Los Angeles Basin Stormwater Conservation Study

Los Angeles County Flood Control District
U.S. Department of the Interior – Bureau Of Reclamation

Task 3 – Downscaled Climate Change & Hydrologic Modeling Results
Stakeholder Technical Advisory Committee Meeting
September 26, 2013

Overview

- **Background**
- **Task 3.1 – Downscaled Climate Change**
  - Results
    - Storm Event Frequency
- **Task 3.2 – Hydrologic Modeling**
  - Results
    - Annual Stormwater Runoff
    - Peak Flood Flows
- **Next Steps**

LA Basin Study

Partnership between:

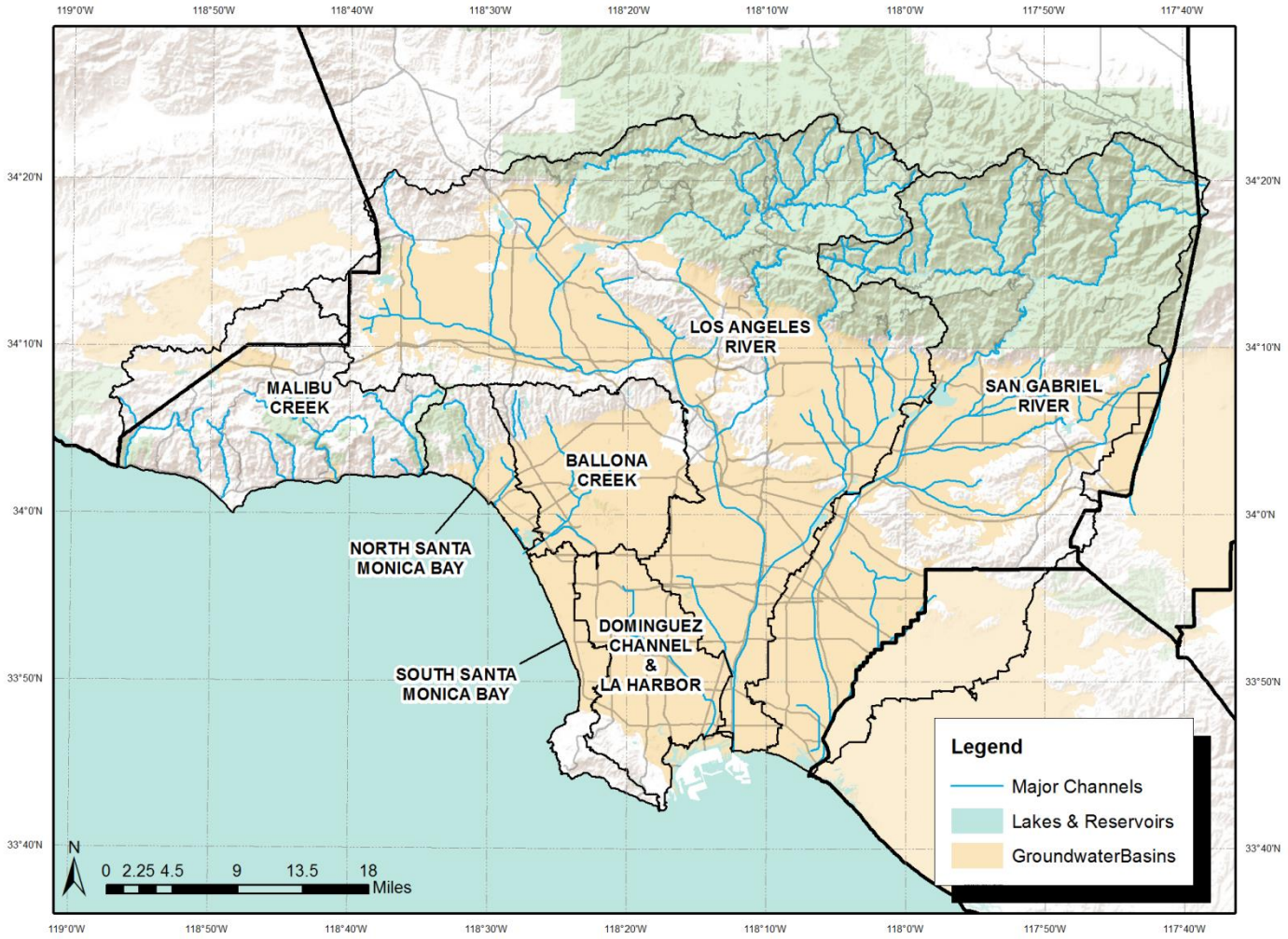
- Los Angeles County Flood Control District
- U.S. Department of the Interior – Bureau of Reclamation

Basin Study Cost Estimate: $2.4 million

Official Start Date – December 27, 2012

- 2.5 Years to Complete Study
- Task 3 Started February 2013

Study Area


119°0'W
118°50'W
118°40'W
118°30'W
118°20'W
118°10'W
118°0'W
117°50'W
117°40'W
34°20'N
34°10'N
34°0'N
33°50'N
33°40'N
LOS ANGELES RIVER
MALIBU CREEK
SAN GABRIEL RIVER
BALLONA CREEK
NORTH SANTA MONICA BAY
DOMINGUEZ CHANNEL & LA HARBOR
SOUTH SANTA MONICA BAY
N
0 2.25 4.5 9 13.5 18
Miles
Legend
Major Channels
Lakes & Reservoirs
GroundwaterBasins

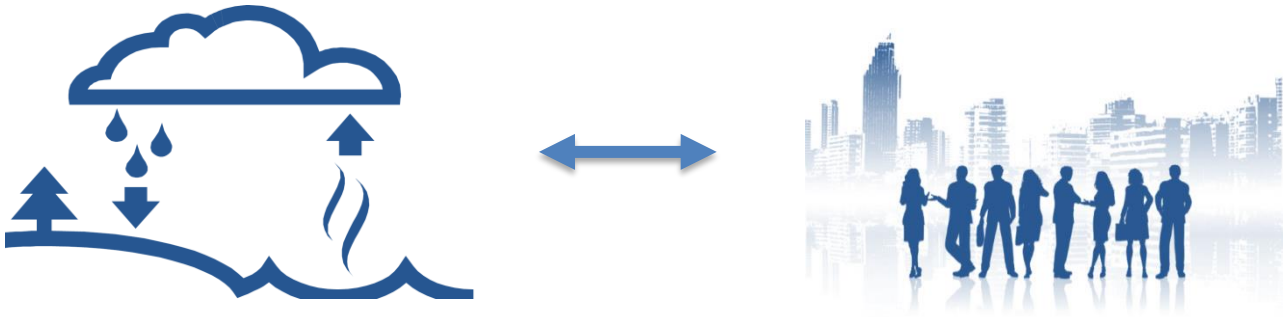
Study Objectives

LA Basin Study Objectives

- Evaluate existing water conservation system
- Evaluate potential for new facilities and operational changes for increased capture and recharge to address future conditions

Key Considerations

- Account for projected climate change
- Population growth

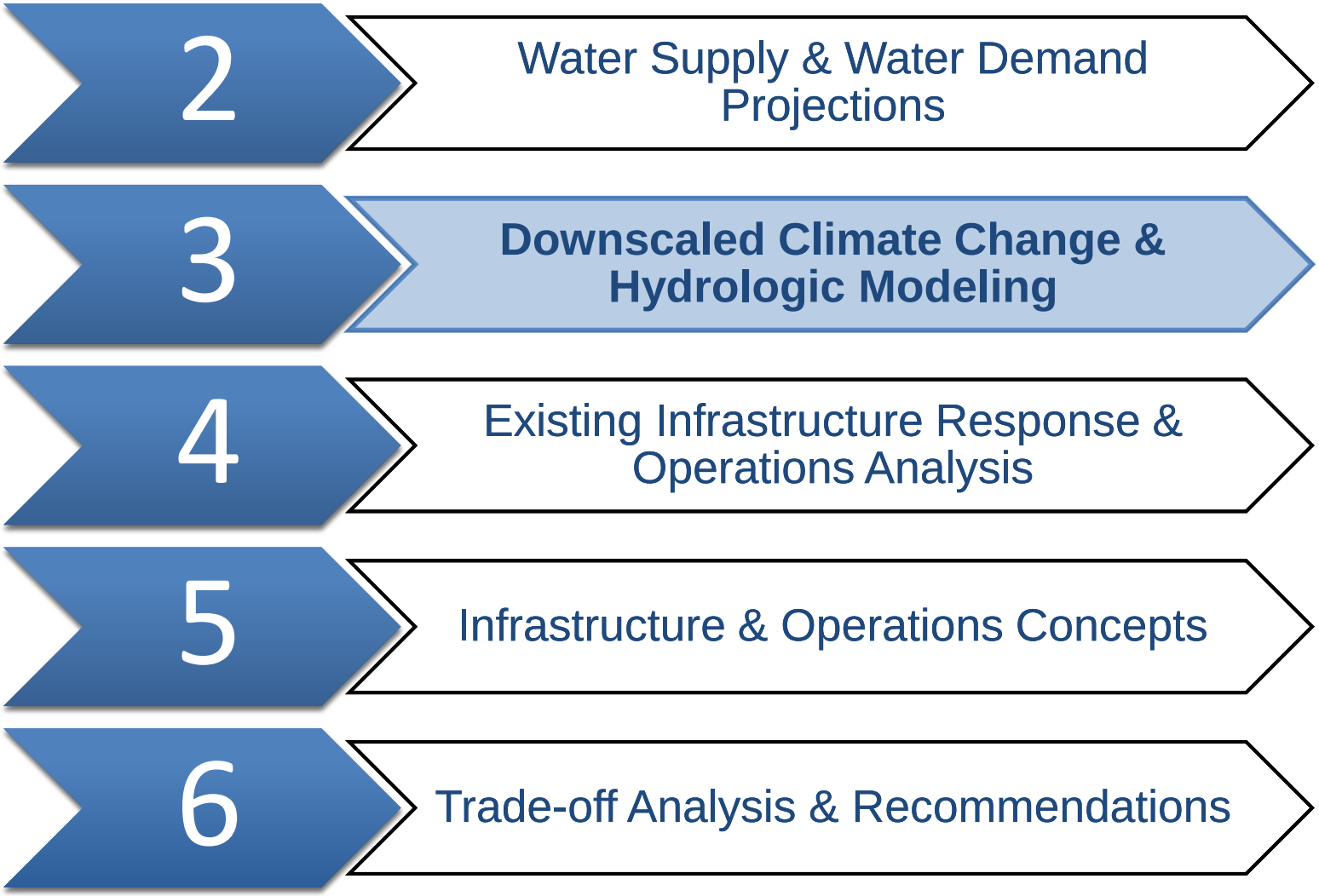


Study Outcome

Planning Document

- Evaluates:
  - Existing water conservation under future conditions
  - Improvements (structural or operational) to existing facilities
  - Potential for new facilities
- Tool for future planning by LACFCD and other Basin Study partners

Major Tasks


2
Water Supply & Water Demand Projections
3
Downscaled Climate Change & Hydrologic Modeling
4
Existing Infrastructure Response & Operations Analysis
5
Infrastructure & Operations Concepts
6
Trade-off Analysis & Recommendations

Task 3 Overview

Task 3.1 – Downscaled Climate Change

- Global data
- Refined for use at regional level
- Model Output

  - Continuous precipitation & evaporation data

Task 3.2 – Hydrologic Modeling

- Watershed Management Modeling System (WMMS)
- Uses Climate Projections
- Analyzes Model Output

  - Continuous runoff data (flow rates and volumes)

Task 3.1 – Downscaled Climate Change

RECLAMATION

Managing Water in the West

Los Angeles Basin Stormwater Conservation Study

Task 3.1: Development of Climate-Adjusted Hydrologic Model Inputs

September 26, 2013

Technical Service Center, Denver, Colorado

U.S. Department of the Interior
Bureau of Reclamation

Task 3.1 Objectives

Develop and evaluate projected future climate conditions related to precipitation frequency over the LA Basin:

1. Consider existing projections of climate change
2. Determine appropriate climate scenarios
3. Prepare data for input into WMMS
4. Determine storm event frequency

Literature Synthesis*

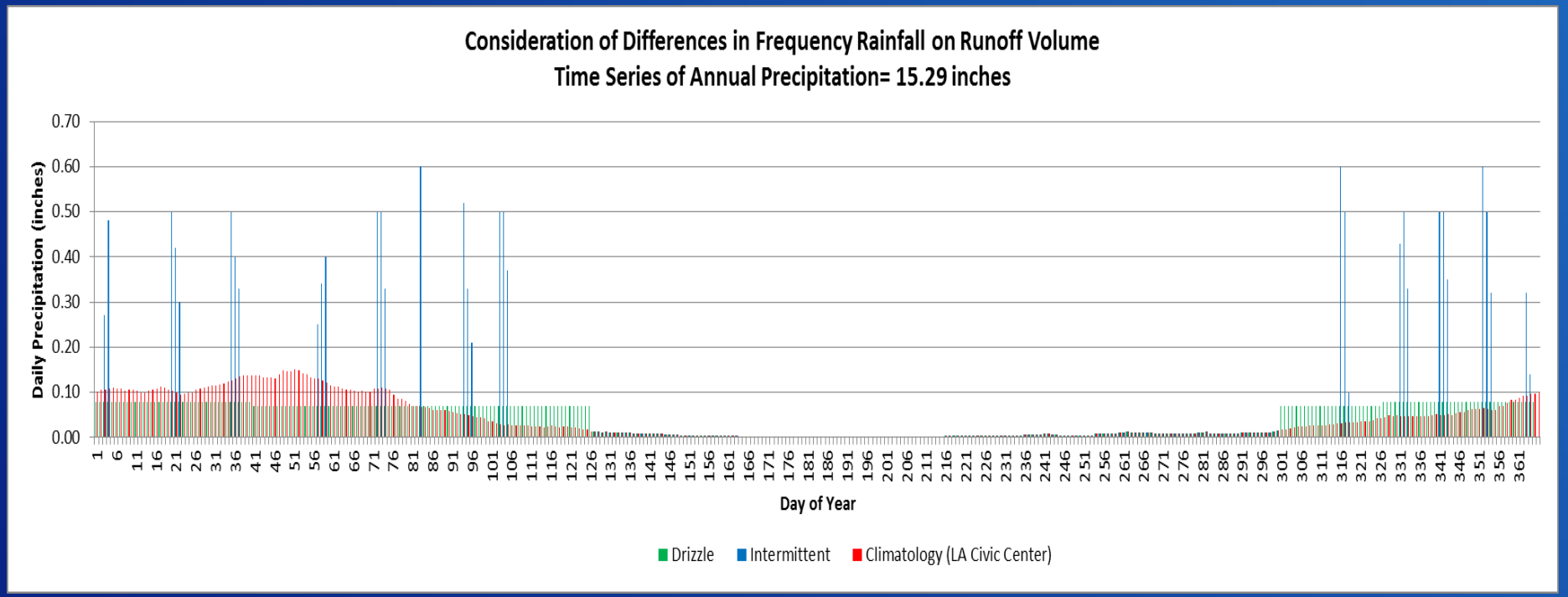
Climate change implications for water and environmental resources

- Increases in temperatures
- Increases in rates of evaporation
- Decreases in annual precipitation
- Increases in extreme precipitation events

*State of the science in 2011, included research from CMIP3 GCMs, regional climate models, and dynamical downscaled projections
http://www.usbr.gov/research/docs/climatechangelitsynthesis.pdf

