CITY OF SAN DIEGO- PUBLIC UTILITIES DEPARTMENT

U. S. DEPARTMENT OF THE INTERIOR – BUREAU OF RECLAMATION

SAN DIEGO WATERSHED BASIN STUDY

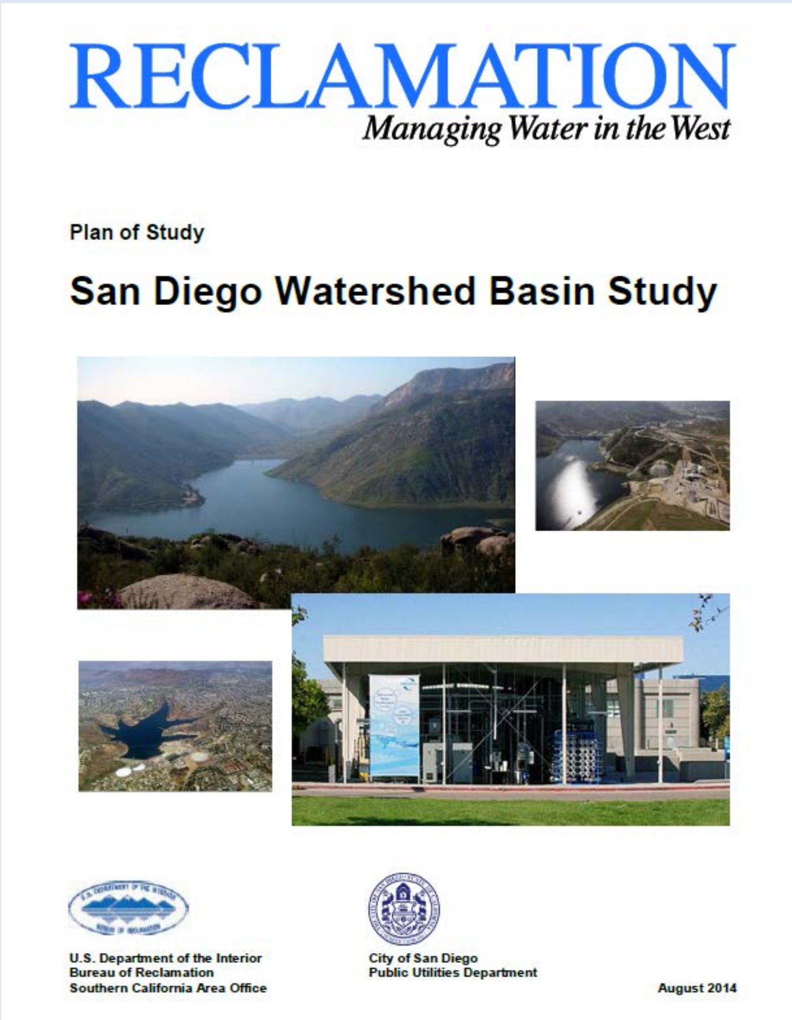
STAKEHOLDER MEETING #2

February 2, 2016

San Diego Watershed Basin Study Agenda

- Welcome and Introductions -Goldy Herbon
- SD Watershed Basin Study Update-Leslie Cleveland
- Task 2.1 and 2.2 Overview
  - Task 2.1- Allison Danner
  - Task 2.2- Dan Broman
- Questions and Comments
- Next Steps- Leslie/Goldy
- Adjourn

Welcome and Introductions



Project Managers
Goldy Herbon, City of San Diego
Leslie Cleveland, Bureau of Reclamation (

USBR Technical Team
Allison Danner, *Civil Engineer (Hydrologic)*

Dan Broman, *Hydrologic Engineer*

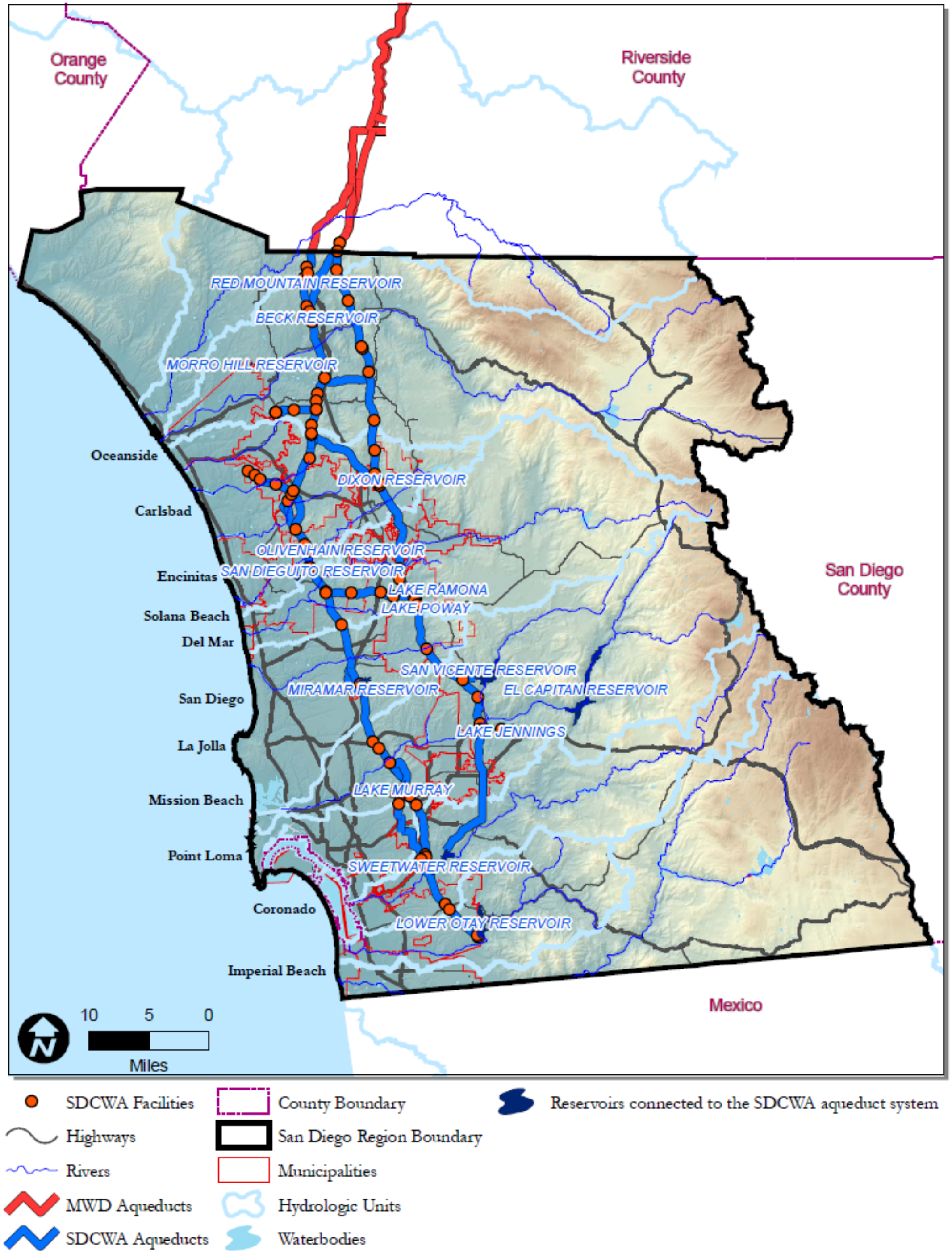
Subhrendu Gangopadhyay, Manager, *Water Resources Planning and Operations Support Group*

BASIN STUDY PURPOSE

- Help bridge current and future water supply gaps
- Complement existing planning efforts

BASIN STUDY OBJECTIVES

- Evaluate water supply and demand conditions under future climate change conditions
- Recommend potential changes to existing structural operations or development of new facilities that could optimize reservoir systems in light of climate change.


Orange County
Riverside County
San Diego County
Mexico
RED MOUNTAIN RESERVOIR
BECK RESERVOIR
MORRO HILL RESERVOIR
DIXON RESERVOIR
OLIVENHAIN RESERVOIR
SAN DIEGUITO RESERVOIR
LAKE RAMONA
LAKE POWAY
SAN VICENTE RESERVOIR
EL CAPITAN RESERVOIR
MIRAMAR RESERVOIR
LAKE JENNINGS
LAKE MURRAY
SWEETWATER RESERVOIR
LOWER OTAY RESERVOIR
Oceanside
Carlsbad
Encinitas
Solana Beach
Del Mar
San Diego
La Jolla
Mission Beach
Point Loma
Coronado
Imperial Beach
10
5
0
Miles
N
SDCWA Facilities
Highways
Rivers
MWD Aqueducts
SDCWA Aqueducts
County Boundary
San Diego Region Boundary
Municipalities
Hydrologic Units
Waterbodies
Reservoirs connected to the SDCWA aqueduct system

BASIN STUDY TASKS

- Task 1 - Project Administration
- Task 2 -Planning/Design/Engineering
- Task 2.1 - Water Supply and Demand Projections
- Task 2.2 - Downscaled Climate Change and Hydrologic Modeling
- Task 2.3 - Existing Structural Response and Operations Guidelines Analysis
- Task 2.4 – Structural and Operations Concepts
- Task 2.5 – Trade-Off Analysis and Recommendations
- Task 2.6 – Final Report

BASIN STUDY TASKS & SCHEDULE

Completion Date

Task 1 Project Administration

- **SDPUD/Reclamation**
  - General Oversight and Project Guidance
  - Study Task Facilitation/Coordination
  - Study Outreach

April 2018

Task 2.1 Water Supply and Demand Projections

- **Reclamation**
  - Literature Review
  - Supply Gap Analysis
  - Assess future supply of
  - Prepare Interim Report
- **SDPUD/Reclamation/STAC/ Study Technical Teams**
  - Document Review

April 2016

Task 2.2 Downscaled Climate Change and Hydrologic Modeling

- **Reclamation**
  - DS & CC Modeling
  - Hydrologic Modeling
  - Draft Interim Downscaled Climate Change Hydrologic Modeling Report
- **SDPUD/Reclamation/STAC**
  - Document Review

