive.htm
	Southern Sierra	In development	http://www.sequoiariverlands.org/learn-irwmp.html
	Tule (conditionally approved)	In development	
	Upper Kings Basin	2007	http://www.krcd.org/water/ukbirwma/index.html
Los Angeles-Ventura	Gateway	In development	http://www.gatewayirwmp.org/
	Greater Los Angeles County	2006	http://ladpw.org/wmd/irwmp/
	Upper Santa Clara River	2008	http://www.ladpw.org/wmd/scr/index.cfm
	Watersheds Coalition of Ventura County	2006	http://portal.countyofventura.org/portal/page/portal/ceo/divisions/ira/WC
Santa Ana	Santa Ana Watershed Project Authority	2010	http://www.sawpa.org/
San Diego	San Diego	2007	http://www.rmcwater.com/clients/sdirwmp/home.html
	South Orange County	2006	http://www.ocwatershed.com/wma_SouthOC.aspx
	Upper Santa Margarita Watershed	2007	https://www.ranchowater.com/irwmp.aspx
Colorado River	Anza Borrego	In development	http://www.borregowd.org/Page_2.php
	Coachella Valley	2010	http://www.cvrwmg.org/
	Imperial	In development	http://www.imperialirwmp.org/
	Mojave	2005	http://www.mojavewater.org/planning.html

This table is up to date as of December 2011, based on information on IRWM regional websites, and some Regional Acceptance Process applications.
Some IRWM regions fall within two funding areas. Regions are listed only once here in the funding area in which it has received the most Prop 84 funding.
"Conditionally Approved" means that the region's boundaries are not yet fully agreed upon with DWR.
A Functionally Equivalent Plan (FEP) is one accepted by DWR in place of an IRWM plan.
Complete IRWM plans were not available on the websites of the following regions: Yuba County (Executive Summary only), East Contra Costa County (FEP), Kaweah River Basin (FEP), and Poso Creek (Brochure only).

Table A2. IRWM Regions interviewed by DWR regional climate specialists

IRWM Region	Date
North Coast	Jan. 18, 2012
Consumnes American Bear Yuba (CABY)	Oct. 19, 2011
Upper Pit River Watershed	Oct. 3, 2011
Upper Sacramento-McCloud-Lower Pit	Nov. 14, 2011
Westside-Sacramento	Oc. 24, 2011
San Francisco Bay Area	Oct. 19, 2011
Toulumne-Stanislaus	Oct. 24, 2011
Antelope Valley	Nov. 9, 2011
Inyo Mono	Nov. 22, 2011
Santa Barbara County	Dec. 2, 2011
Upper Kings Basin	No date
Gateway	Dec. 8, 2011
Greater Los Angeles County	Dec. 5, 2011
Upper Santa Clara River	Oct. 28, 2011
Watersheds Coalition of Ventura County	Nov. 30, 2011
SAWPA	Dec. 1, 2011
San Diego	Nov. 8, 2011
South Orange	Dec. 8, 2011
Coachella Valley	Feb. 6, 2012
Imperial Valley	Dec. 29, 2011

Interviews were conducted by DWR regional climate change specialists Erin Chappell (North Central), Peter Coombe (Northern), Lauma Jurkevics (Southern), and Michelle Selmon (South Central). Communications between the DWR and IRWM regional representatives were by phone, email or in-person. A written record was produced for each interview. That record was provided to the author of this report.

Appendix B. Climate Change Priority Projects meeting other Statewide Priorities in Round 1 Proposition 84 Implementation Grants

IRWM Region	Climate Change Priority Projects	Climate Change Projects also classified under other Statewide Priorities							DAC Prog. Preference	
		Drought	Water Quality	Water Use/Reuse Efficiency	Env. Stewardship	Integrated Flood Mgmt	Equitable Distrib. of Benefits	Tribal Water/Nat. Resources	DAC Water Project	DWR Approved DAC Water Project
North Coast	15	6	9	7	13	8	12	8	4	2
American River Basin	13	11	4	6	12	3	2	0	2	0
Cosumnes American Bear Yuba	16	16	1	16	16	0	16	0	13	13
San Francisco Bay Area	5	3	5	3	5	3	3	0	2	1
East Contra Costa County	2	1	1	1	1	0	1	0	0	0
Madera	2	2	2	1	1	2	0	0	0	0
Mokelumne/Amador/Calaveras	4	4	0	3	0	0	4	0	2	2
Antelope Valley	1	1	1	1	1	0	0	0	0	0
Inyo-Mono	12	11	10	11	3	1	13	0	3	1
Tahoe-Sierra	3	3	3	3	3	2	3	0	3	0
Greater Monterey County	2	1	2	1	1	1	2	0	1	1
Santa Barbara County	7	6	4	5	3	1	6	0	5	3
San Luis Obispo	2	2	1	1	1	0	2	0	2	0
Kaweah River Basin	3	3	0	3	2	2	1	0	0	1
Poso Creek	5	5	4	4	2	1	4	0	1	1
Upper Kings Basin	5	5	5	4	1	0	2	0	2	1
Greater Los Angeles County	0	0	0	0	0	0	0	0	0	0
Upper Santa Clara River	3	3	3	3	1	1	3	3	3	0
Watersheds Coalition of Ventura County	8	6	8	6	8	2	1	0	1	1
Santa Ana Watershed (SAWPA)	13	13	12	6	6	4	10	0	5	1
San Diego	8	4	7	5	2	3	2	0	1	0
South Orange County	3	3	3	3	3	3	3	0	3	1
Upper Santa Margarita Watershed	4	3	3	3	2	0	1	1	3	1
Coachella Valley	2	1	1	1	0	0	2	2	2	1
Mojave	2	2	1	1	2	2	2	0	2	0
TOTALS	**140**	**115**	**90**	**98**	**89**	**39**	**95**	**14**	**60**	**31**