Precipitation Frequency

Annual precipitation

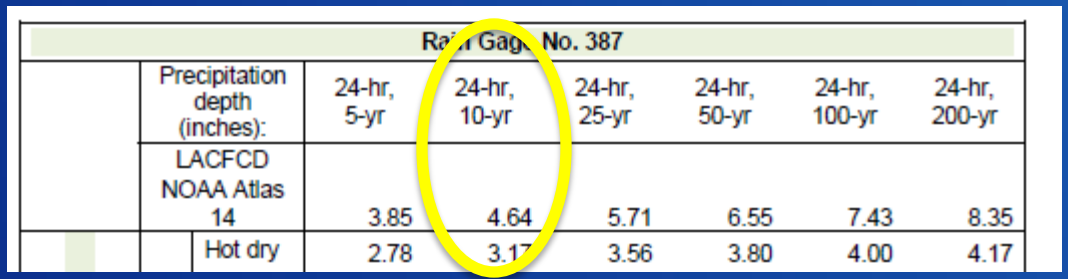


RECLAMATION

Precipitation Frequency

Assigns a probability to the magnitude

- 10% chance of storm with 4.64” in any given year

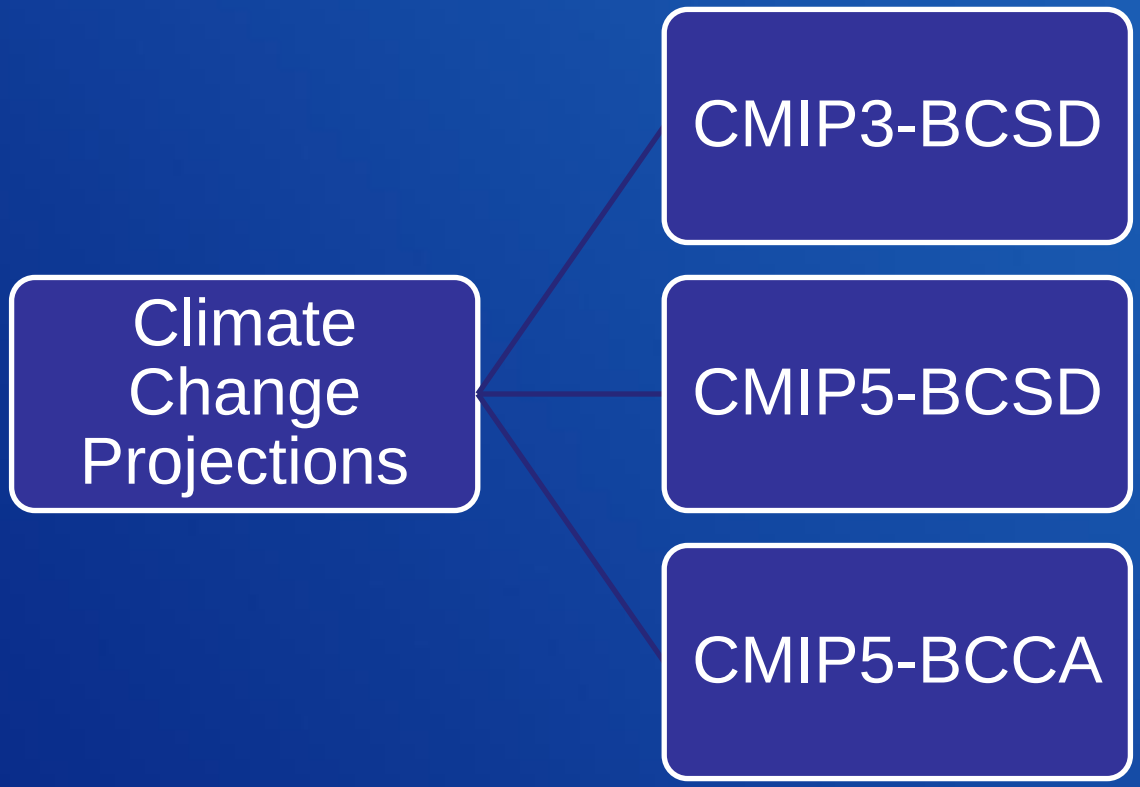


Rain Gage No. 387							
	Precipitation depth (inches):	24-hr, 5-yr	24-hr, 10-yr	24-hr, 25-yr	24-hr, 50-yr	24-hr, 100-yr	24-hr, 200-yr
	LACFCD NOAA Atlas 14	3.85	4.64	5.71	6.55	7.43	8.35
	Hot dry	2.78	3.17	3.56	3.80	4.00	4.17

Better suited towards design of infrastructure than annual precipitation.

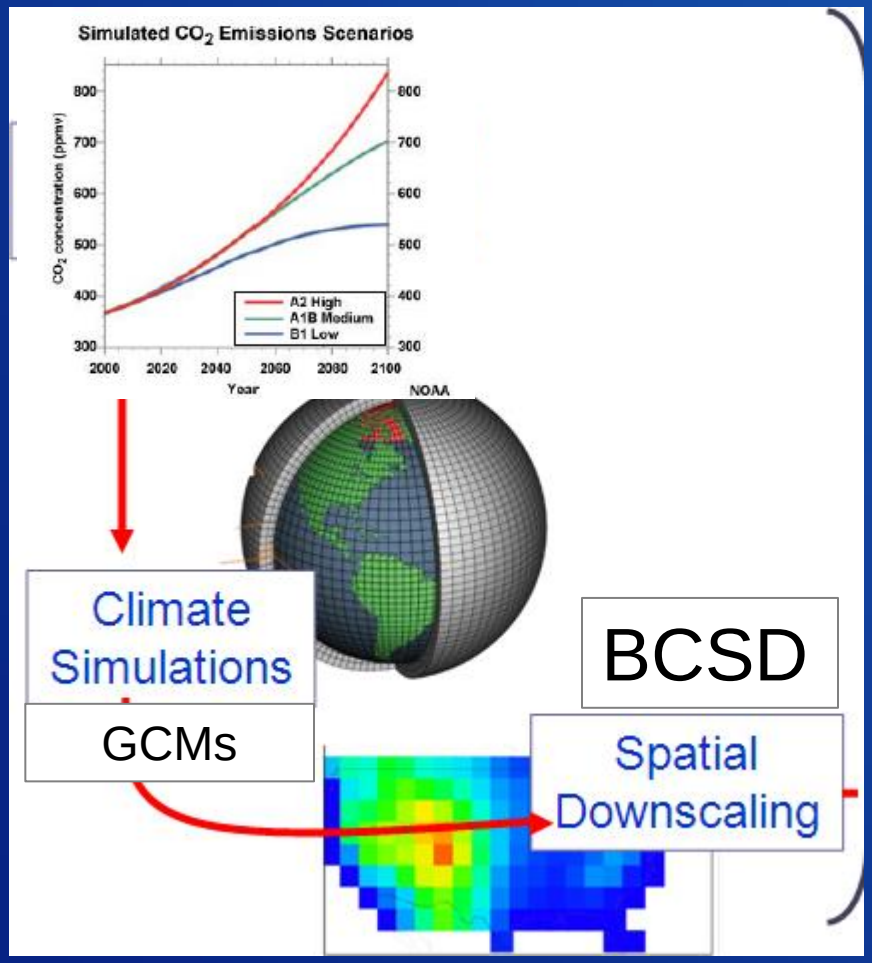
RECLAMATION

Sub-task 1: Consider existing climate change projections

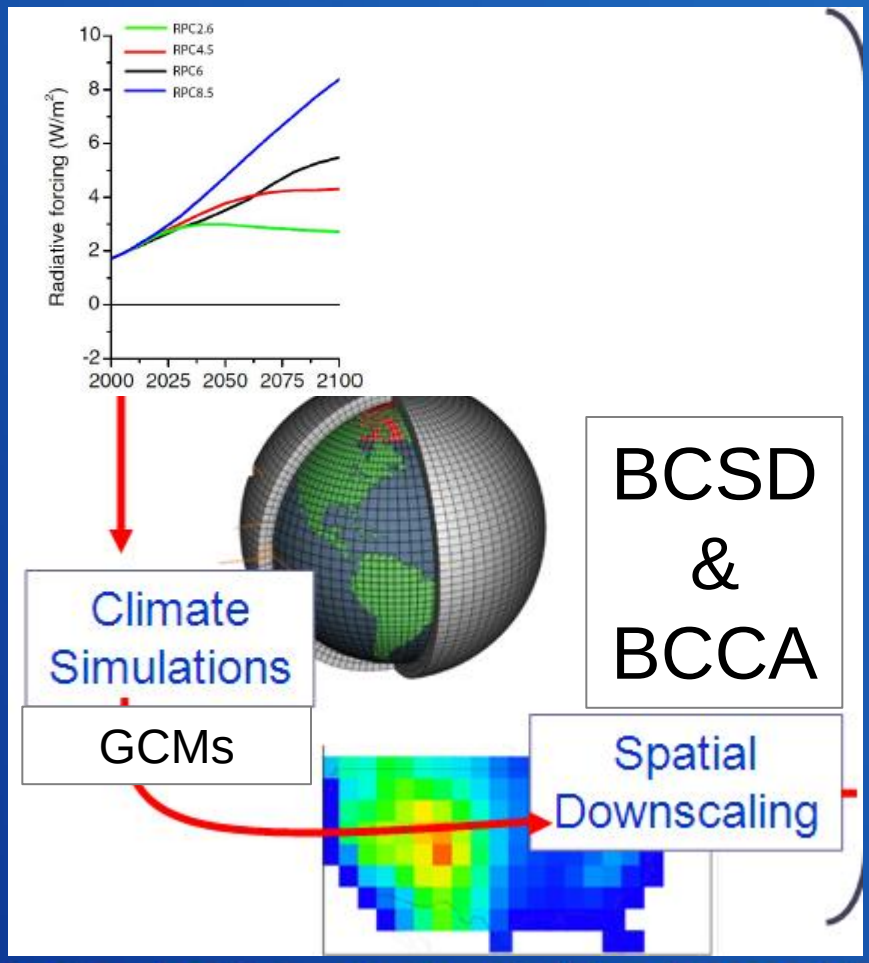


Downscaled Projections

CMIP3

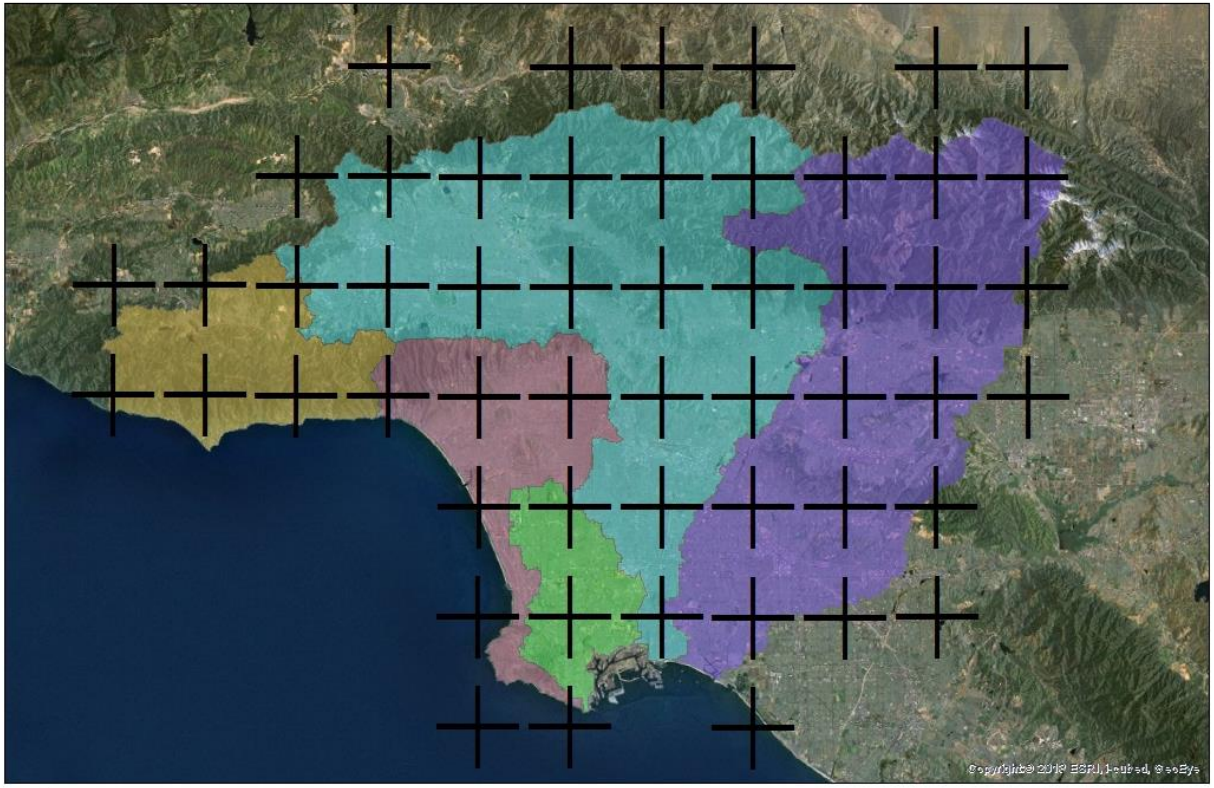


CMIP5



RECLAMATION

Spatial Subset

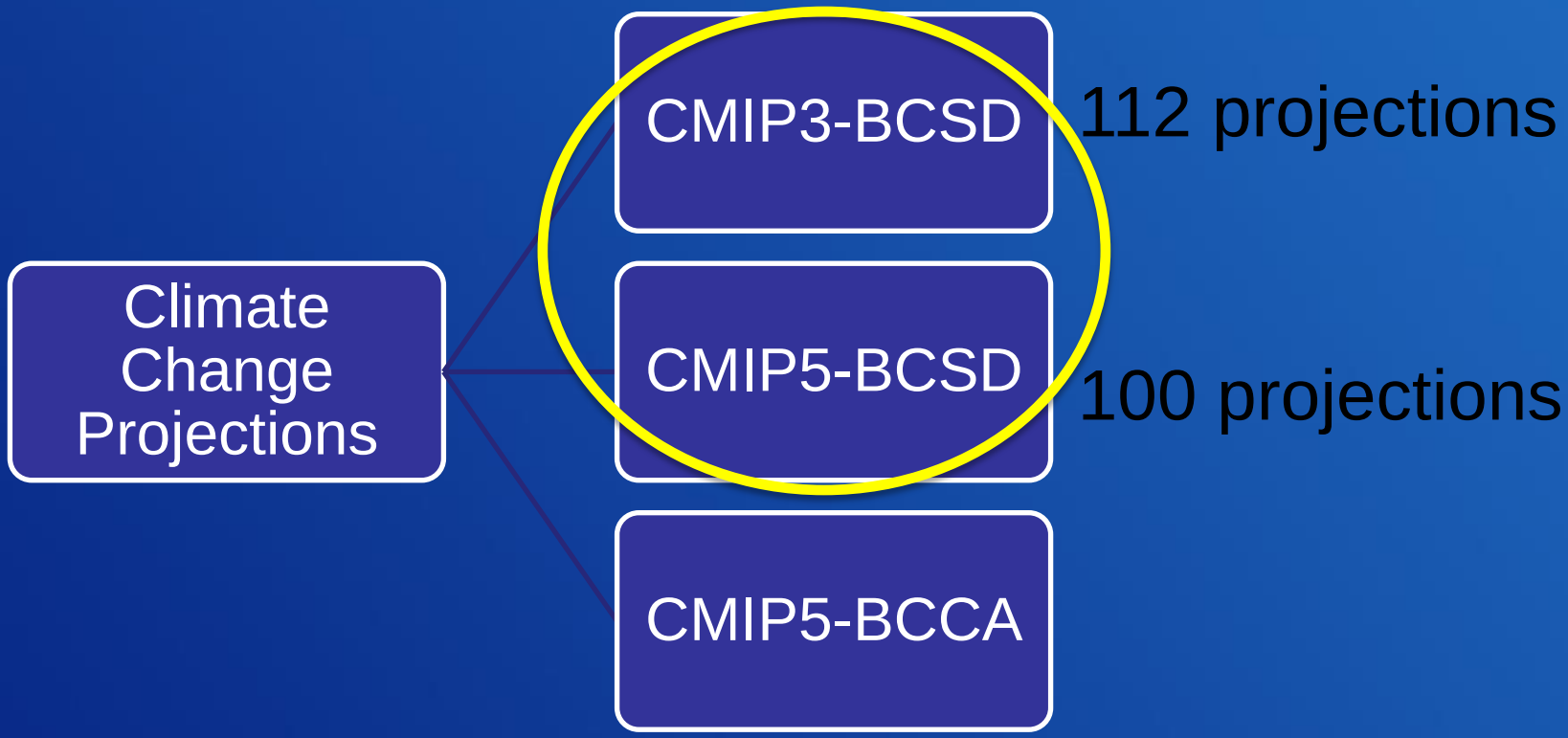


RECLAMATION

Temporal Subset

Future Period	Start year	End year	Duration
Historical reference period	1986	1999	14 years
Future period 1	2011	2024	14 years
Future period 2	2025	2038	14 years
Future period 3	2039	2052	14 years
Future period 4	2053	2066	14 years
Future period 5	2067	2080	14 years
Future period 6	2081	2099	19 years

Climate Projections



Grouped CMIP3-BCSD projections to inform five climate scenarios, then grouped CMIP5-BCSD projections

Climate Scenarios

Q1. Enhanced precipitation magnitude with hotter temperature (hot-wet)

Q2. Diminished precipitation magnitude with hotter temperature (hot-dry)