April 2016

Completion Date

Task 2.3 Existing Structural Response and Operations Guidelines Analysis

- **SDPUD/Reclamation/STAC**
  - Develop Concepts
- **Reclamation**
  - Evaluate and Refine Concepts
  - Appraisal-Level Concept Planning
  - Interim Structural and Operations Concepts Report
- **SDPUD/Reclamation/STAC**
  - Document Review
- **Peer Reviewers**
  - Document Review

January 2017

Task 2.4 Structural and Operations Concepts

- **SDPUD/Reclamation/STAC**
  - Review of existing data
  - Develop Concepts
  - Draft and Final document Review
- **Reclamation**
  - Refine and integrate concepts
  - Concept Planning
  - Prepare Draft Interim Report

January 2017

Task 2.5 Trade-Off Analysis and Recommendations

- **Reclamation**
  - Conduct Trade-Off Analysis
- **SDPUD/STAC/ Study Technical Teams**
  - Develop Recommendations
- **SDPUD/Reclamation/STAC**
  - Document Review
- **Peer Reviewers**
  - Document Review

February 2017

Task 2.6 Final Report

- **SDPUD/Reclamation**
  - Prepare Final Report
  - Publish and Distribute Final Report
- **Reclamation**
  - Peer Review
- **SDPUD/Reclamation/STAC**
  - Internal Review
- **STAC/General Public**
  - Public Review

April 2018

Task 2.1 and 2.2 Overview

- 2.1-Water Supply and Water Demand Projections- Allison Danner-BOR

- 2.2-Downscaled Climate Change and Hydrologic Modeling- Dan Broman-BOR

RECLAMATION

Managing Water in the West

San Diego Basin Study Task 2.1 Update

San Diego Basin Study STAC Meeting
February 2, 2016

Allison Danner, Civil Engineer (Hydrologic), Bureau of Reclamation, Lower Colorado Region, Engineering Services Office

U.S. Department of the Interior
Bureau of Reclamation

Task 2.1 Outline

1. Introduction
2. Water Demand
3. Water Supply
4. Supply-Demand Gap Analysis
5. Conclusion

RECLAMATION

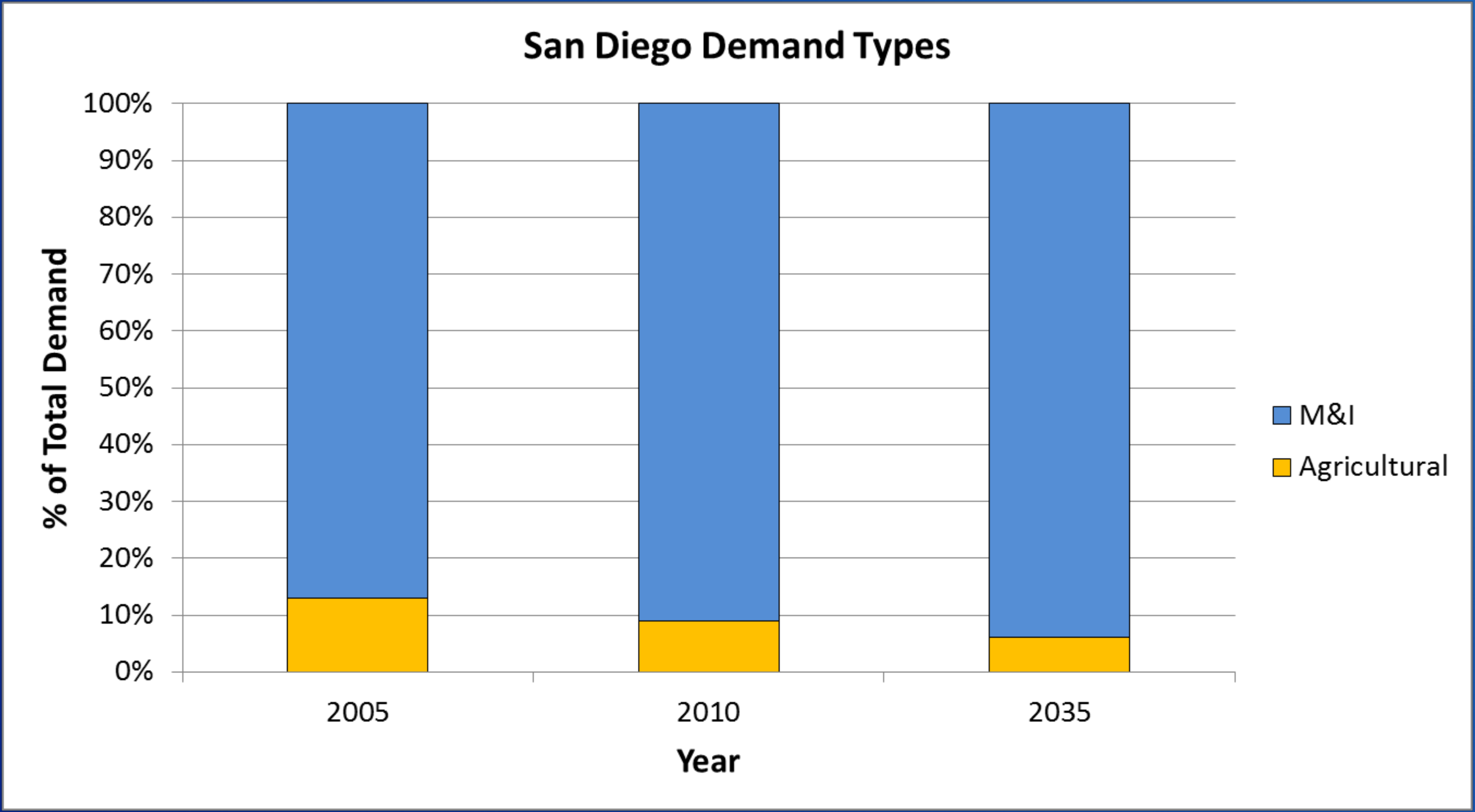
1. Introduction

- **Purpose:** Characterize existing and projected water supply and demand within the Study Area

- **Approach:** Literature review supplemented with analysis

2. Water Demands

Demand Types



RECLAMATION

2. Water Demand
Water Demand Projections

- **Demand projections for 2015-2035 extracted from 2010 SDCWA UWMP**
  - **M&I – Demand model with SANDAG Series 12 demographic data**
  - **Agricultural – Ag demand model**
  - **SBX7-7 conservation**

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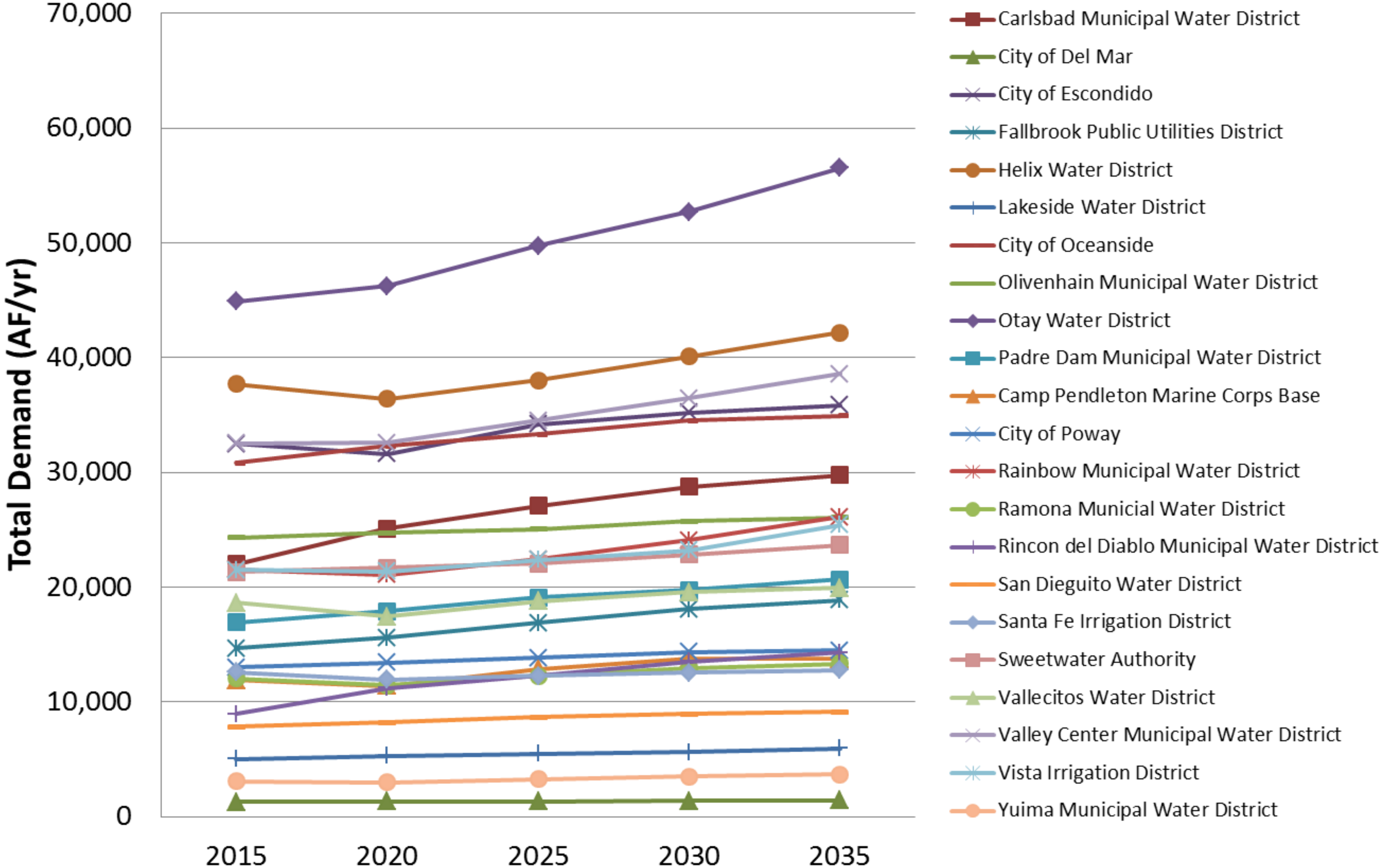
Total Demands from 2010 SDCWA UWMP
All Member Agencies Except City of San Diego