The figures in this table were gathered from Attachment 11 in each funded Implementation grant proposal. This data, combined with the figures for all Implementation projects (see Table 5) were used to create Table 7, which compared the set of Climate Change Priority projects with the overall portfolio of 192 funded Implementation projects.

Most proposals indicated speciifcally which projects met particular priorities/preferences. CABY's description was more general, but was interpreted to mean that all projects were related to climate change. Some proposals specified whether priorities were met directly or indirectly. Both are included here.

Appendix C. Examples of descriptions of Climate Change Priority projects in Round 1 Implementation Proposals.

IRWM Region	Example description of project(s) addressing climate change	Aspects of Climate Change Response Actions addressed (as classified in Table 8)
CABY	The proposal includes 16 integrated projects addressing drought preparedness through infrastructure improvements, conservation efforts, and creation of a water trust. The response to climate change is described for the proposal as a whole, which will integrate climate change projections into drought planning efforts, based on the modeling efforts described in CABY's Planning Grant proposal. These have already been initiated: "prelilminary calculations have been prepared and will serve as a basis for the Drought Action Plan included in each integrated drought and water planning activity." *Attachment 11, pp. 6-7*	Adaptation: efficiency of water use/reuse Other: increase reliabiity of local supply/import dependence
Madera	The Root Creek In-Lieu Groundwater Recharge Project "will make available surface water delivery possible to areas that are now dependent on groundwater pumping. The reduced pumping will save an estimated 1.2 million KW hours/year." The Sierra National Forest Fuel Reduction Project "provides a climate change mitigation through reducing the probability of severe wildfires - something which has increased (and will continue to increase) due to climate change." *Attachment 11, p. 9.1-12*	GHGs/energy: water system energy efficiency Other: reduce wildfire potential
Bay Area	Integrated Water Quality Improvement, Flood Management and Ecosystem Restoration in Bay Area Disadvantaged Communities (DAC) Program: "Climate change response will entail identifying hydraulic constrictions of waterways and stormwater systems near the Bay or ocean which will have practical results on decreasing inundation zones. The increase of floodplain and wetland areas and stream restoration will directly benefit the disadvantaged communities' capacity for resilience in the face of climate change." *Attachment 11, p. 11-10.*	Adaptation: system modification to address climate change, floodplain/watershed protection. Other: tidal marsh restoration (SLR)
Poso Creek	Four projects related to groundwater use and management. Projects are described as addressing climate change by "allow[ing] maximum ground-water recharge" or "increas[ing] management flexibility". *Attachment 11, Exhibit 11-2.*	Adaptation: conjunctive water management
Greater Monterey County	The San Jerardo Wastewater Project implements water conservation and water quality improvement measures for a rural, low-income farmworker community. In addition to improving water use efficiency and water recycling, the project "includes installation of solar-powered surface aerators...for adequate aerobic digestion of organic matter." Another project, Integrated Ecosystem Restoration in Elkhorn Slough, "increases the resilience of tidal marsh to climate change by making it better able to keep pace with sea level rise. It also restores tidal marsh, which will capture and sequester carbon at a rate of approximately 225 tons per year." *Attachment 11, pp. 5-7*	GHGs/energy: cleaner energy sources, water use efficiency, water recycling Other: carbon sequestration, tidal marsh restoration (SLR)
Upper Santa Clara River	Multiple projects address adaptation to climate change in that they "diversify the supply sources available in the Region, promote water use efficiency, and result in increased water recycling." Energy/GHGs are addressed in that "the new recycled water supply source will require less energy and result in fewer greenhouse gas emissions than a like amount of imported water (see Attachment 8 for the full analysis). Energy savings (and greenhouse gas emissions reductions) are enhanced by reduced water demands." *Attachment 11, p. 7*	Adaptation: efficiency of water use/reuse. GHGs/energy: water efficiency, water recycling. Other: increase reliability of local supply/reduce import dependence
Coachella Valley	The Regional Water Conservation Program "could cut energy consumption related to water systems and water use, thereby decreasing greenhouse gas (GHG) emissions. This program will certainly contain projects that will adapt to climate change effects through water use efficiency." The Short Term Arsenic Treatment Project "will directly address climate change issues by utilizing low energy demand devices for the local treatment of groundwater...effectively reducing GHG emissions by offsetting the need to implement more energy consumptive conventional pumping devices." *Attachment 11, pp. 11-7/8.*	Adaptation: efficiency of water use/reuse. GHGs/energy: reduce energy consumption