Q3. Diminished precipitation magnitude with warmer temperature (warm-dry)

Q4. Enhanced precipitation magnitude with warmer temperature (warm-wet)

Q5. Central tendency

All scenarios showed an increase in temperature

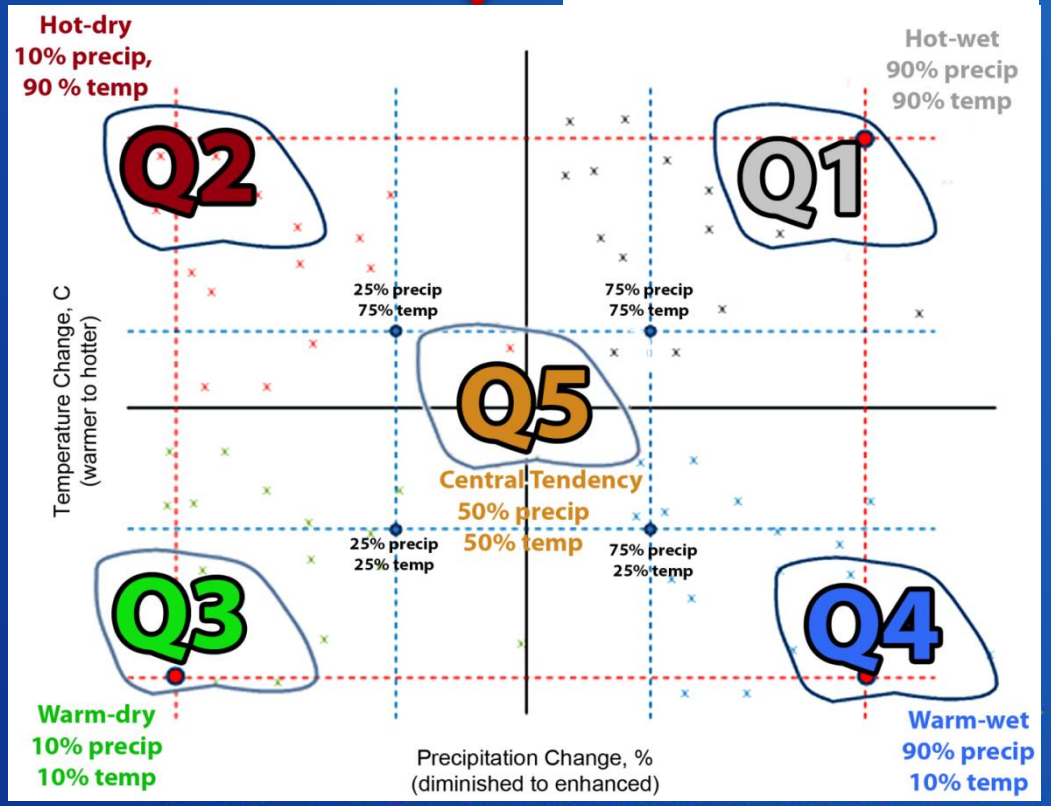
Climate Scenarios

Climate Change Projections

- CMIP3-BCSD
- CMIP5-BCSD
- CMIP5-BCCA

112 monthly projections

5 scenarios



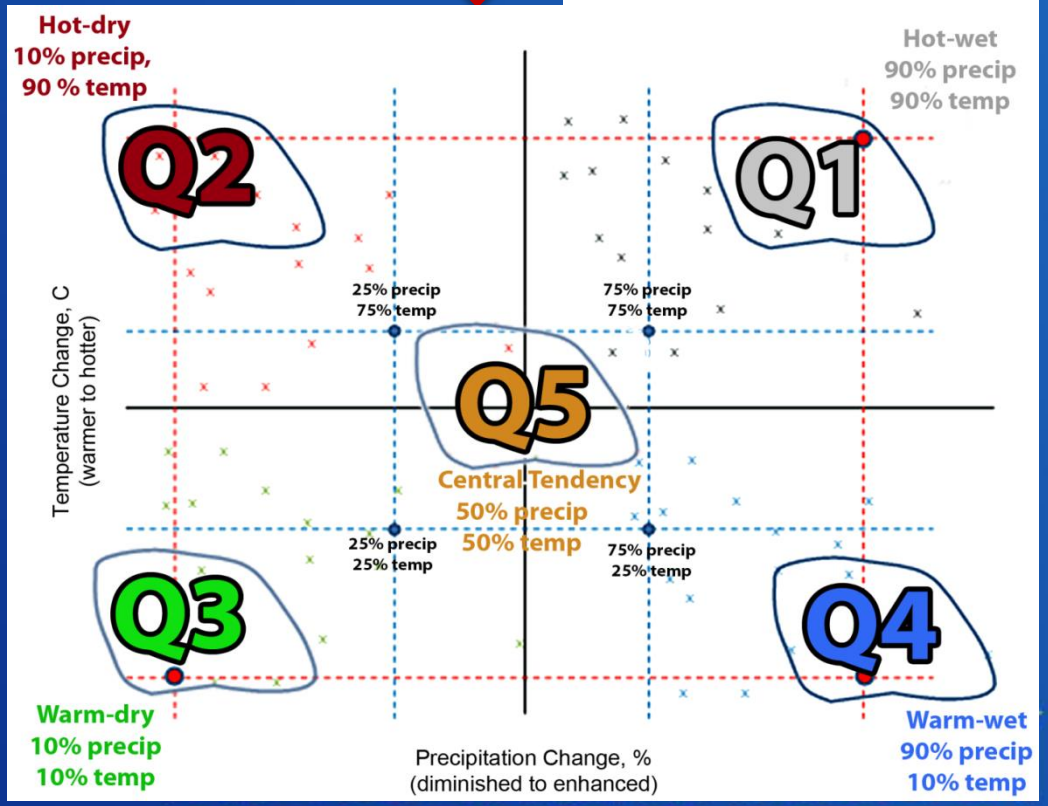
Climate Scenarios

Climate Change Projections

- CMIP3-BCSD
- CMIP5-BCSD
- CMIP5-BCCA

100 monthly projections

5 scenarios

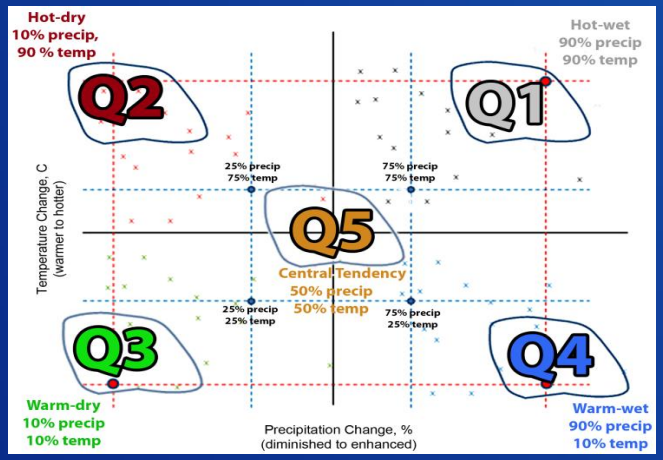


Climate Scenarios

- Change in precipitation (x-axis)
  - Percent change in precipitation between the 1-in-50-year precipitation event in the simulated historical reference period and in a future period
- Change in temperature (y-axis)
  - Difference between the average temperature in the simulated historical reference period and in a future period

Climate Scenarios

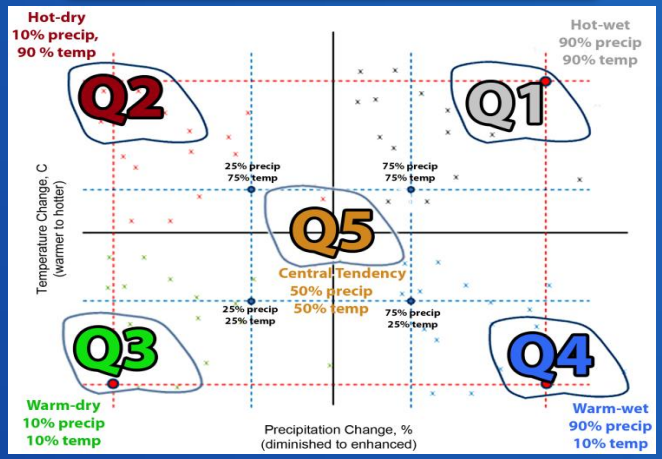
CMIP3-BCSD (112 projections)



Select the 10 closest projections for each climate scenario

5 CMIP3-BCSD climate scenarios

CMIP5-BCSD (100 projections)



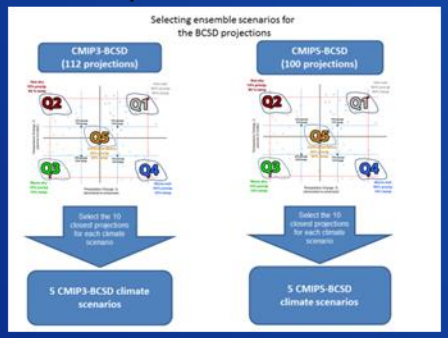
Select the 10 closest projections for each climate scenario

5 CMIP5-BCSD climate scenarios

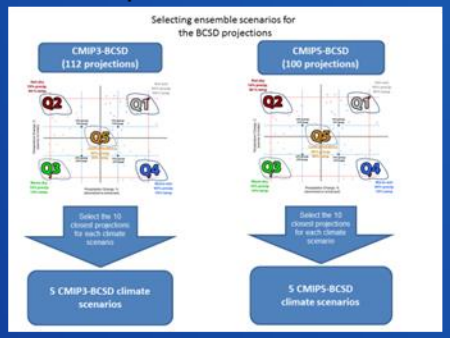
RECLAMATION

Climate Scenarios

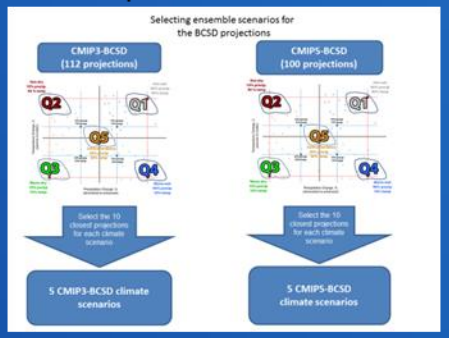
Future period 1: 2011 - 2024



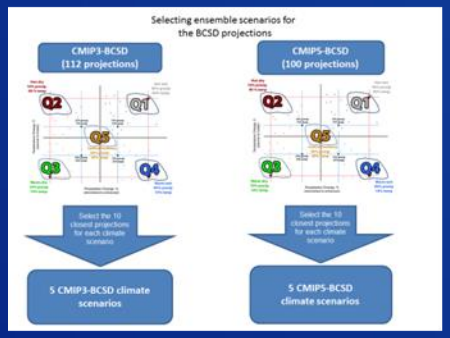
Future period 2: 2025 -2038



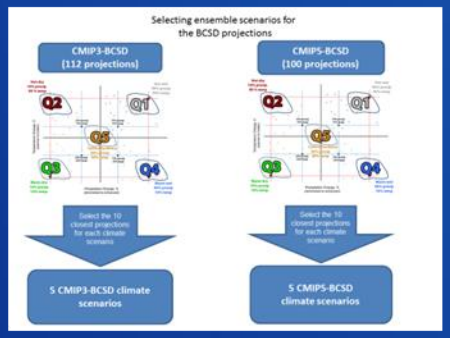
Future period 3: 2039 -2052



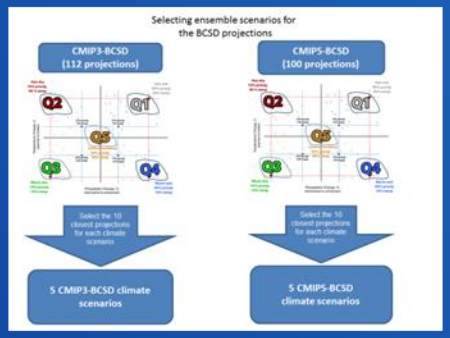
Future period 4: 2053-2066



Future period 5: 2067-2080



Future period 6: 2081-2099



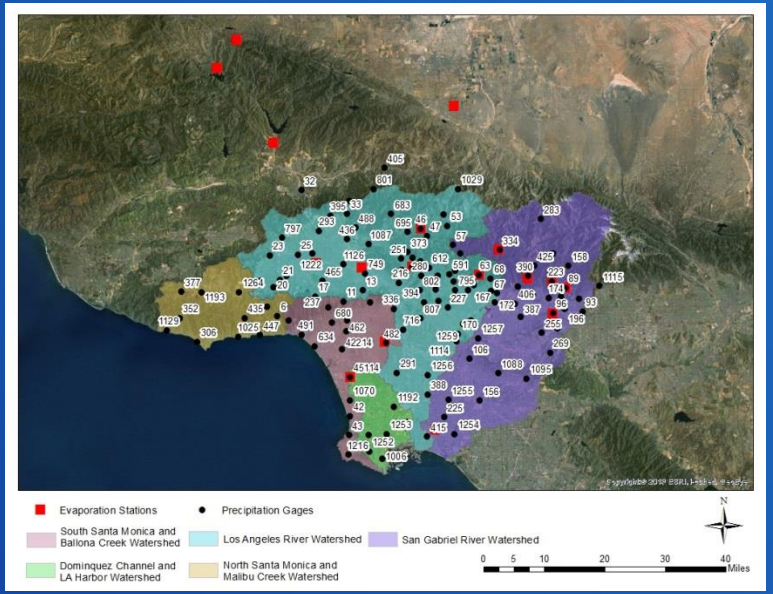
This projection selection was completed for all six future periods.

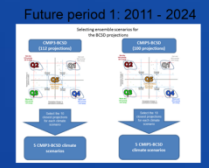
RECLAMATION

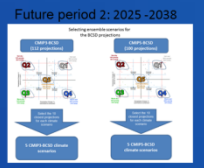
Precipitation Time-Series

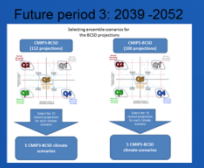
Needed for WMMS:

- Continuous
- Hourly
- 2011-2099
- At each precipitation gage





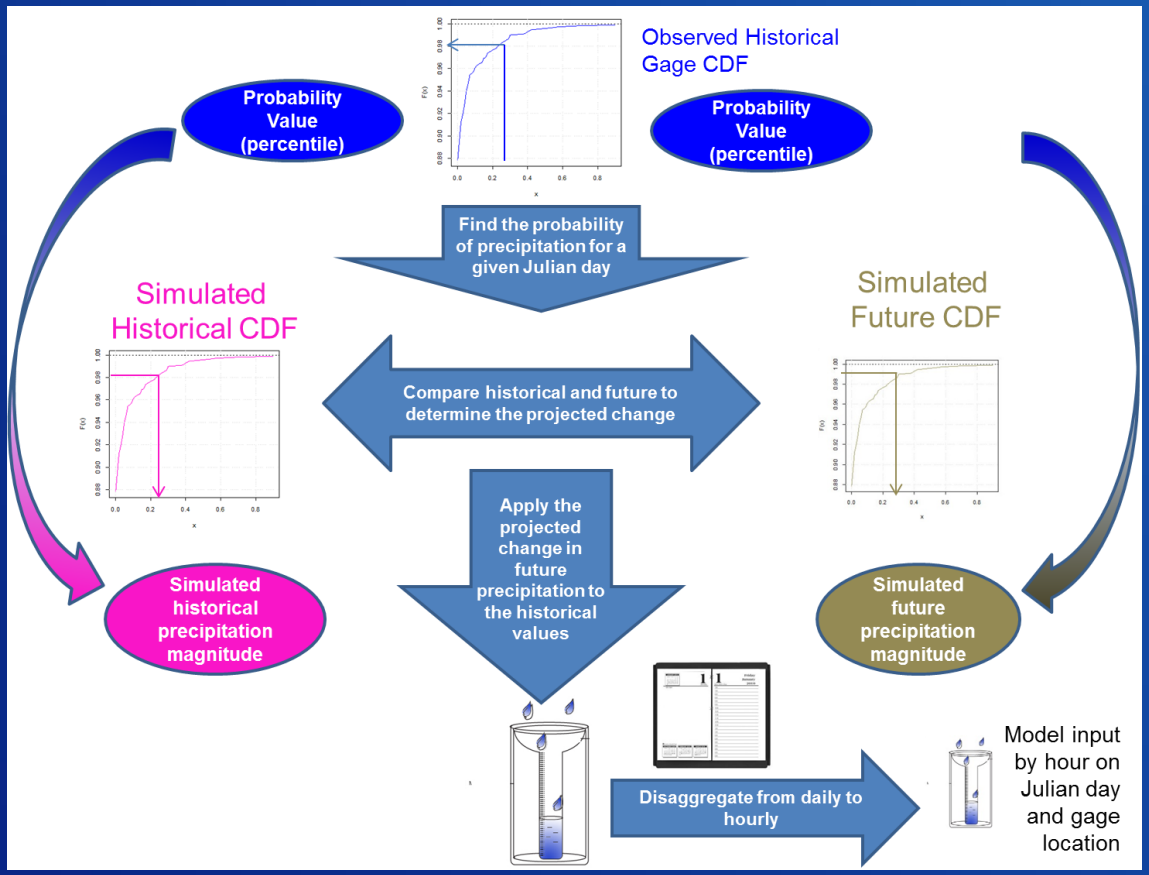




This projection selection was completed for all six future periods.