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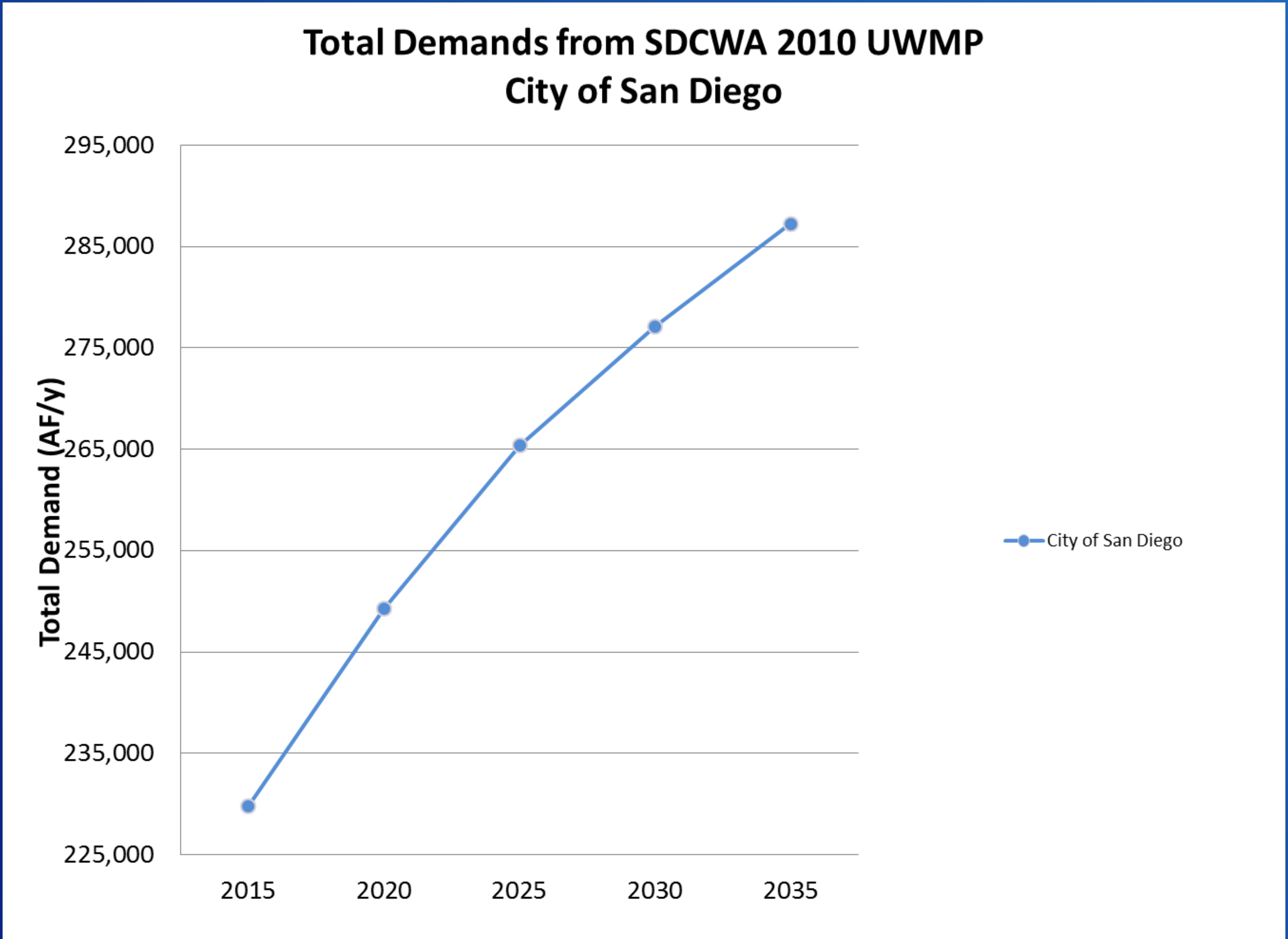
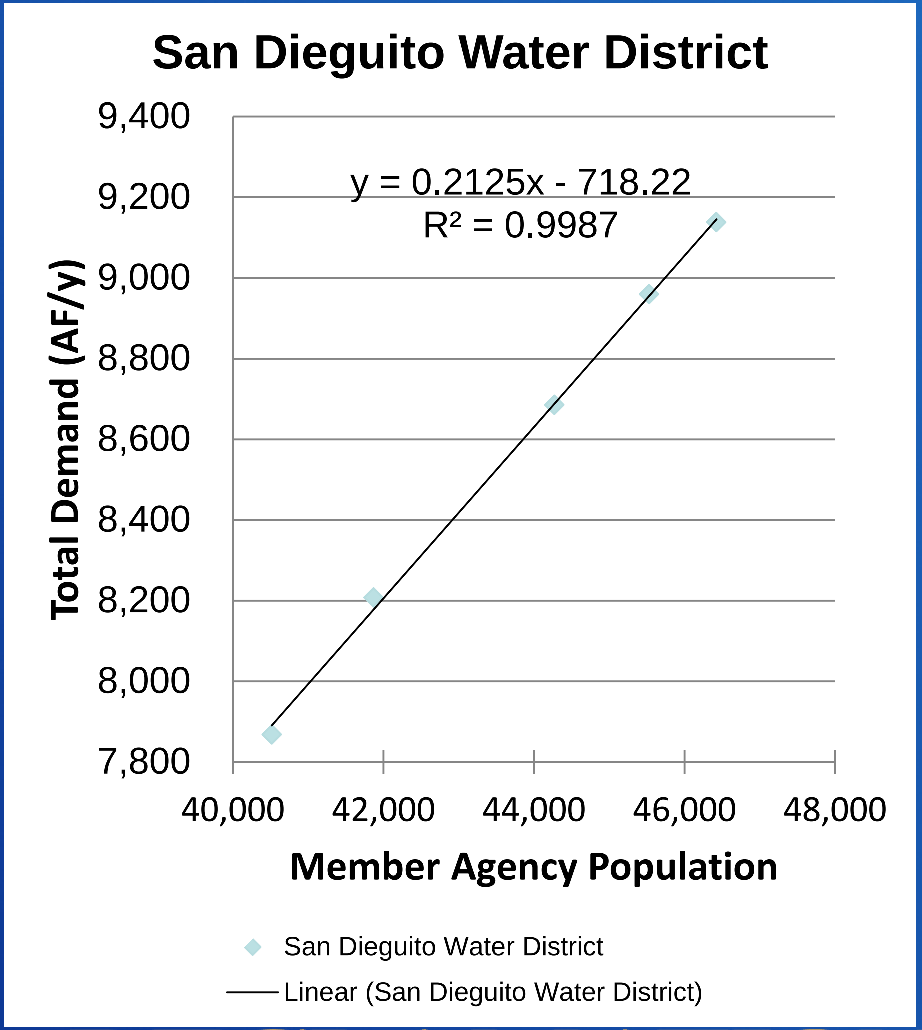


RECLAMATION

2. Water Demand

Water Demand Projections - Regression

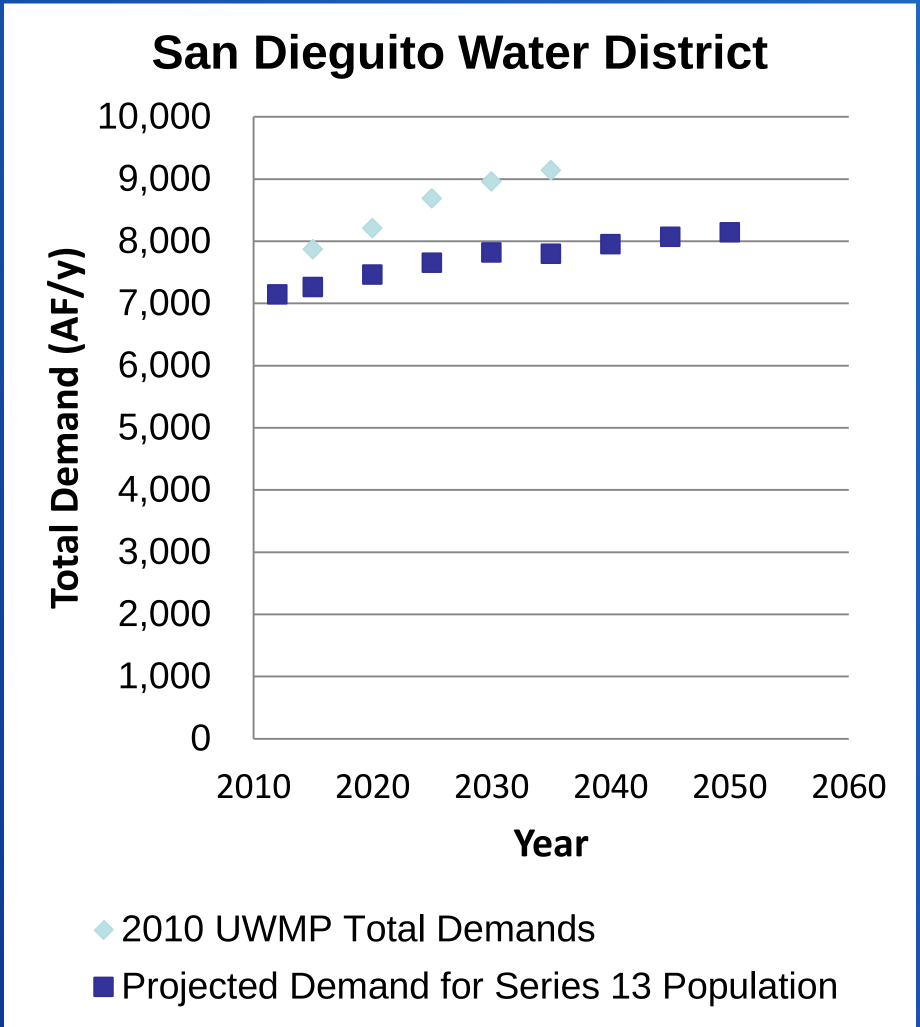
- **Regression between demands and population used to project to 2050**
  - **Regressed 2010 SDCWA UWMP demands against Series 12 population data for 2015-2035**