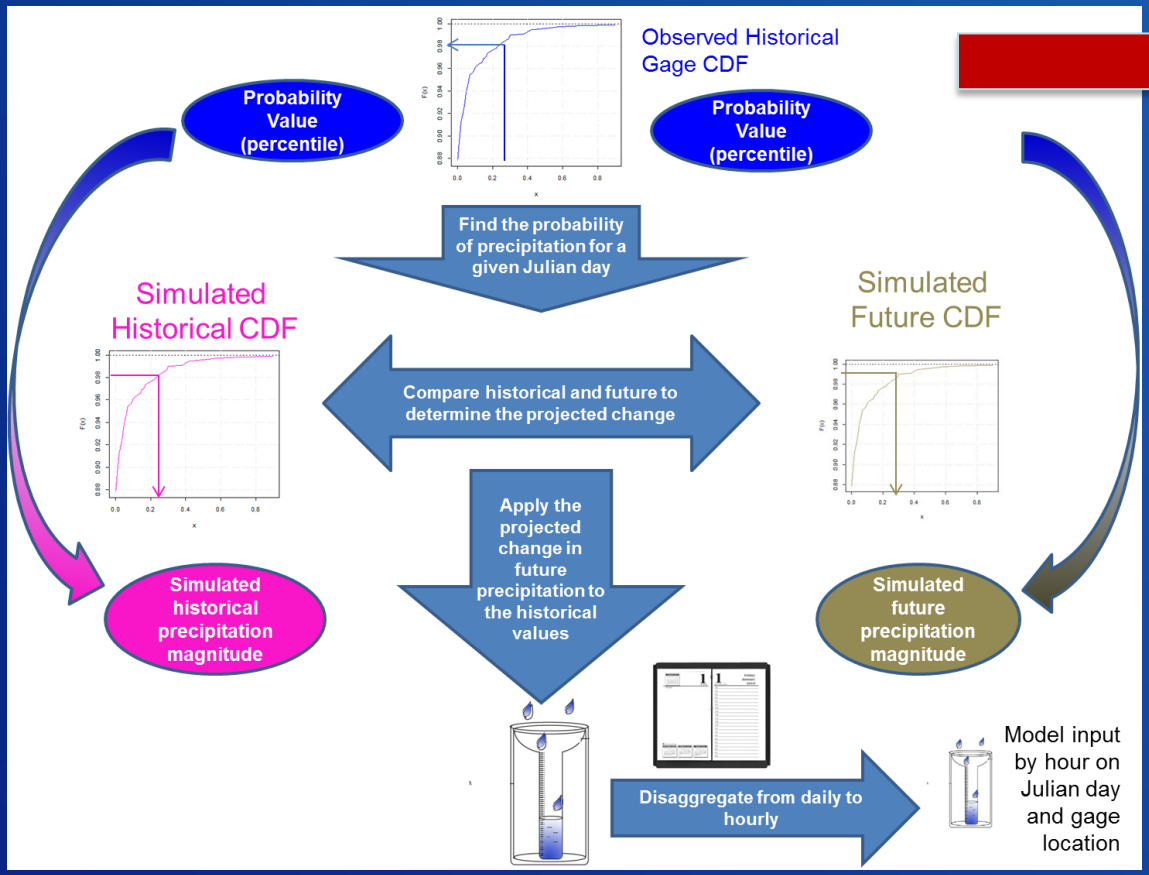
RECLAMATION

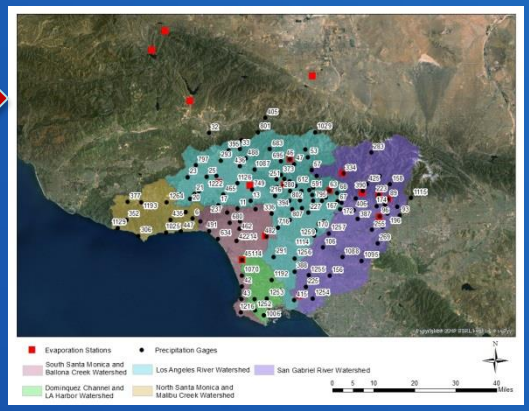
Precipitation Time-Series



RECLAMATION

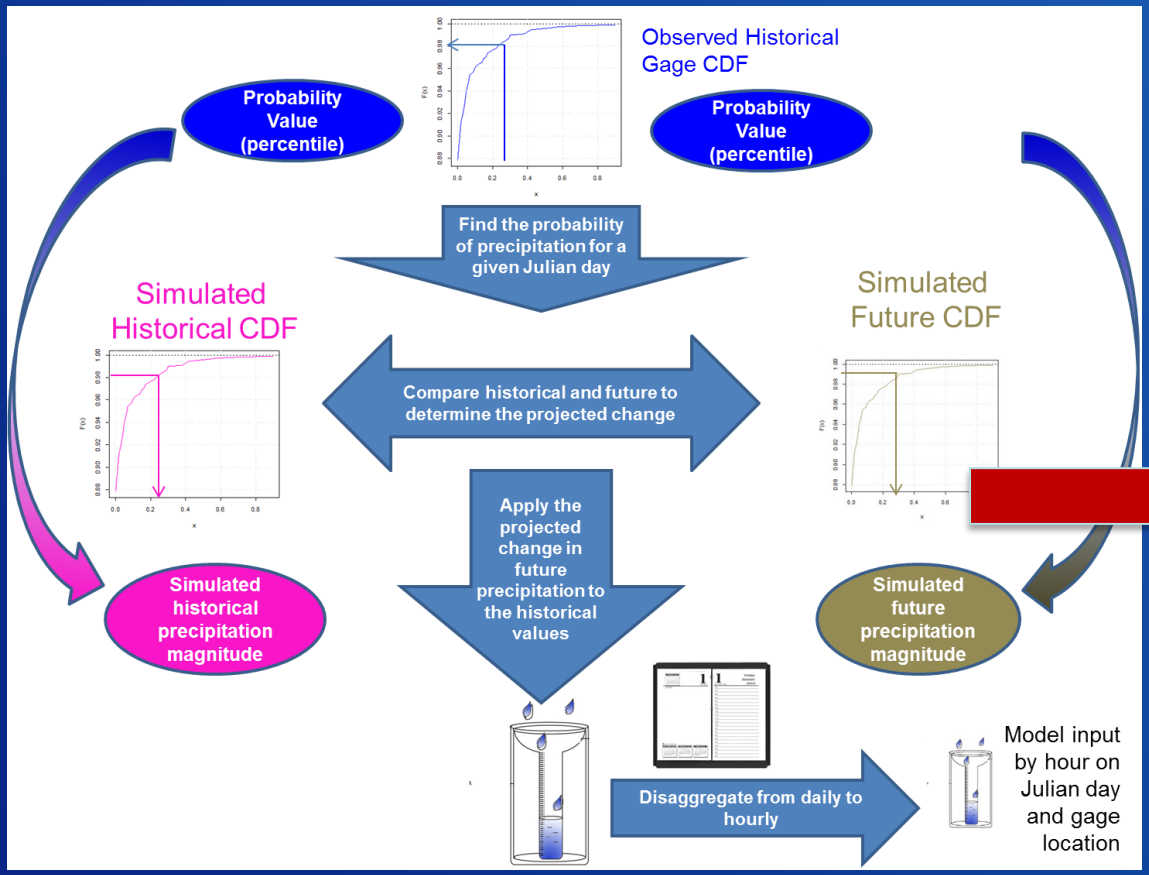
Precipitation Time-Series

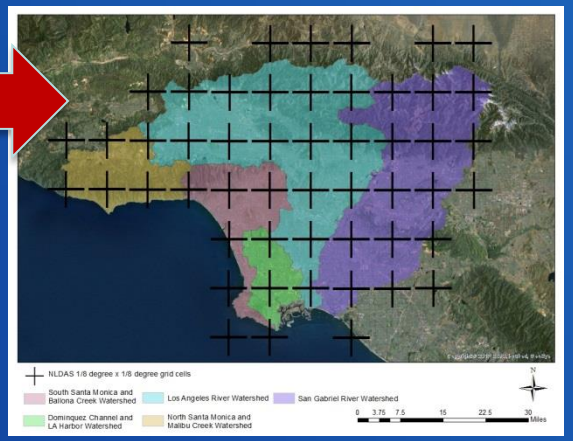




RECLAMATION

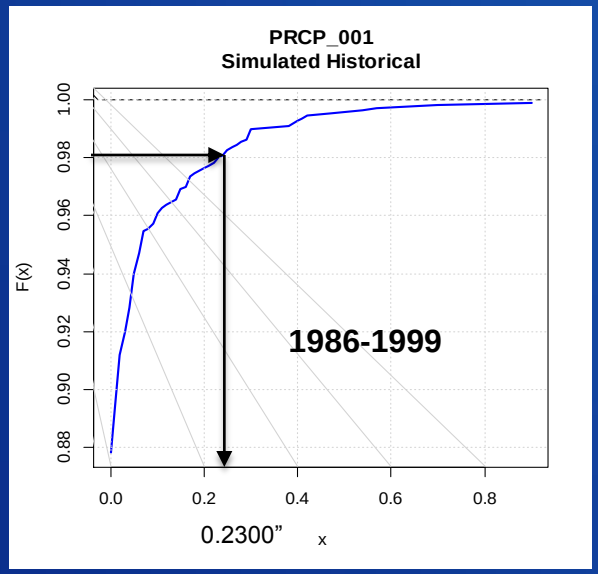
Precipitation Time-Series

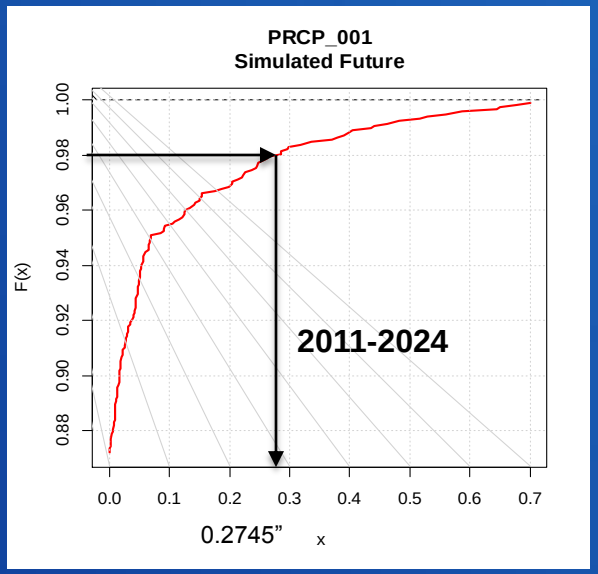




RECLAMATION

Climate Conditioned Weather Sequences





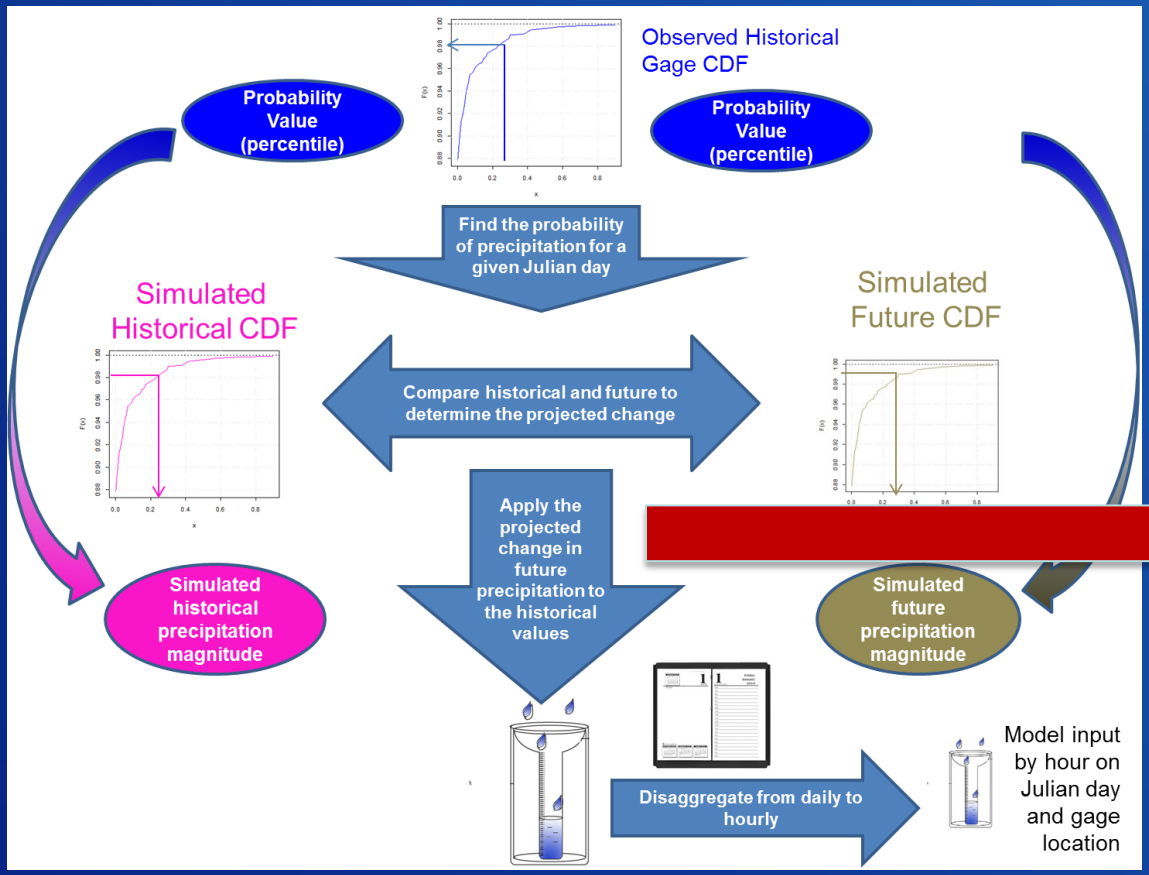
In this example, change factor for percentile 0.98 is,

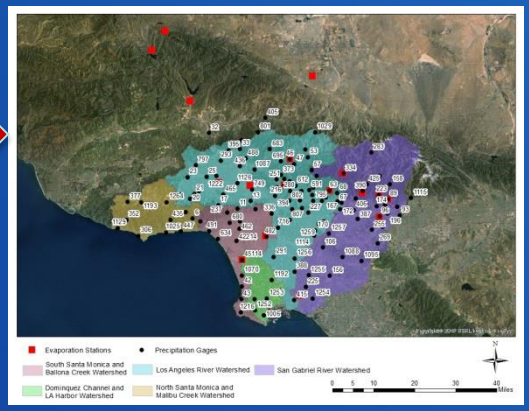
100*(0.2745 – 0.2300) /0.2300 = 19.35%

Interpretation - for the Q1 scenario in the first future period (2011-2024), at the 0.98 percentile, precipitation is expected to increase by 19.35% from the historical period (1986-1999).

RECLAMATION

Precipitation Time-Series

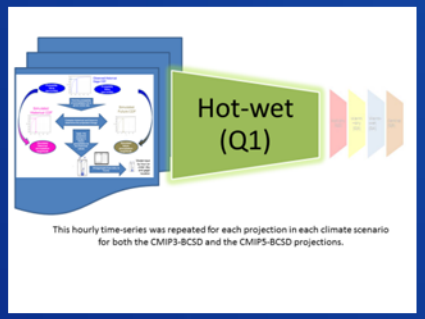




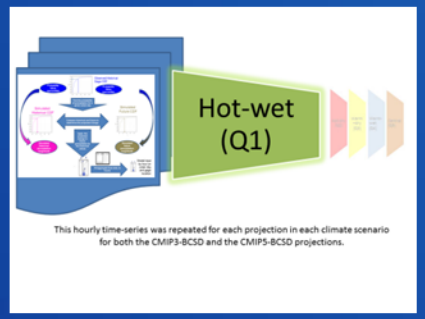
RECLAMATION

Precipitation Time-Series

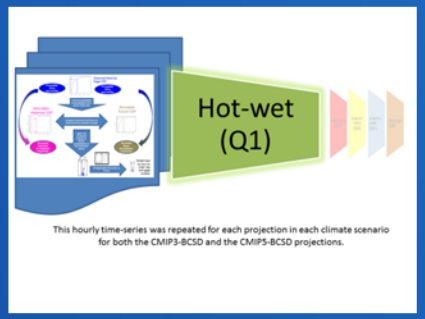
Future period 1: 2011 - 2024



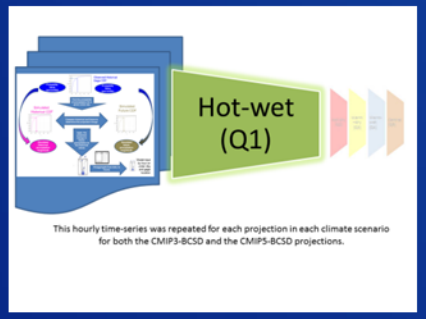
Future period 2: 2025 -2038



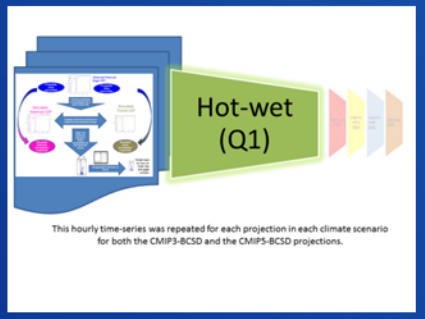
Future period 3: 2039 -2052



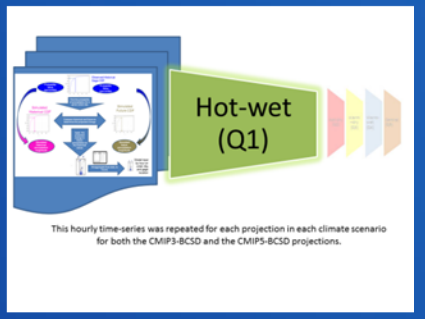
Future period 4: 2053-2066



Future period 5: 2067-2080



Future period 6: 2081-2099



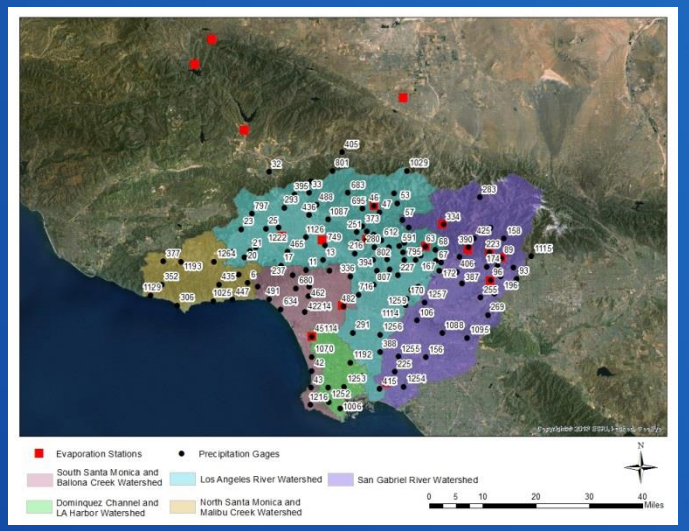
For each climate scenario,
this hourly time-series was repeated for all six future periods
and concatenated.

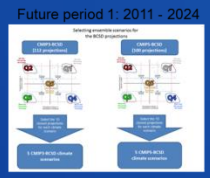
RECLAMATION

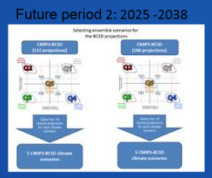
Potential Evaporation Time-Series

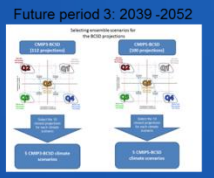
Needed for WMMS:

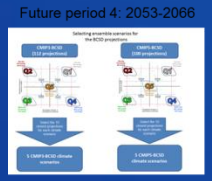
- Continuous
- Hourly
- 2011-2099

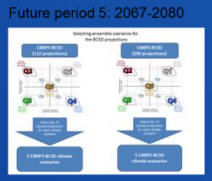


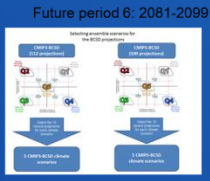












This projection selection was completed for all six future periods.

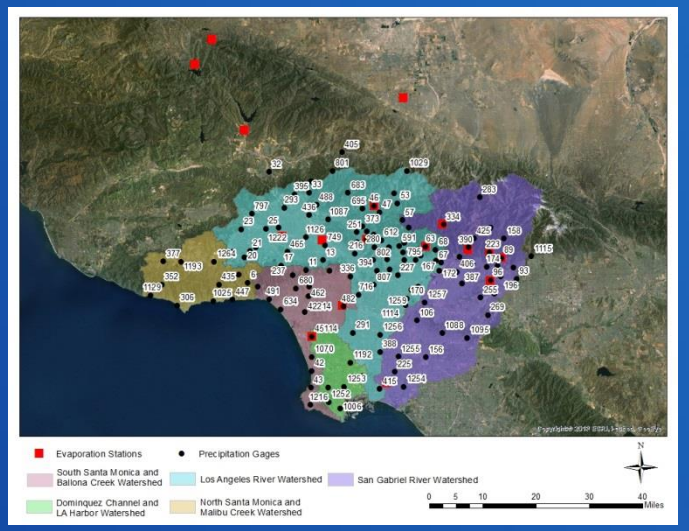
RECLAMATION

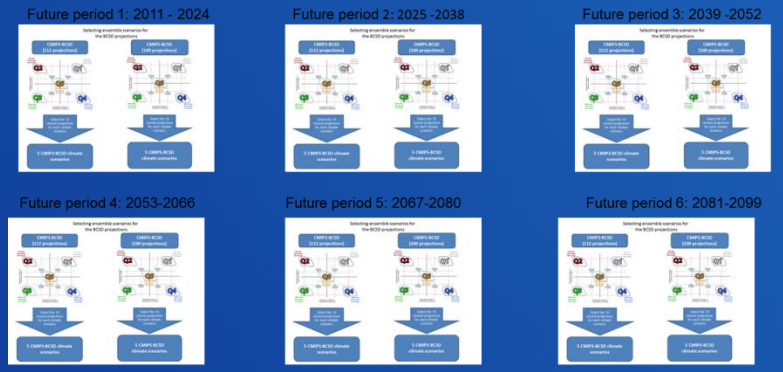
Potential Evaporation Time-Series

Needed for WMMS:

- Continuous
- Hourly
- 2011-2099

Used a similar approach as that used for precipitation (quantile mapping)



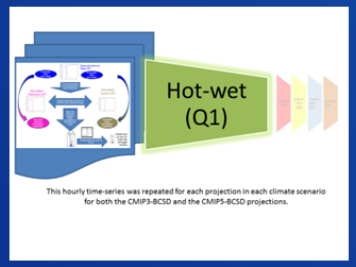


This projection selection was completed for all six future periods.

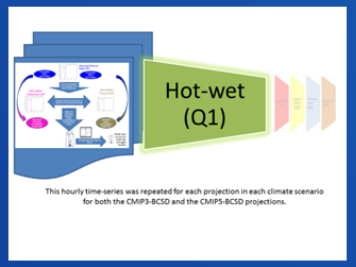
RECLAMATION

Potential Evaporation Time-Series

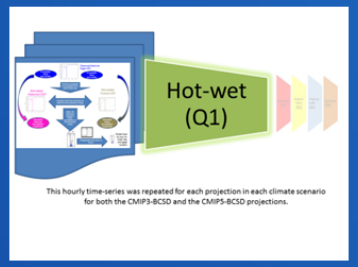
Future period 1: 2011 - 2024



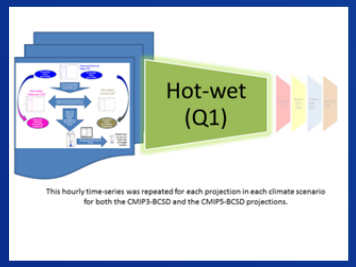
Future period 2: 2025 -2038



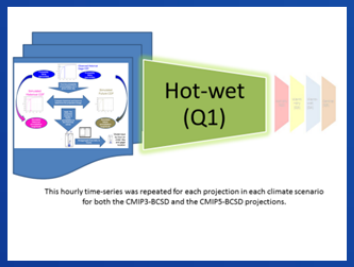
Future period 3: 2039 -2052



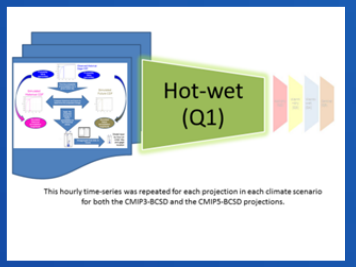
Future period 4: 2053-2066



Future period 5: 2067-2080



Future period 6: 2081-2099

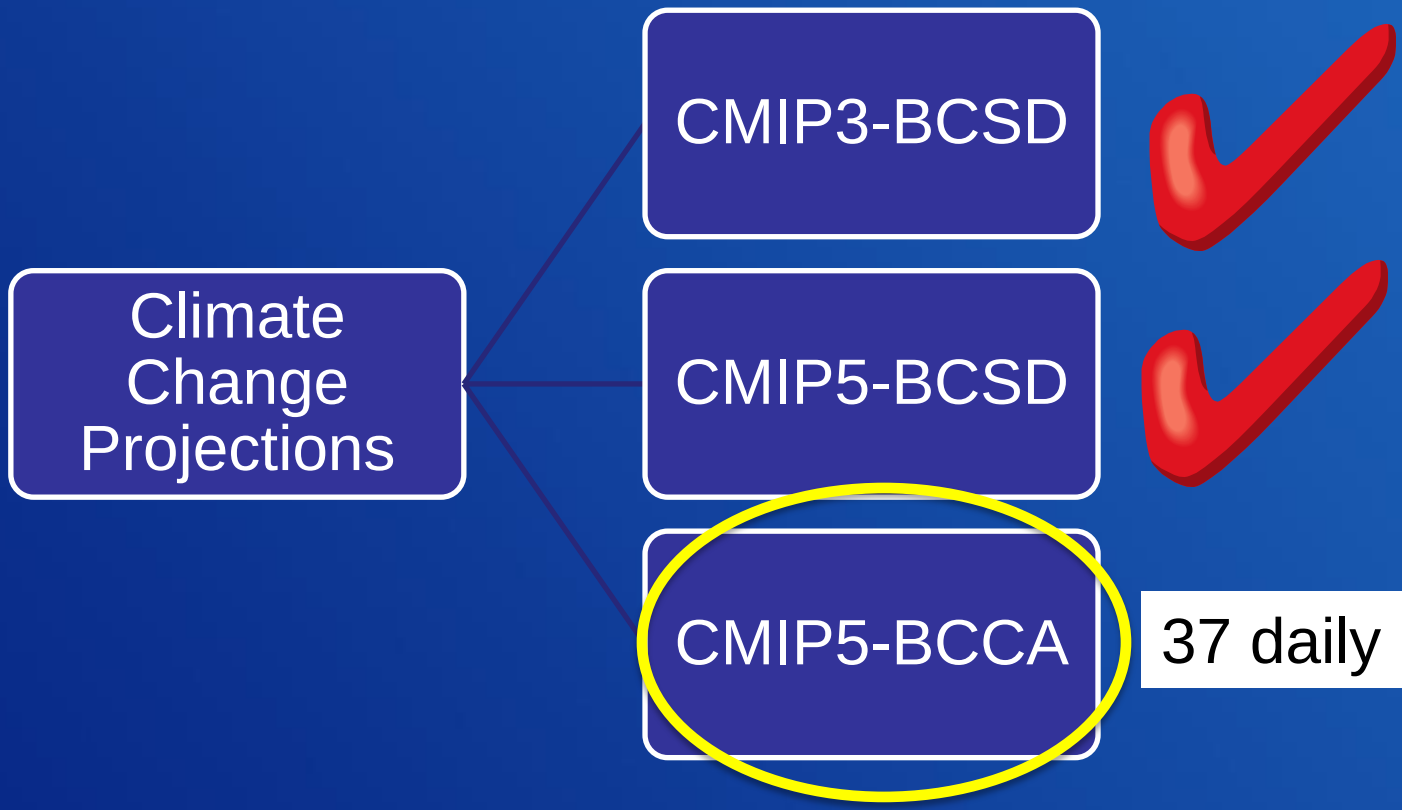


For each climate scenario,
this hourly time-series was repeated for all six future periods
and concatenated.

The simulated open water evaporation was developed from the Variable Infiltration Capacity (VIC) model.

RECLAMATION

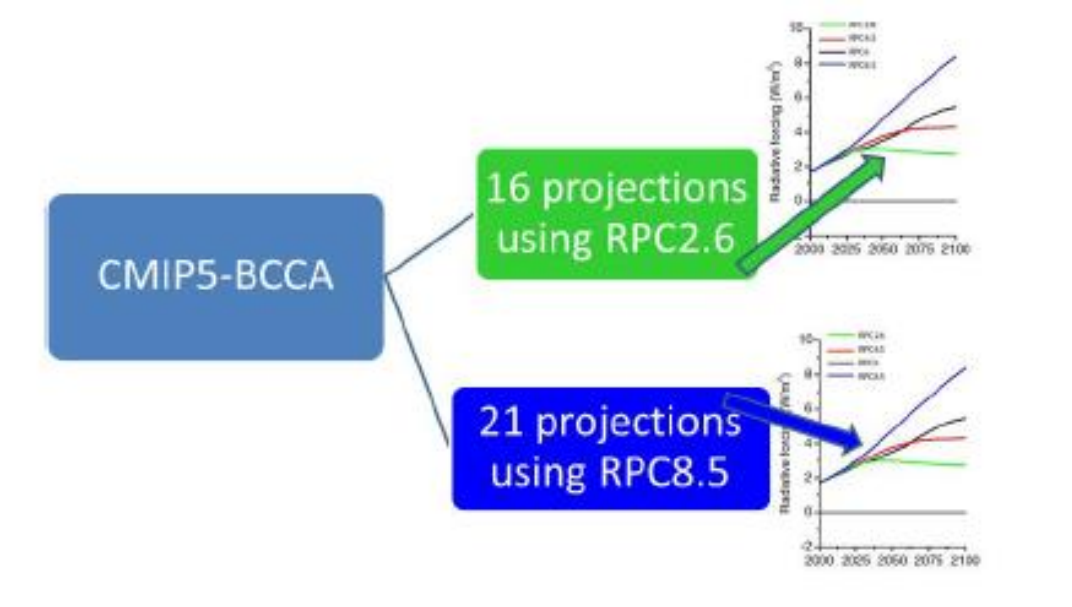
Climate Projections



Subset of CMIP5-BCCA from high and low emissions pathways

RECLAMATION

CMIP5-BCCA Projections

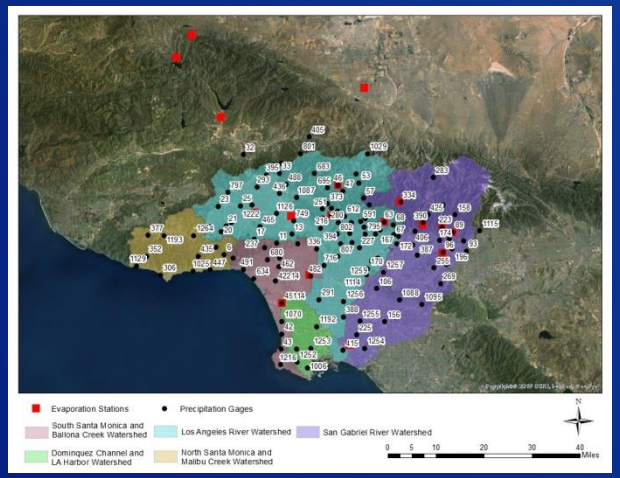


RCP2.6: “high mitigation” pathway
RCP8.5: “business-as-usual” pathway

RECLAMATION

Precipitation Time-Series

- CMIP5-BCCA projections on daily time-step.
- Needed to disaggregate to hourly.
- Used 3-day sequences from the historical observations.