2. Water Demand

Water Demand Projections – Extension to 2050

- **Regression between demands and population used to project to 2050**
  - Projected 2015-2050 demands from Series 13 population data
  - Exception: Constant value assumed for Camp Pendleton due to poor regression fit



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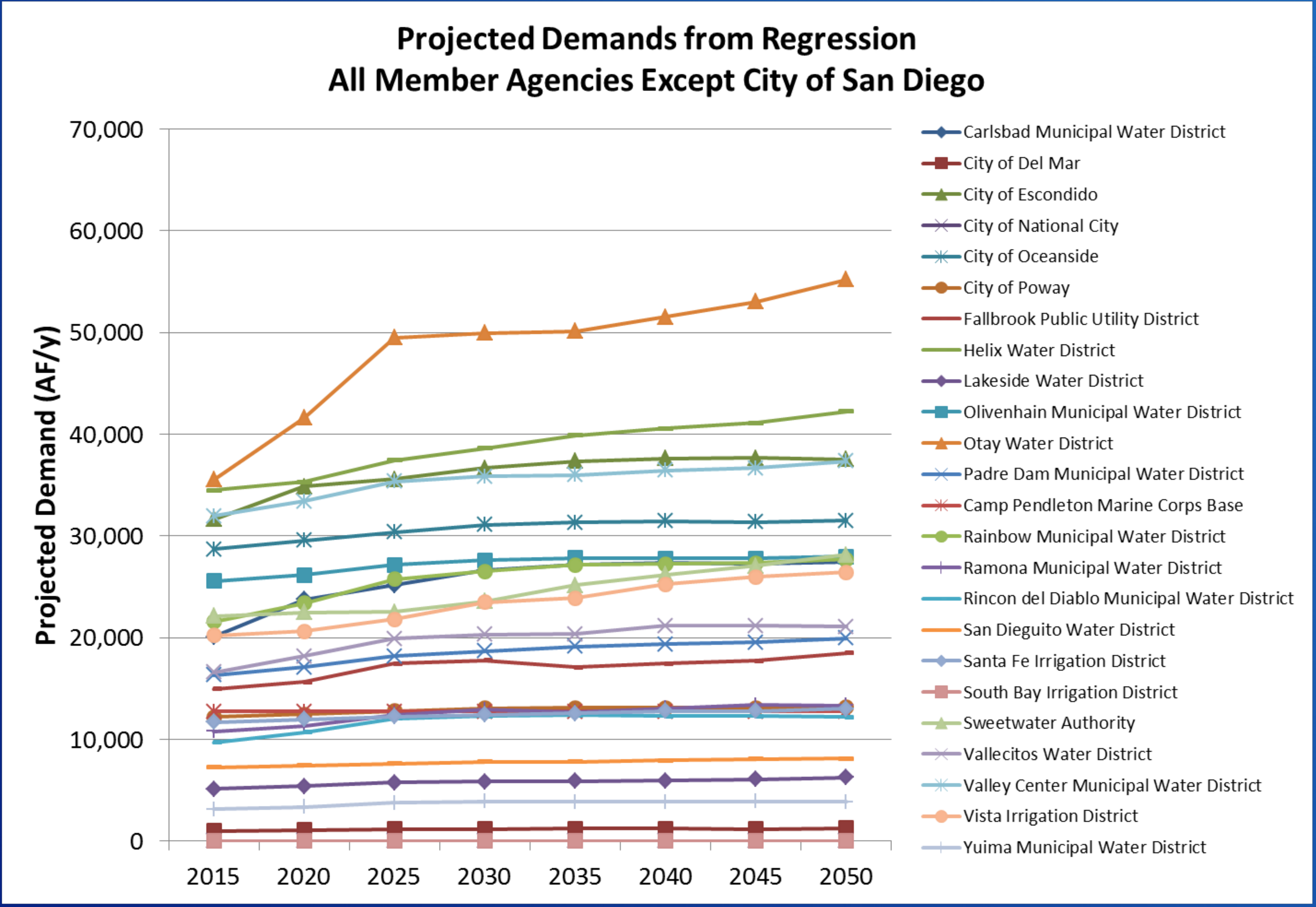

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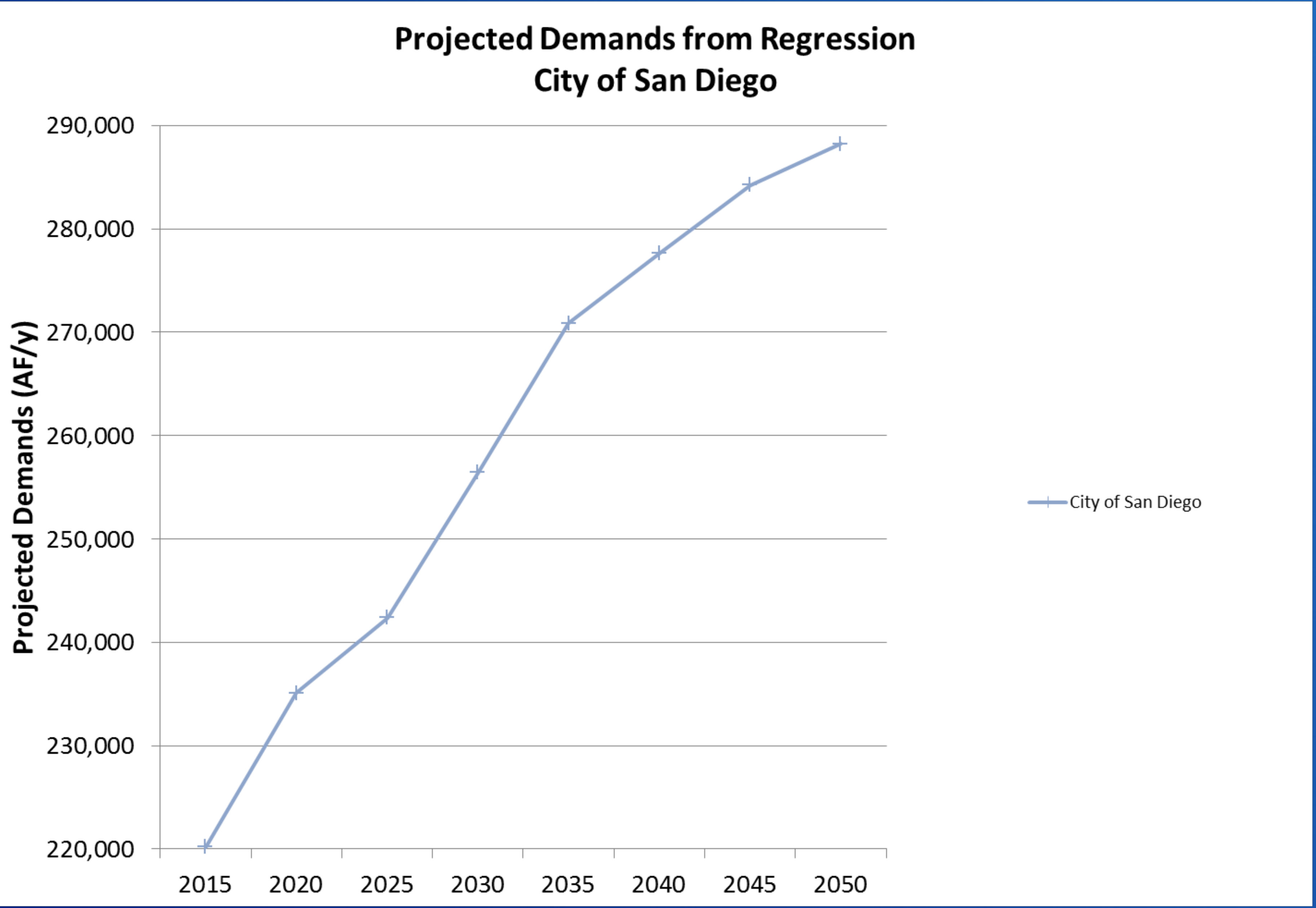
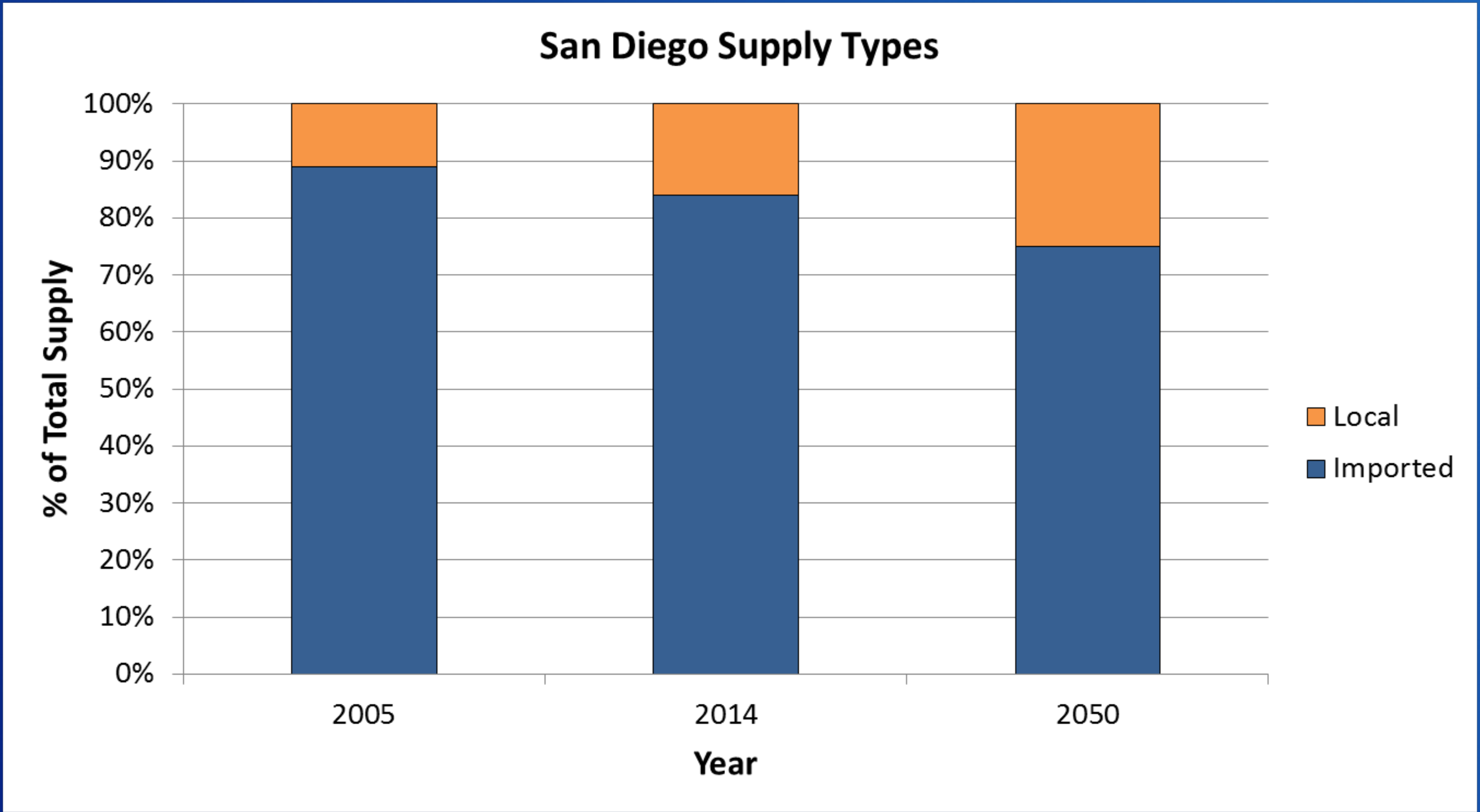