RECLAMATION

Potential Evaporation Time-Series

- Daily maximum and minimum temperature from CMIP5-BCCA were used in the Hargreaves-Samani model
- Bias-corrected at each of the LACDPW's evaporation stations
- Daily disaggregated to hourly by the average historical hourly distribution

Task 3.1 Objectives

Develop and evaluate projected future climate conditions related to precipitation frequency over the LA Basin:

1. Consider existing projections of climate change
2. Determine appropriate climate scenarios
3. Prepare data for input into WMMS
4. Determine storm event frequency

Sub-task 4: Storm Event Frequency

Storm event frequency provides:

- Magnitude of the storm event (inches)
- Likelihood of the storm event to occur (50-yr recurrence interval has a 2% chance of occurring within any given year)

Developed storm event frequency for the 47 model runs:

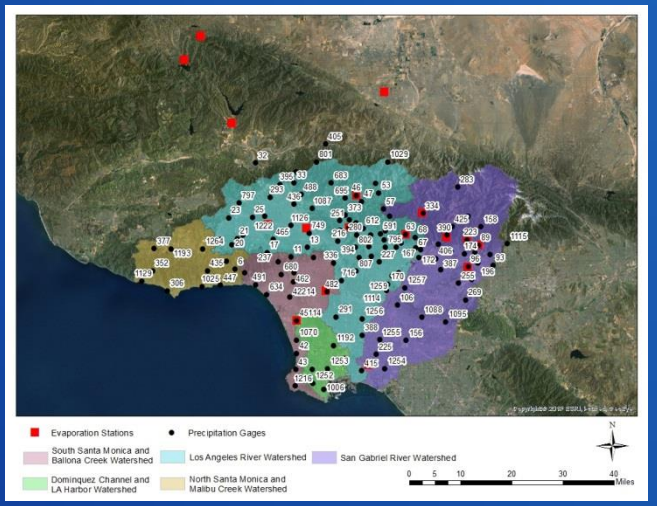
- 5 climate scenarios for CMIP3-BCSD
- 5 climate scenarios for CMIP5-BCSD
- 16 “high mitigation” CMIP5-BCCA
- 21 “business-as-usual” CMIP5-BCCA

Storm Event Frequency

Storm event frequency calculated at each of the 134 rain gages

Storm event frequency calculated at the following recurrence intervals (24-hr duration):

- 5-year
- 10-year
- 25-year
- 50-year
- 100-year
- 200-year



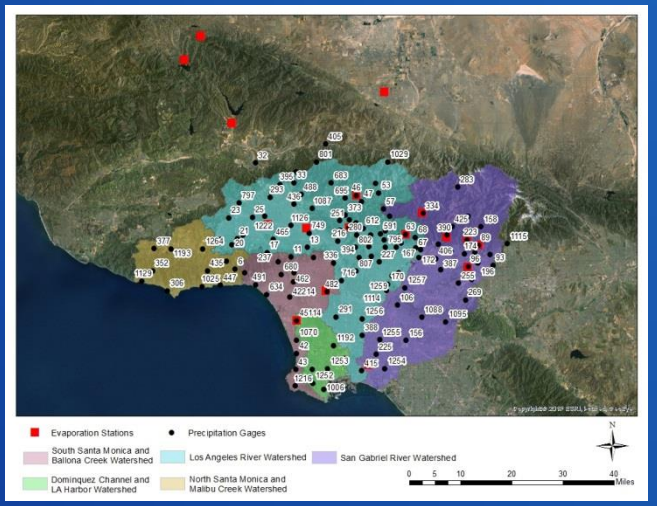
RECLAMATION

Storm Event Frequency

Storm event frequency calculated at each of the 134 rain gages

Storm event frequency calculated at the following recurrence intervals (24-hr duration):

- 5-year
- 10-year
- 25-year
- 50-year
- 100-year
- 200-year



RECLAMATION

Storm Event Frequency

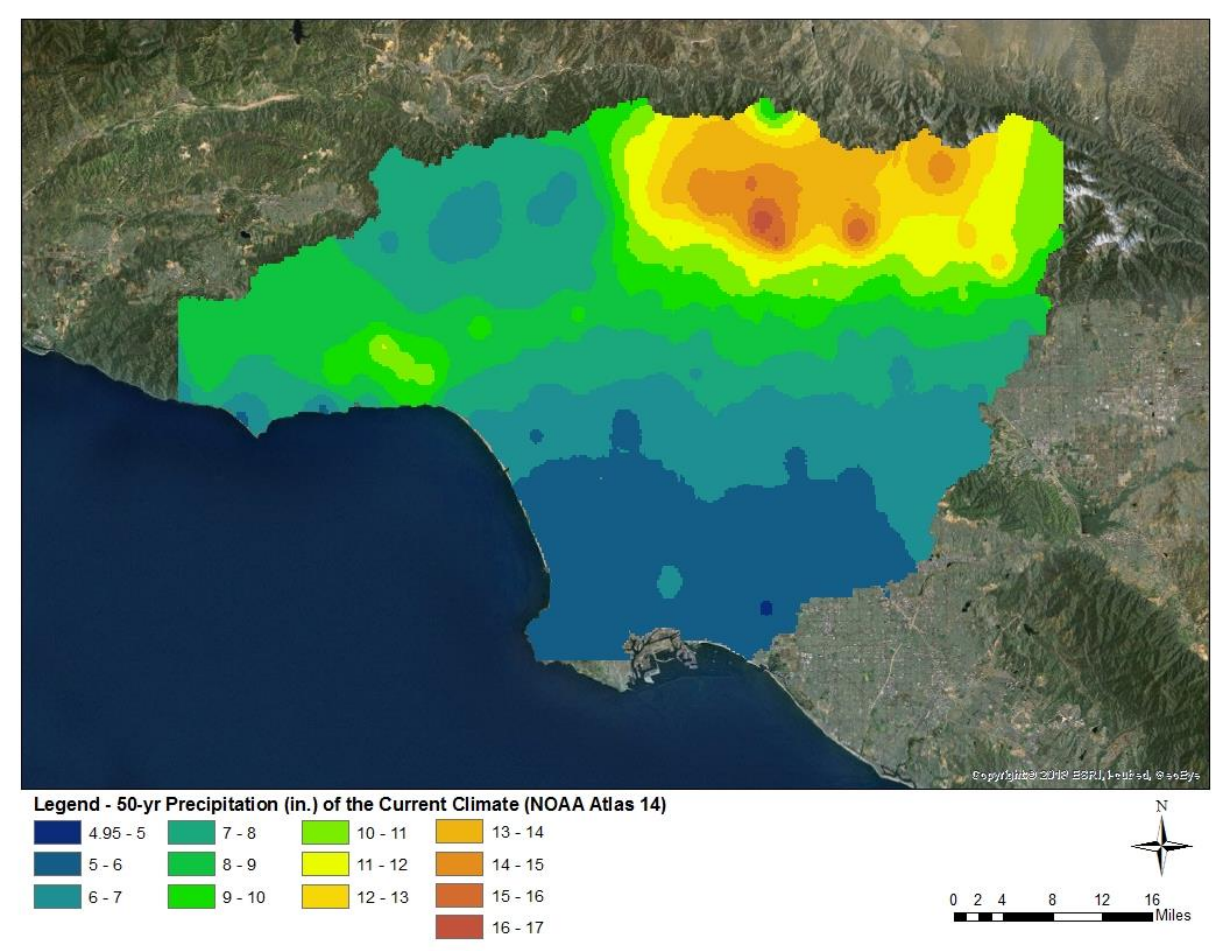
Rain Gage No. 32								
	Precipitation depth (inches):		24-hr, 5-yr	24-hr, 10-yr	24-hr, 25-yr	24-hr, 50-yr	24-hr, 100-yr	24-hr, 200-yr
	LACFCD		4.48	5.56	6.93	7.94	8.94	9.94
	NOAA Atlas 14		4.52	5.51	6.80	7.78	8.77	9.78
BCSD	CMIP3	Hot dry	3.31	4.13	5.25	6.13	7.06	8.04
		Hot wet	4.25	5.40	6.97	8.21	9.53	10.92
		Central	3.60	4.40	5.41	6.14	6.87	7.58
		Warm dry	3.34	4.27	5.58	6.67	7.85	9.13
		Warm wet	4.55	5.79	7.50	8.87	10.31	11.85
	CMIP5	Hot dry	3.75	4.56	5.57	6.31	7.04	7.76
		Hot wet	4.96	6.19	7.80	9.02	10.28	11.56
		Central	3.66	4.55	5.73	6.64	7.59	8.57
		Warm dry	3.25	3.98	4.91	5.60	6.29	6.97
		Warm wet	4.23	5.39	7.01	8.34	9.78	11.34
	Minimum		**3.25**	**3.98**	**4.91**	**5.60**	**6.29**	**6.97**
	Maximum		**4.96**	**6.19**	**7.80**	**9.02**	**10.31**	**11.85**

Storm Event Frequency

Rain Gage No. 32							
	Precipitation depth (inches):		24-hr, 5-yr	24-hr, 10-yr	24-hr, 25-yr	24-hr, 50-yr	24-hr, 100-yr	24-hr, 200-yr
	LACFCD		4.48	5.56	6.93	7.94	8.94	9.94
	NOAA Atlas 14		4.52	5.51	6.80	7.78	8.77	9.78
BCCA	RCP2.6	0.01	3.19	3.78	4.51	5.03	5.42	5.66
		0.25	3.59	4.23	4.85	5.33	5.75	6.13
		0.5	3.76	4.36	5.08	5.54	5.93	6.33
		0.75	4.02	4.65	5.32	5.81	6.23	6.64
		0.99	4.29	4.84	5.51	6.01	6.47	7.00
	RCP8.5	0.01	3.12	3.62	4.20	4.60	4.94	5.25
		0.25	3.64	4.28	4.96	5.43	5.70	5.89
		0.5	3.87	4.52	5.30	5.64	6.05	6.46
		0.75	4.27	4.89	5.56	6.01	6.59	6.94
		0.99	4.82	5.21	5.89	6.54	7.22	7.92
	Minimum		**3.12**	**3.62**	**4.20**	**4.60**	**4.94**	**5.25**
	Maximum		**4.82**	**5.21**	**5.89**	**6.54**	**7.22**	**7.92**

RECLAMATION

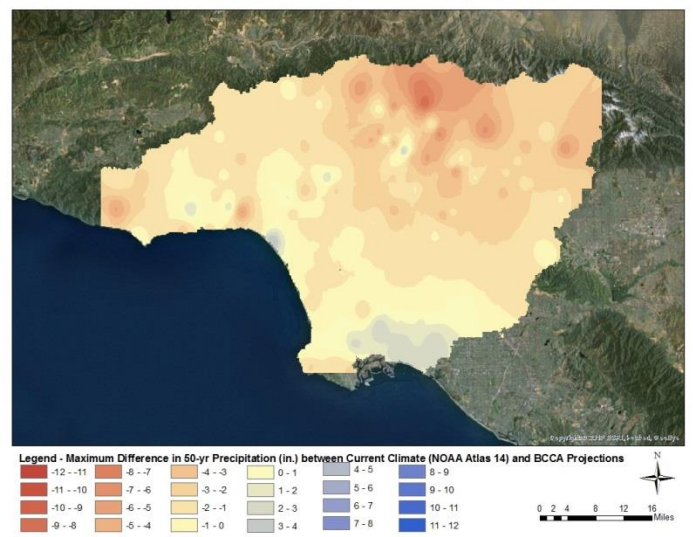
Storm Event Frequency Current Climate

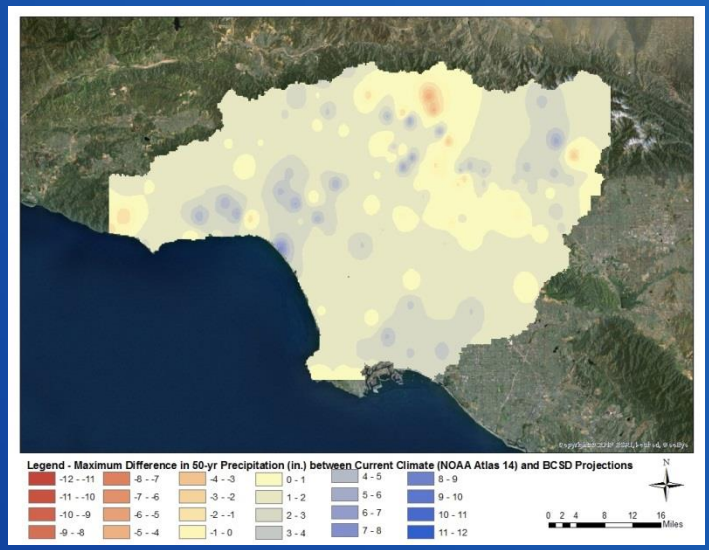


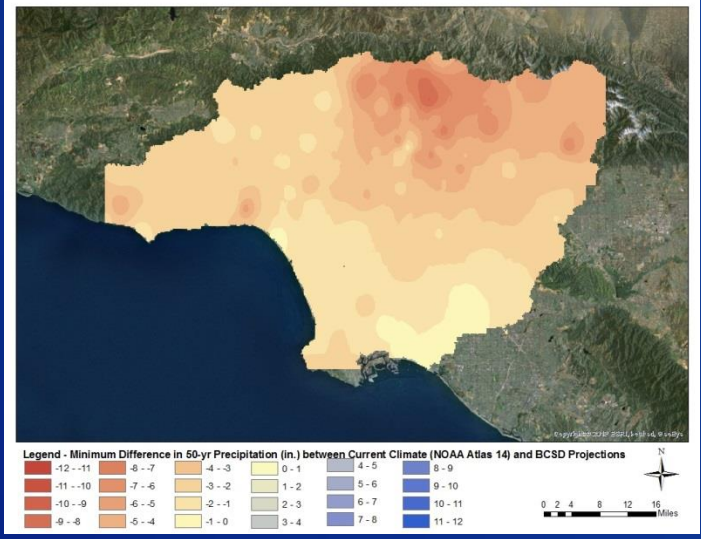
Perica et al., 2012

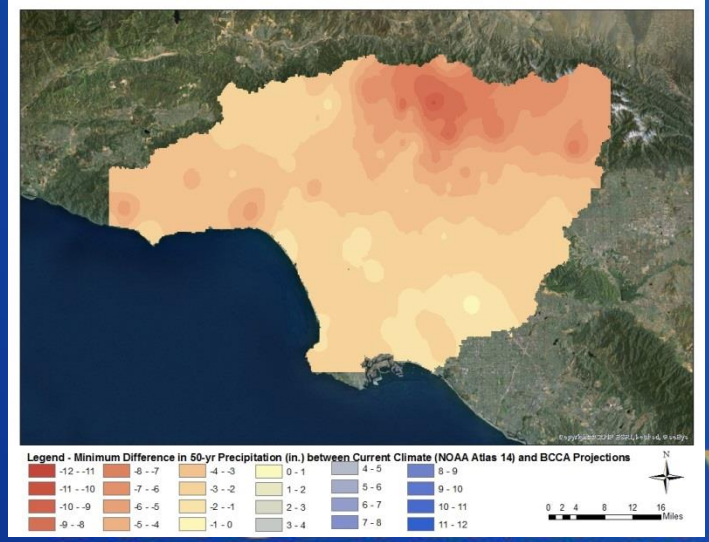
RECLAMATION

Storm Event Frequency Variability





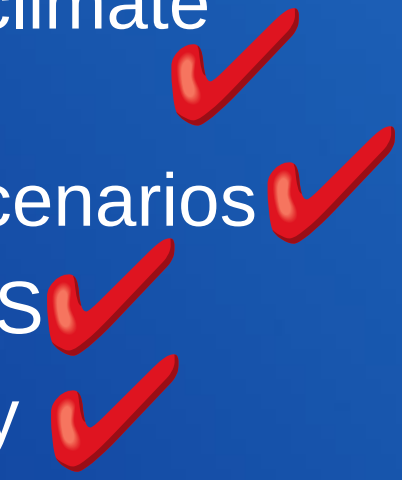




Task 3.1 Objectives

Develop and evaluate projected future climate conditions related to precipitation frequency over the LA Basin:

1. Consider existing projections of climate change
2. Determine appropriate climate scenarios
3. Prepare data for input into WMMS
4. Determine storm event frequency



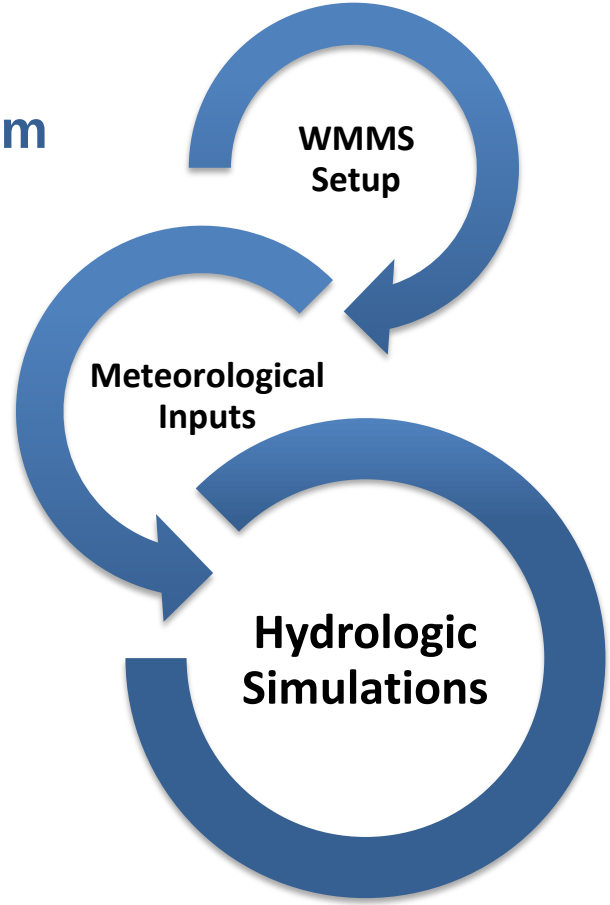
RECLAMATION

Task 3.2 – Hydrologic Modeling

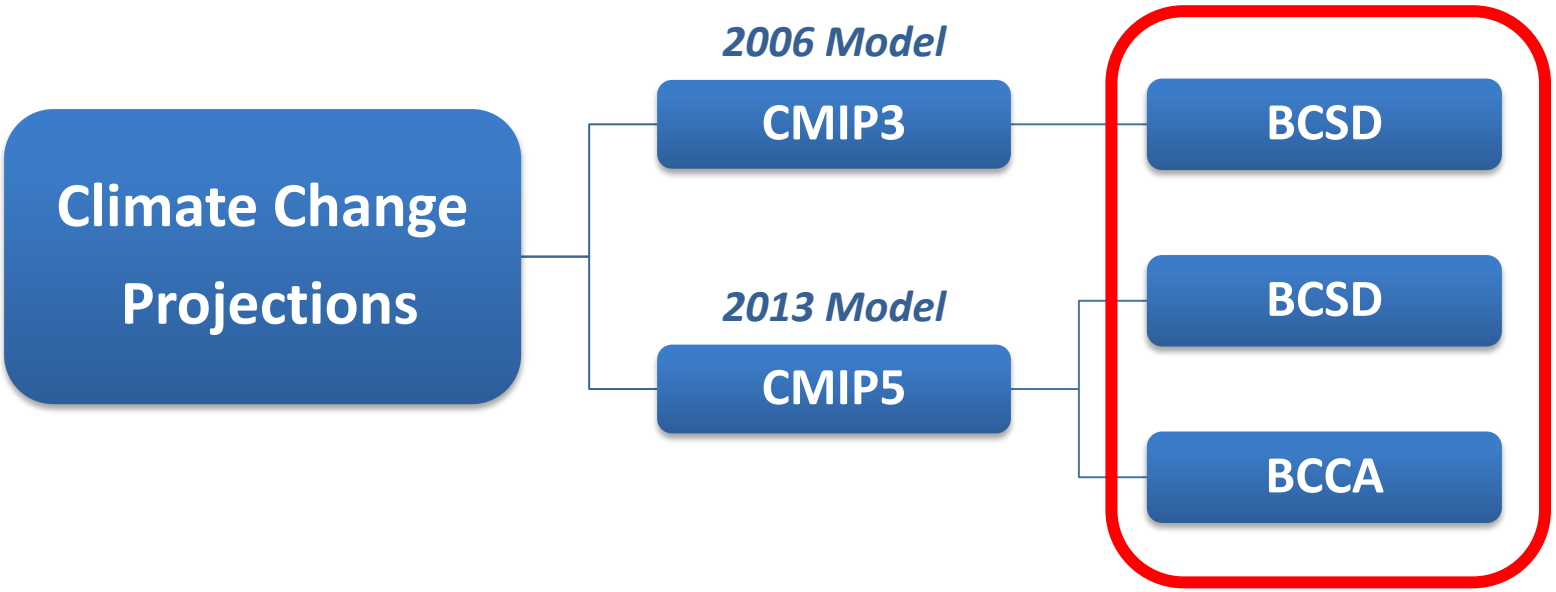
Hydrologic Modeling

Watershed Management Modeling System

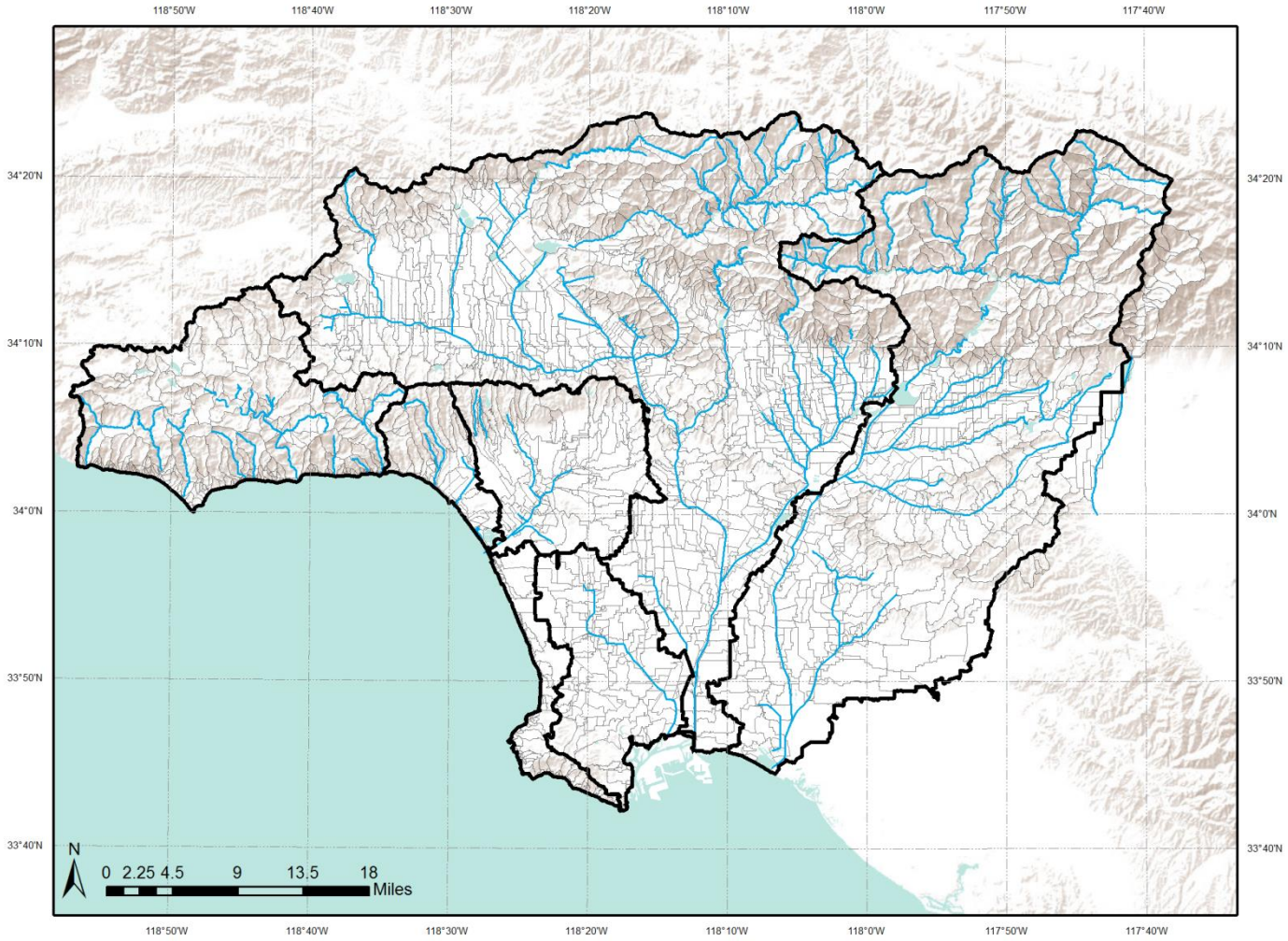
- Historic Hydrology
  - Water Year 1987-2000
  - *Baseline Conditions*
- Projected Hydrology
  - Water Year 2012-2095