RECLAMATION

3. Water Supply

Water Supply Types

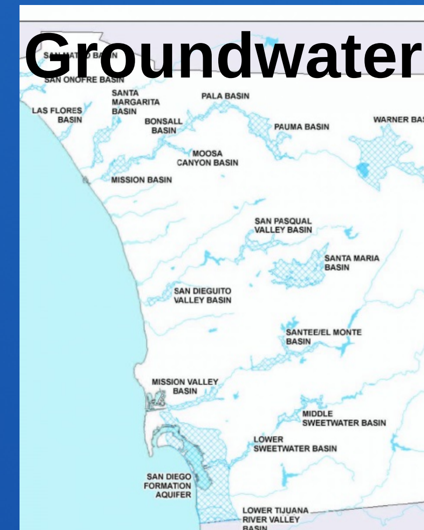


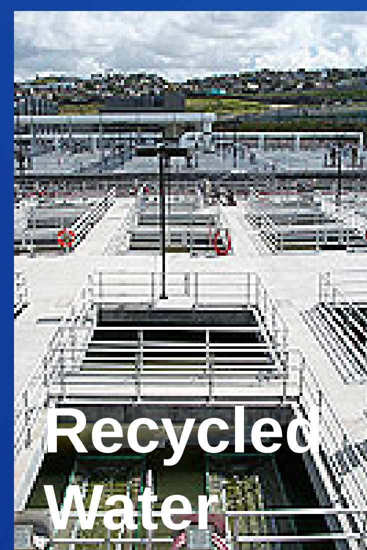
RECLAMATION

3. Water Supply

Normal Year Supply Sources

Imported Water





RECLAMATION

3. Water Supply
Dry Year and Emergency Supplies

Dry Year Supplies

- Carryover storage program
  - San Vicente Reservoir
- Water Banking
  - Semitropic-Rosamond Water Bank Authority
  - Semitropic Water Bank

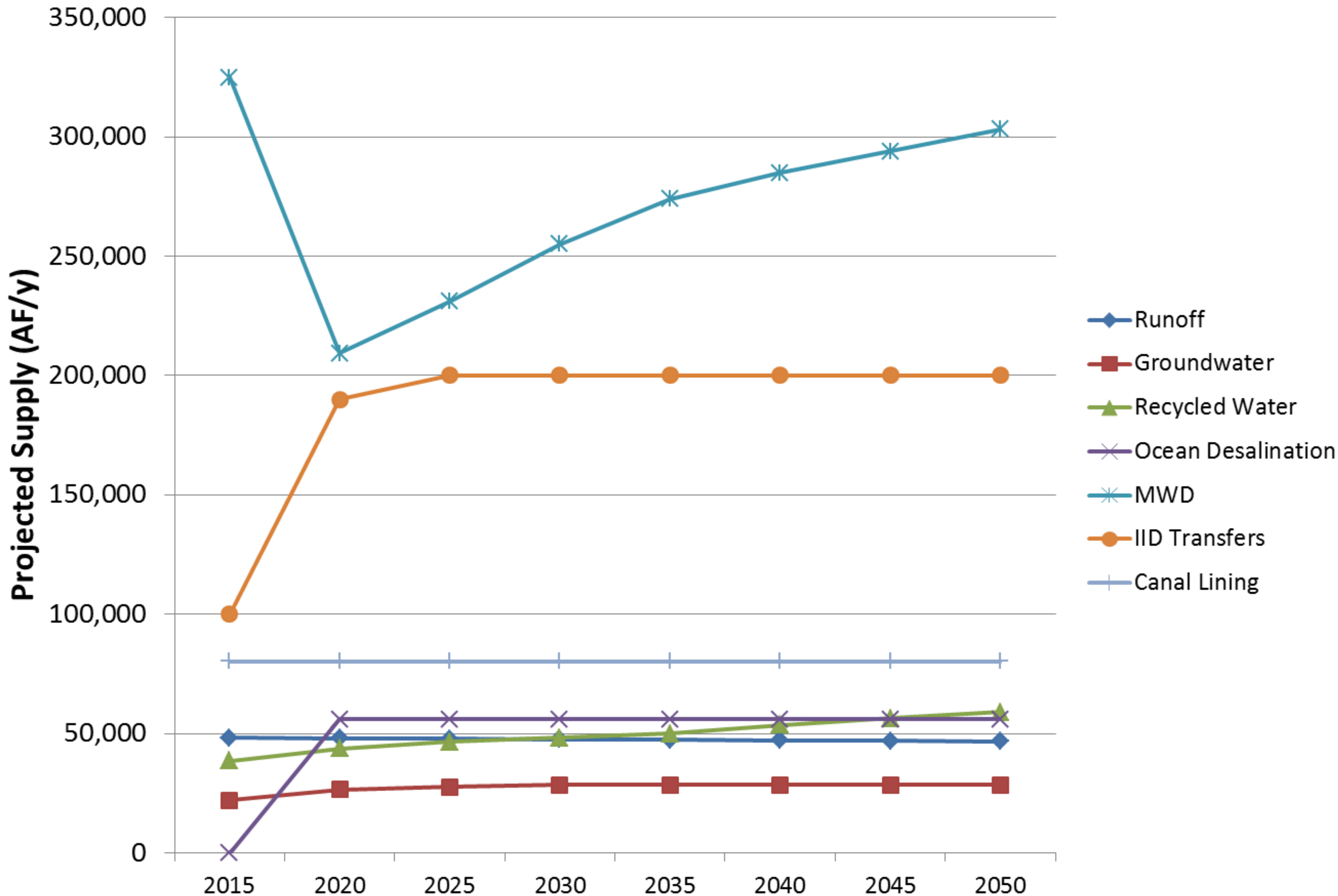
Emergency Supplies

- Emergency Storage Project
  - Storage at Olivenhain and San Vicente Reservoirs
  - Pipelines to transfer water around SDCWA service area

3. Water Supply
Water Supply Projections

- Values for 2015-2035 extracted from 2010 SDCWA UWMP
- 2040-2050 Supplies estimated by:
  - Surface Water - Regression for 2015-2035
  - Groundwater – Constant at 2035 value
  - Recycled Water – Regression for 2015-2035
  - Ocean Desalination – Water purchase agreement
  - Conserved Water– According to applicable agreements
  - MWD Imported Supply – Difference between projected demand and other sources of supply

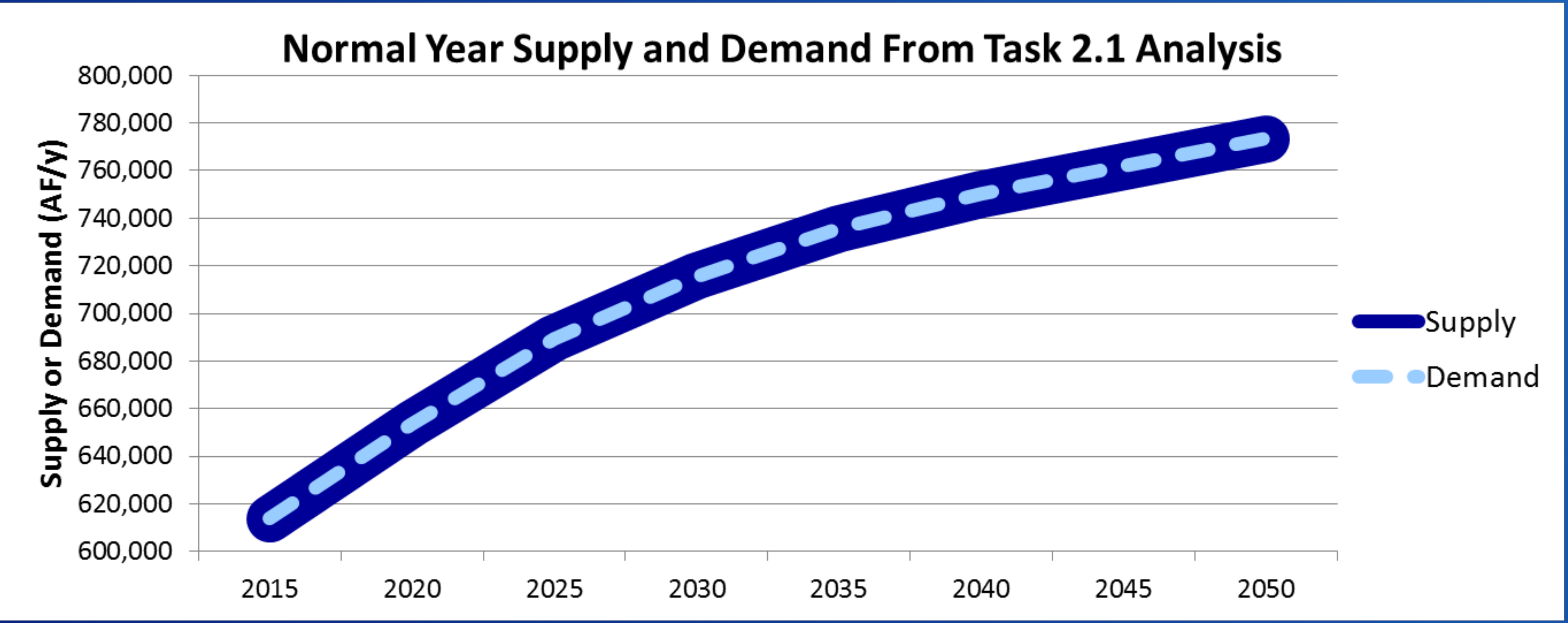
San Diego Projected Supply



RECLAMATION

4. Supply-Demand Gap Analysis
Normal Years

- Normal Years
  - No supply-demand gaps
  - Calculation of MWD supply assumes sufficient supply



RECLAMATION

4. Supply-Demand Gap Analysis
Dry Years

- Single Dry Years
  - No supply-demand gaps
  - Calculation of MWD supply assumes sufficient supply
- Multiple Dry Years
  - Supply-Demand gaps in all time periods
  - Assumes MWD will be allocating supply
  - Gaps attributed to the increase in demand outpacing increasing supply

5. Conclusion

- Both supply and demand increase between 2015 and 2050
  - Increasing M&I demand, decreasing agricultural demand
  - Increasing local supply, decreasing imported supply
  - Supply and demand are equal for normal and single dry year hydrology
  - Supply gaps are possible under multiple dry year hydrology
- Future Basin Study Tasks:
  - 2.3 Modeling supply and demand under current and future climate
  - 2.4 Evaluating structural and non-structural concepts for addressing supply-demand gaps

Questions?

Allison Danner, adanner@usbr.gov, (702)293-8331

RECLAMATION

RECLAMATION

Managing Water in the West

San Diego Basin Study

2.2 Climate Impacts and Hydrological Modeling

February 2, 2016

U.S. Department of the Interior
Bureau of Reclamation

Climate Impacts Overview

How might climate change impact the reliability and volumes of imported water supplies to the region?

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How will changes in local weather patterns impact the ability to capture and use local surface supplies?

RECLAMATION

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RECLAMATION

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How will changes in local weather patterns impact local water quality?

RECLAMATION

Climate Impacts Overview

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How will changes in local weather patterns impact the ability to capture and use local surface supplies?

How will changes in local weather patterns impact the ability to capture and use local groundwater supplies?

How will changes in local weather patterns impact local water quality?

Which watersheds will be impacted the most by climate change and what is the magnitude?

Future Climate Scenarios

Climate models are run with different future scenarios to provide projections of future climate

Two sets of climate projections CMIP3 and CMIP 5; use different future scenarios

Local surface water, groundwater, and water quality analyses based on CMIP5

Imported water analysis for the Colorado River and State Water Project based on CMIP3

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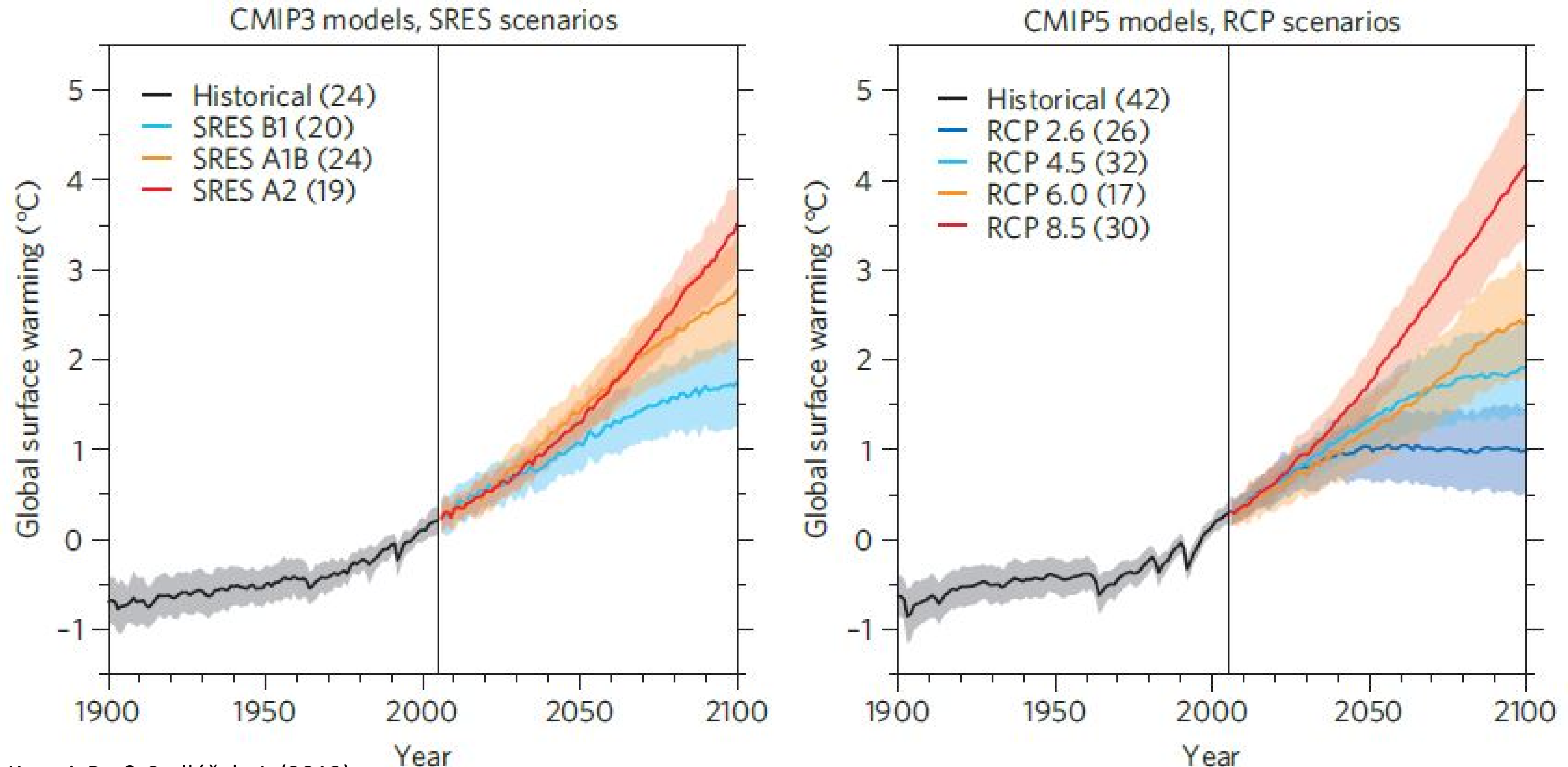
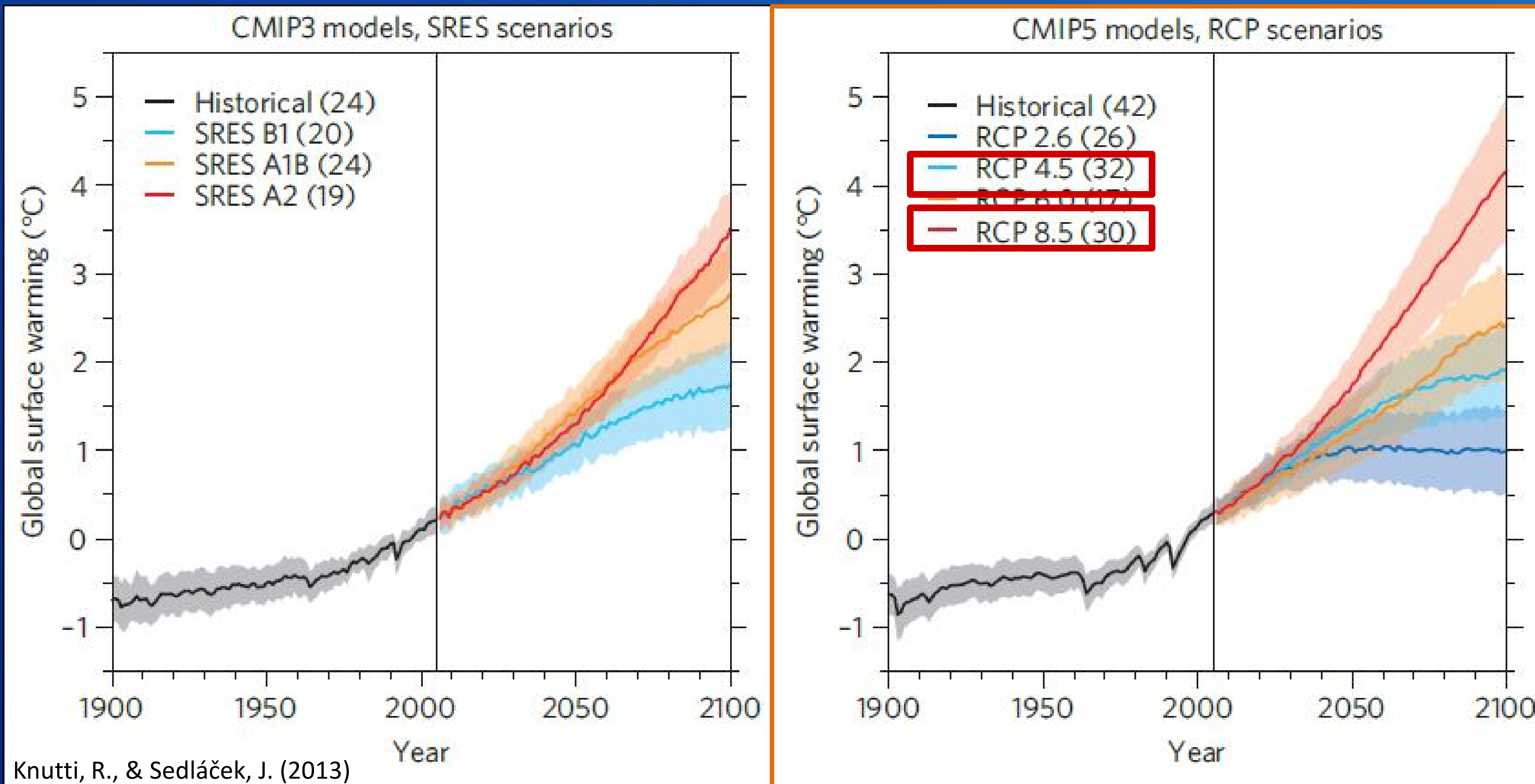
Future Climate Scenarios