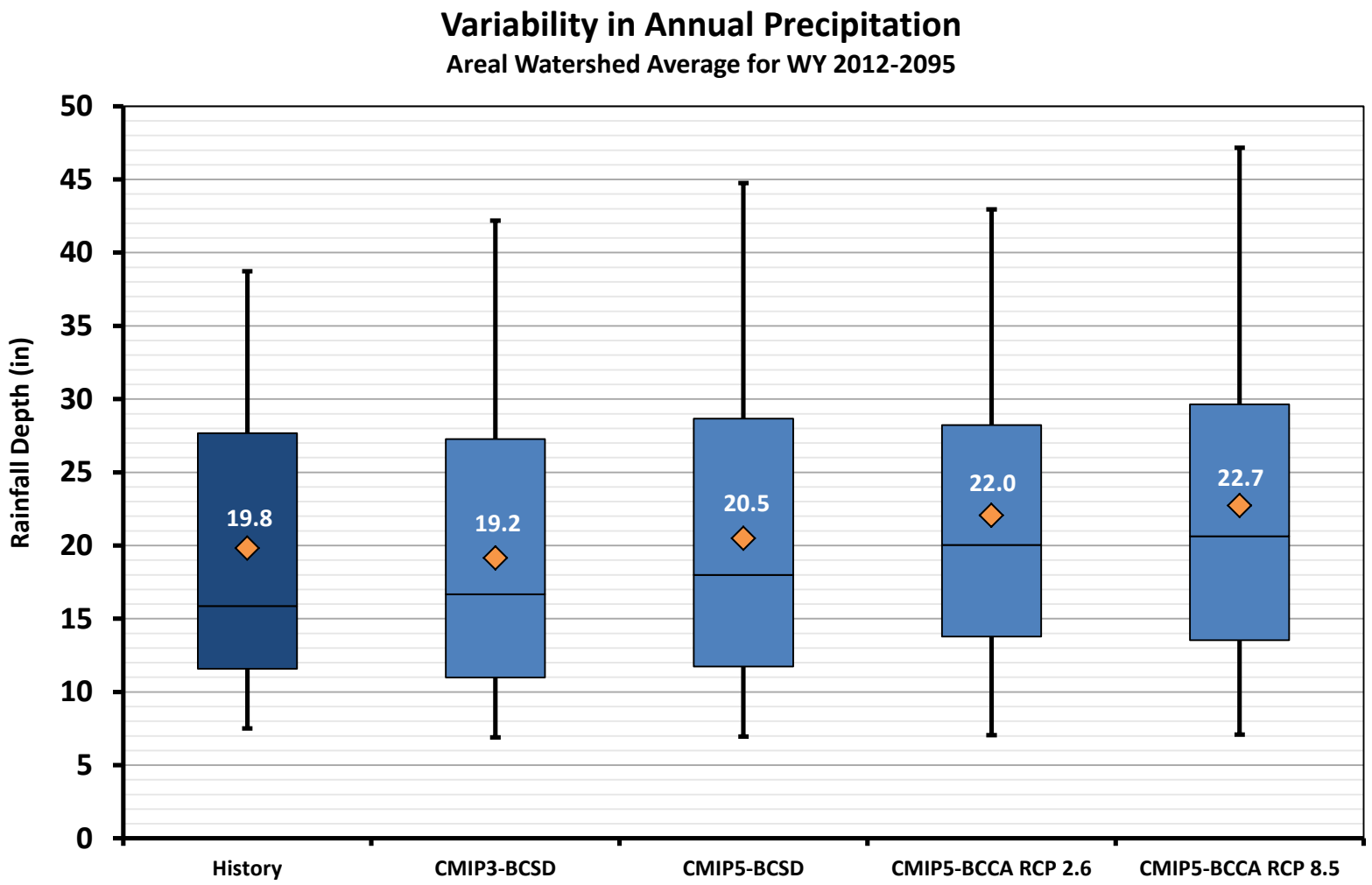
Climate Projections



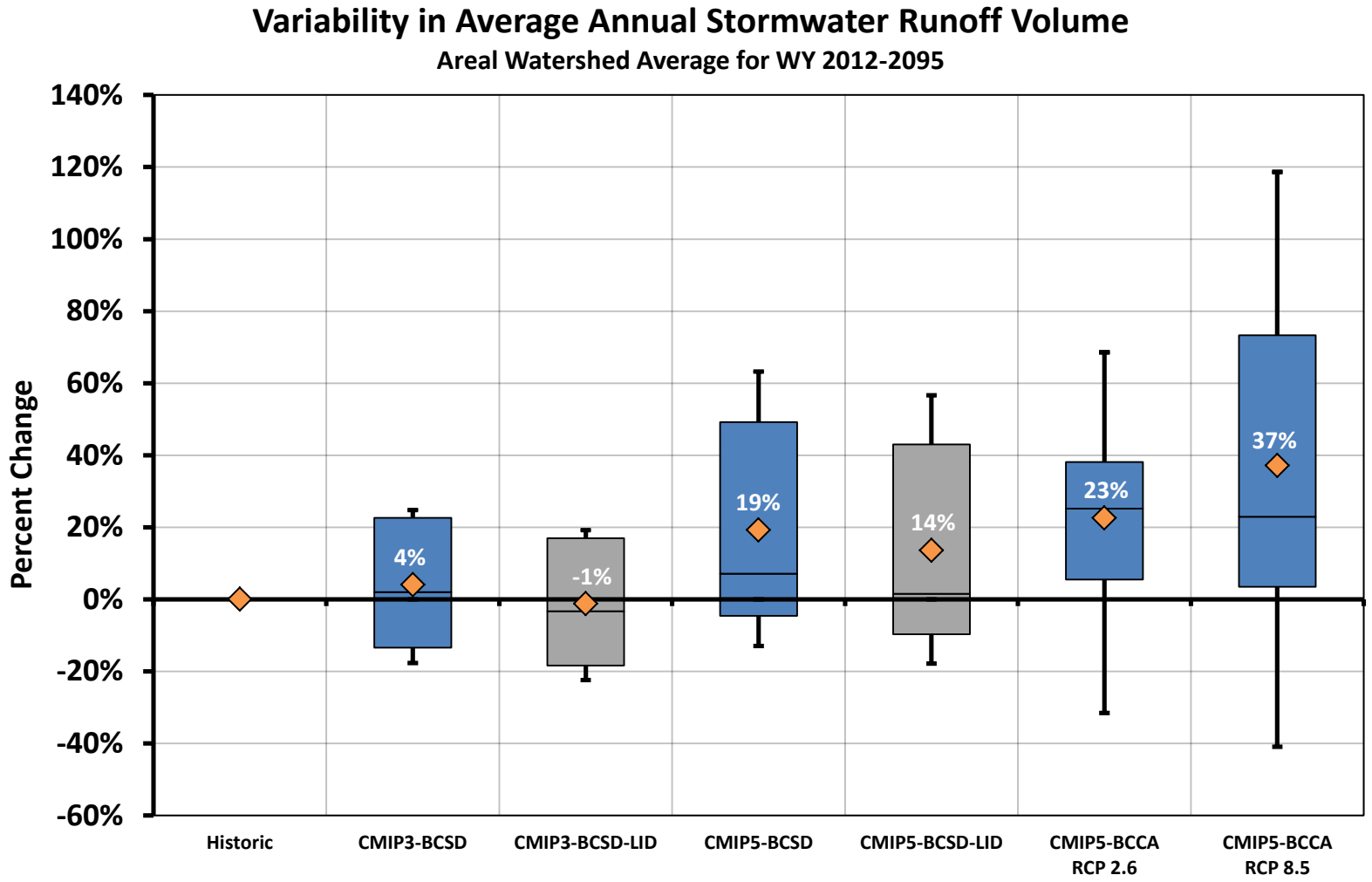
Overall Watershed Results



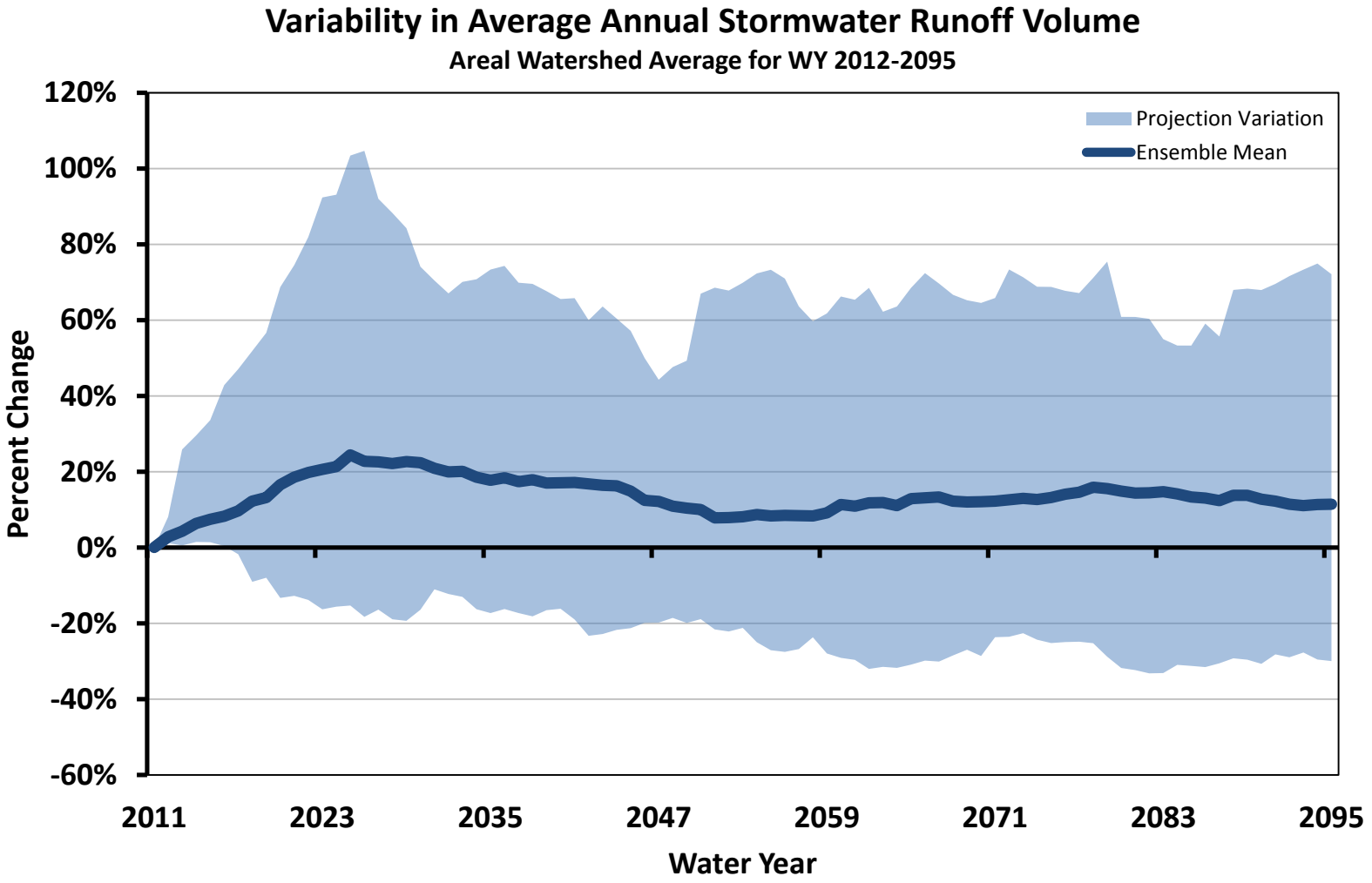
Projected Precipitation



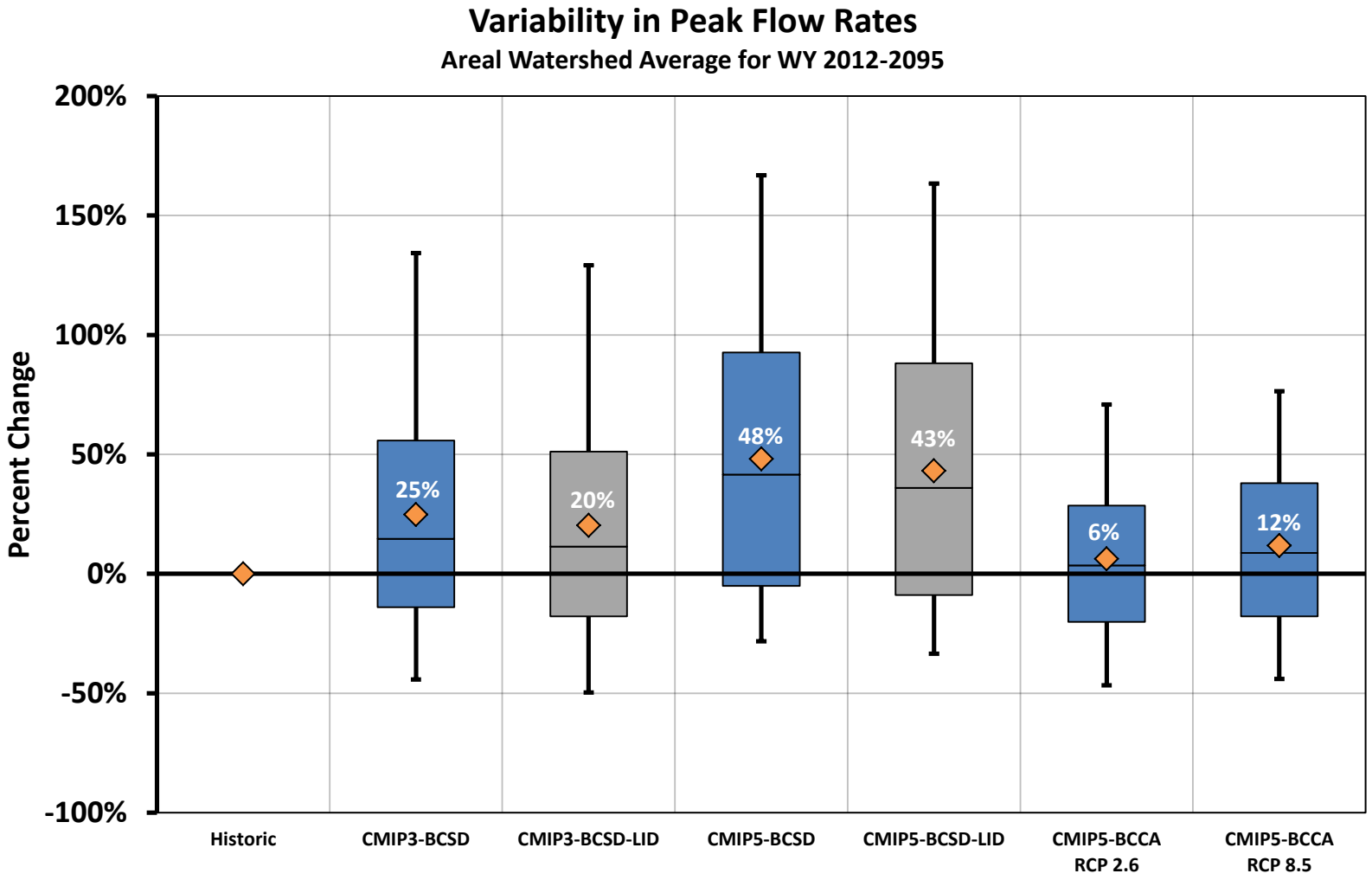
Projections - Stormwater Runoff



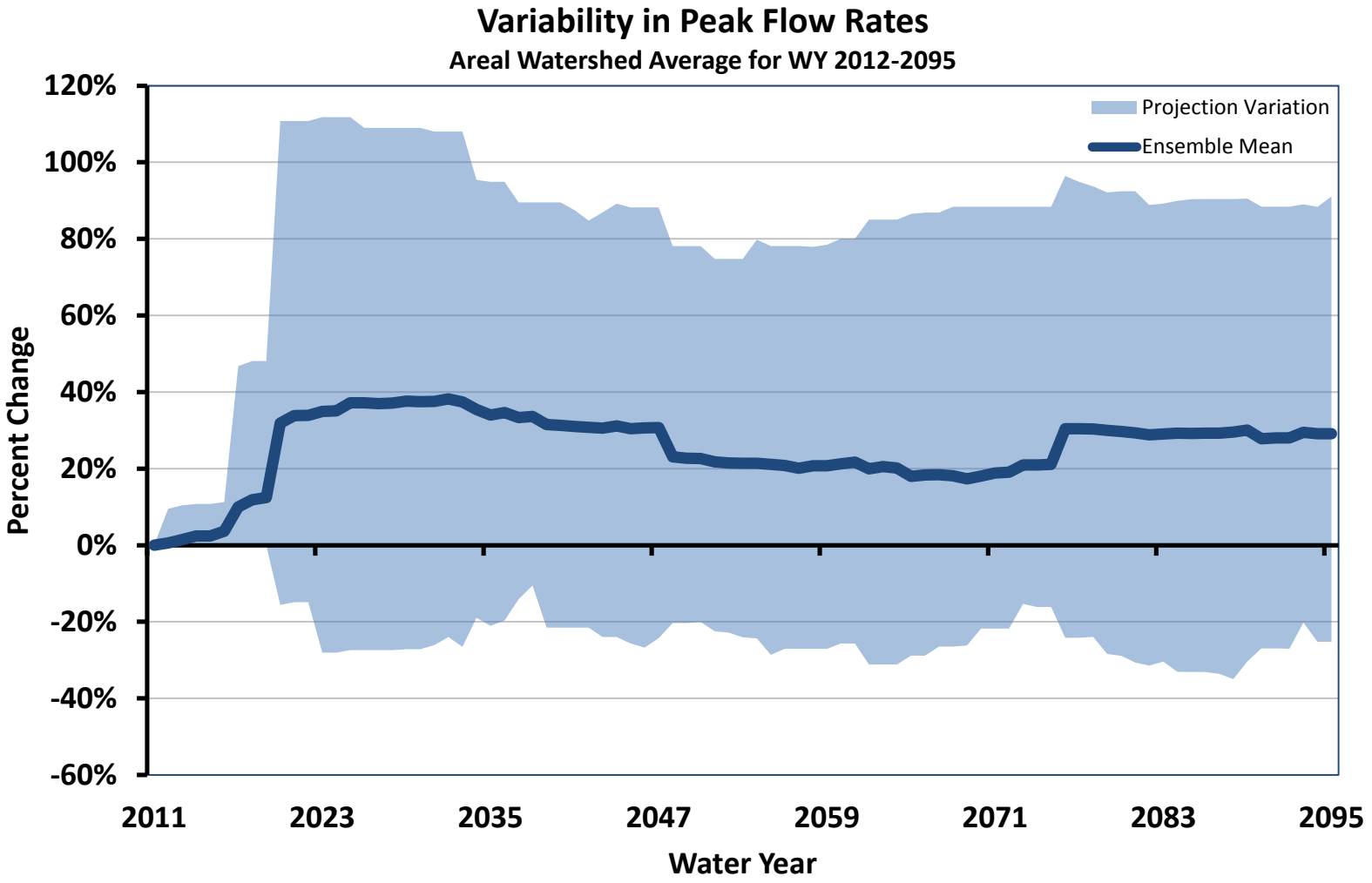
Projections - Stormwater Runoff



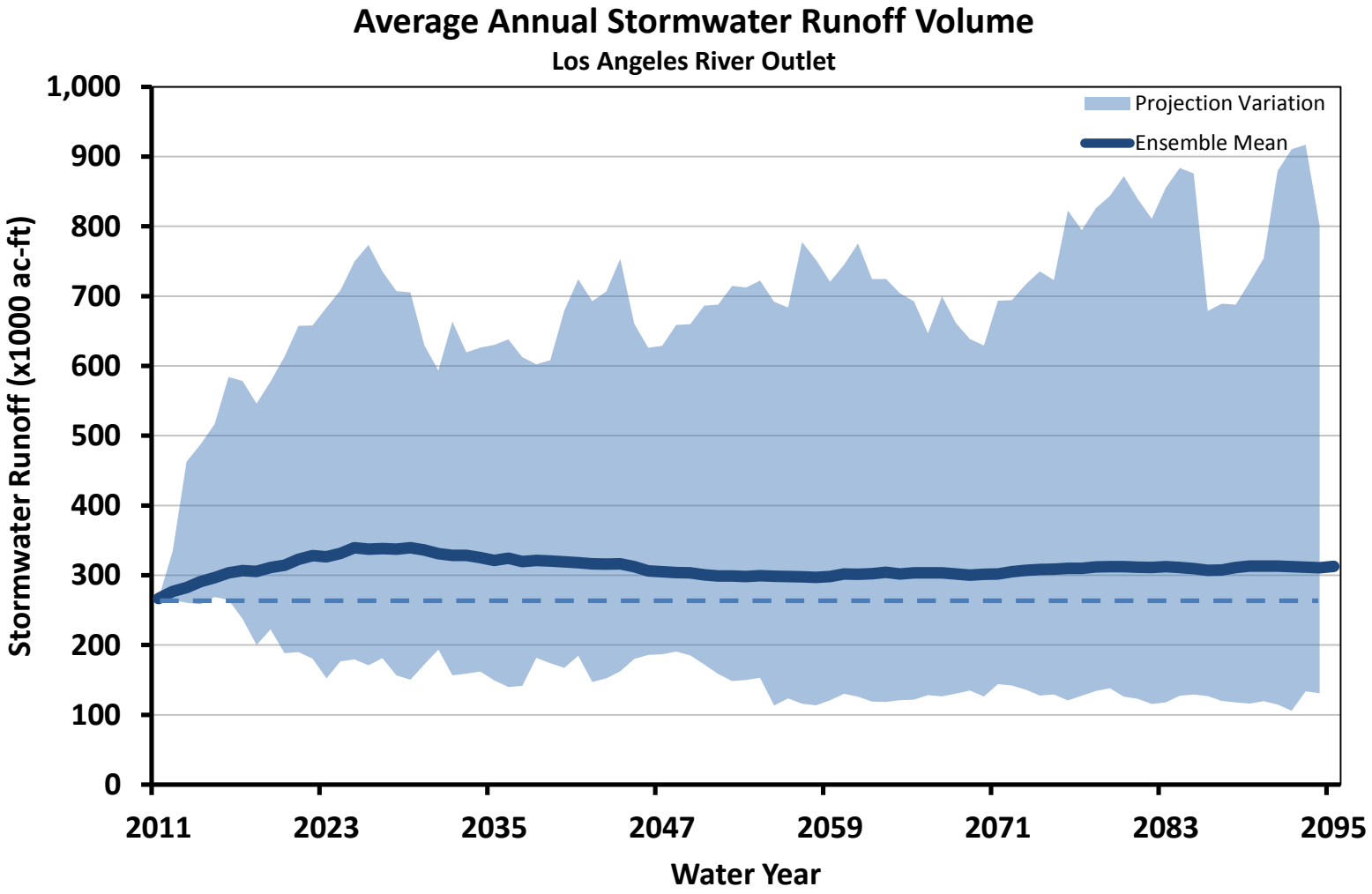
Projections - Peak Flow



Projections - Peak Flow



Los Angeles River



Conclusions

Stormwater Runoff Volumes

- Projected increase in overall runoff volumes

Peak Flood Flow Rates

- Projected increase in overall flow rates

Low Impact Development

- Potential to supplement stormwater recharge supplies
- Nominal effect on reducing peak flow rates

There is a large variability within the climate projections. While most projections show increases, some indicate potential for decreases.

Task 3 Q&A

Next Steps

STAC Review of Task 3 Reports

Public Meeting – Fall 2013

Next Tasks

- Task 2 – Water Supply & Demand Projections
- Task 4 – Existing Infrastructure Response & Operations Plans Analysis

Contacts

Los Angeles Basin Stormwater Conservation Study

http://www.usbr.gov/lc/socal/basinstudies/LABasin.html

LACFCD Contact:

Lee Alexanderson, P. E.
County of Los Angeles
Department of Public Works
Los Angeles County Flood Control District
Watershed Management Division
(626) 458-4370
lalexanderson@dpw.lacounty.gov

Reclamation Contact:

Amy Witherall, Water Resources Planner
Department of the Interior
Bureau of Reclamation
Lower Colorado River Region
Southern California Area Office
(951) 695-5310
awitherall@usbr.gov