Knutti, R., & Sedláček, J. (2013)

Future Climate Scenarios



Knutti, R., & Sedláček, J. (2013)

Focus on:
4.5 (low rate of dev.)
8.5 (high rate of dev.)

Different socio-economic scenarios (RCPs)

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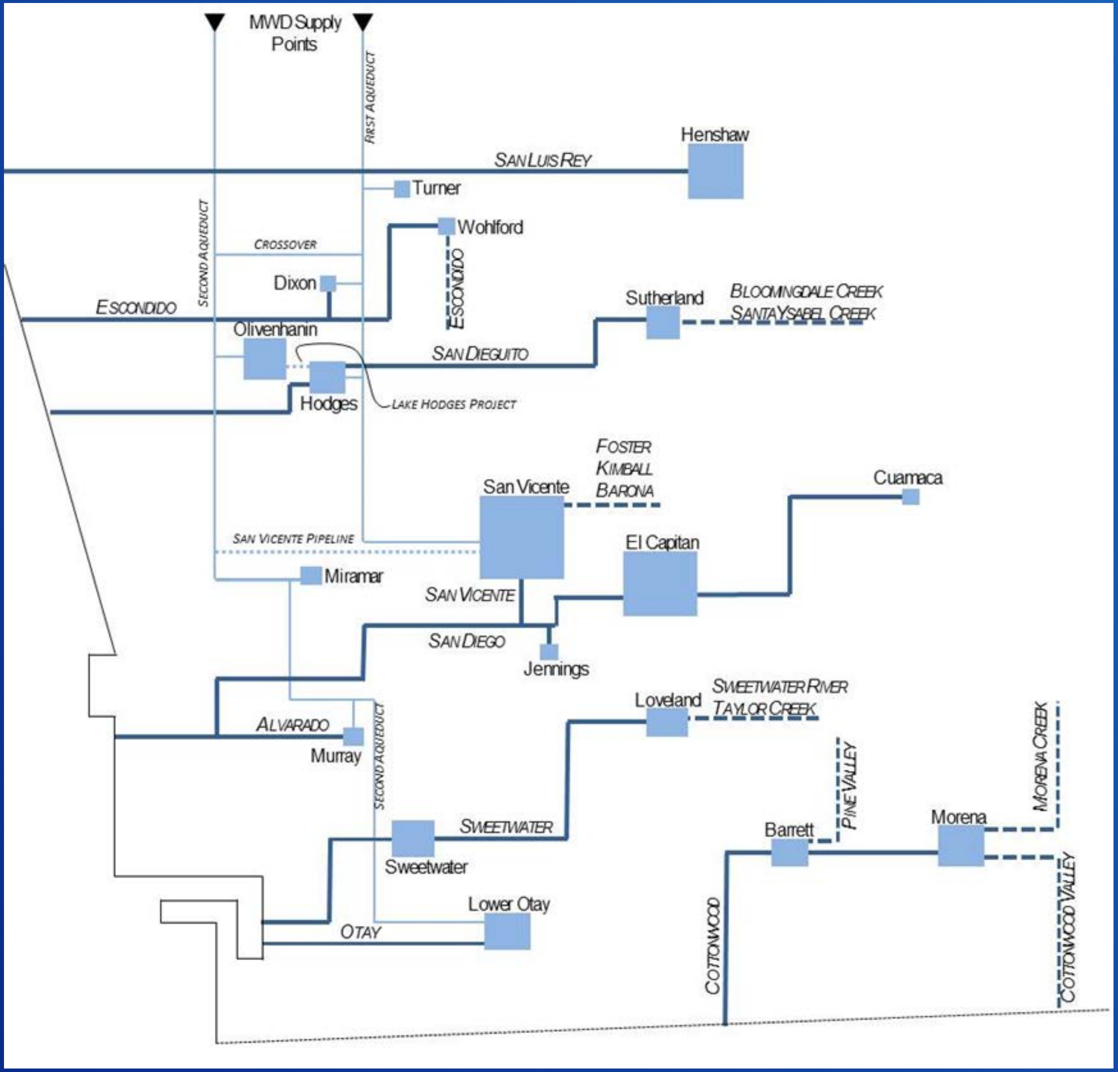
Future Climate Scenarios

Climate model projections are at a coarse spatial scale → to examine local impacts they need to be **'downscaled'**

Precipitation, temperature, etc. are used to generate streamflow using the **VIC hydrologic model**

Study Region



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Imported Water

Water allocation from source to use is controlled by several entities and many legal agreements between parties

Outlined the currently allocation structure for imported water from the **Colorado River** and the **State Water Project**

Examined the impact of climate on these two main sources of water using:

- Colorado River Basin Water Supply and Demand Report
- Sacramento and San Joaquin Basin Climate Impacts Assessment → Basin Study currently ongoing

Imported Water

Colorado River

Three measures used in the Colorado River Basin study used to examine climate impacts:

- Lake Mead pool elevation < 1,000ft and <1,050ft
- Frequency of shortages to Lower Basin states
- Mean shortages to Lower Basin states

These data were obtained from the basin study and use CMIP3 climate projections

Imported Water

Colorado River

Demand Scenarios

Scenario	Description
A	Continuation of growth, development patterns and institutions follow long-term trends
B	Slow growth with emphasis on economic efficiency
C1 C2	Economic resurgence (population and energy) and current preference toward human and environmental values
D1 D2	Expanded environmental awareness and stewardship with growing economy

Imported Water

Colorado River

Management Scenarios

Scenario	Description
IG	Keep 2007 Interim Operating Guidelines in place after 2026
NA	Revert to No-Action alternative after 2026

**does not take into account management changes found in Minute 319*

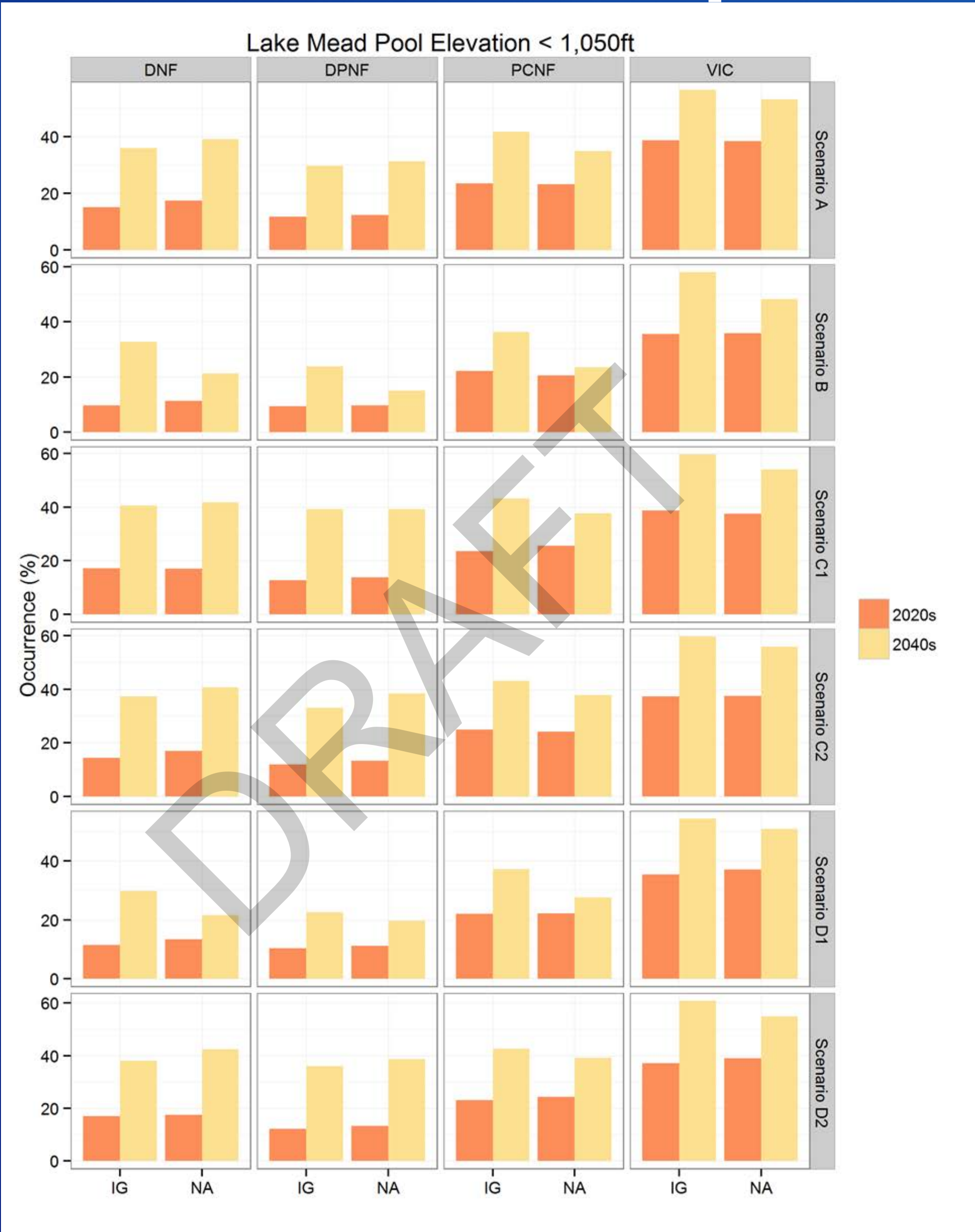
Imported Water

Colorado River

Hydrologies

Scenario	Description
DNF	Resampled natural flows → reshuffling observed flows
DPNF	Direct resampled paleo natural flows → reshuffling of flows from paleoclimate record
PCNF	Paleo conditioned resampled natural flows → reshuffling natural flows conditioned on paleoclimate record
VIC	Hydrologic modeled flows using climate change projections

Imported Water



Mead Pool Elev. <1050ft

(in any one month of one year)

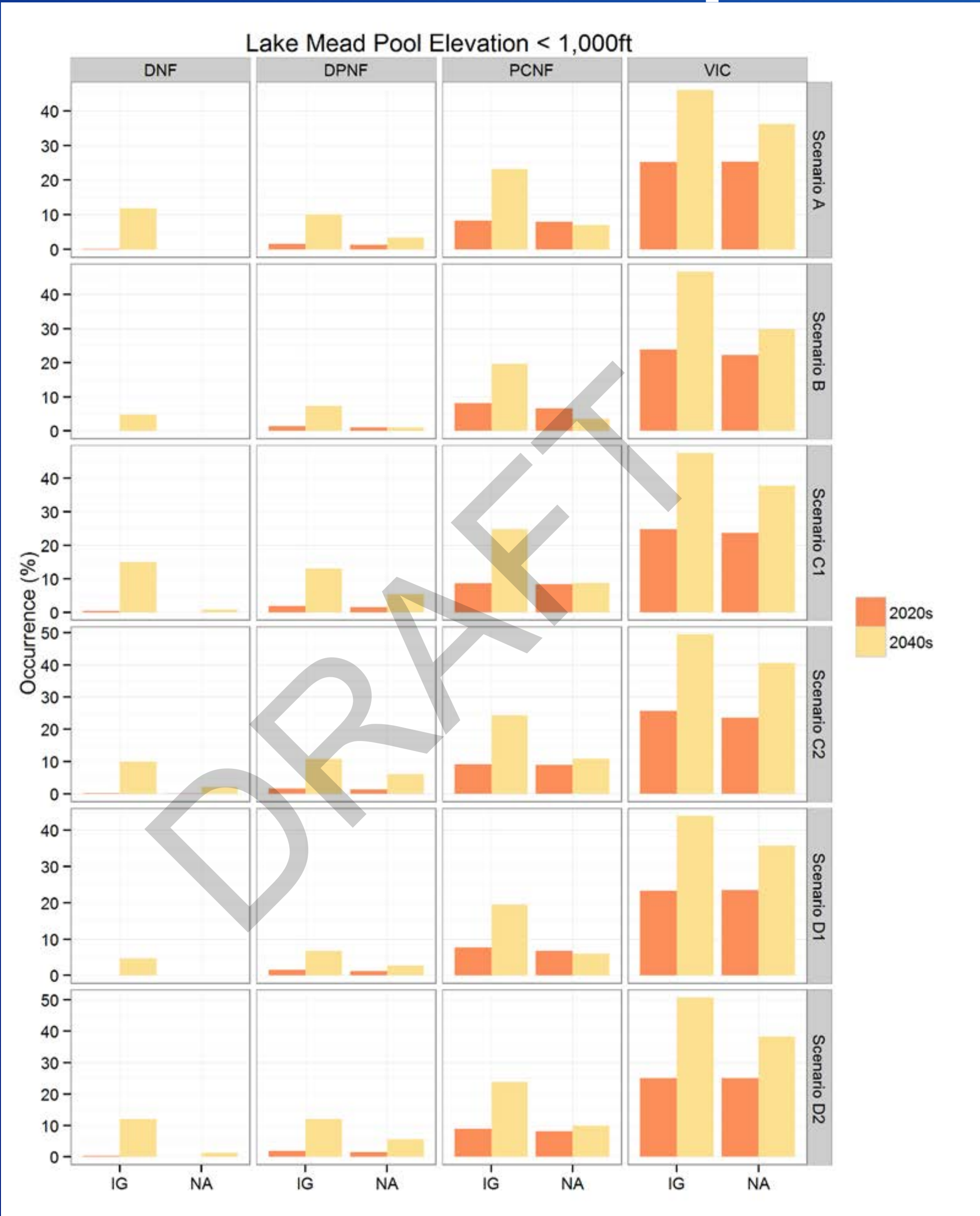
Resampled flows ~10-20% occurrence for all demand scenarios in 2020s

VIC ~35-40% for same period

VIC ~50% occurrence for all demands in 2040s

RECLAMATION

Imported Water



Mead Pool Elev. <1000ft

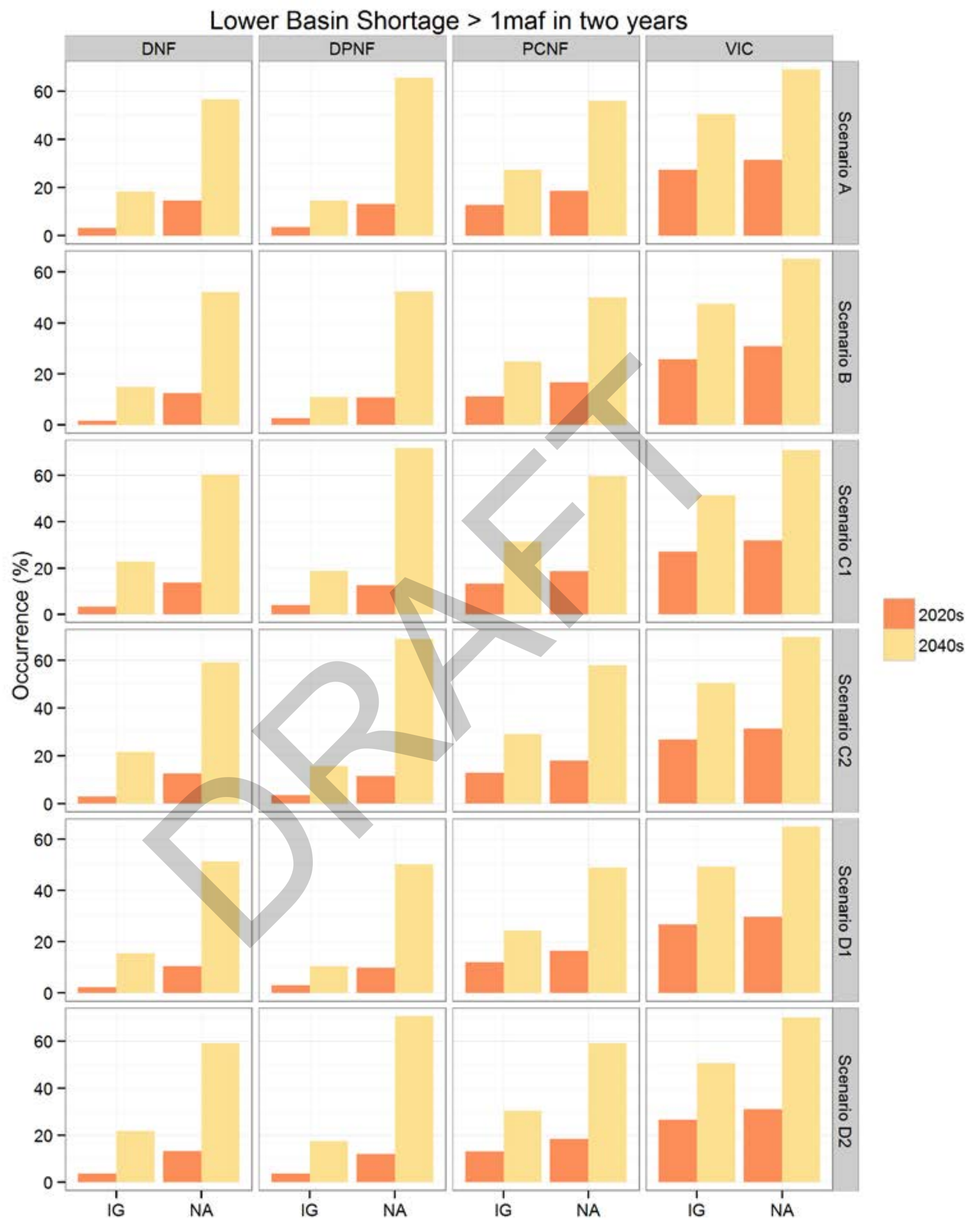
(in any one month of one year)

VIC ~25-40% occurrence for all demands in 2020s

VIC ~45% occurrence for all demands in 2040s

RECLAMATION

Imported Water



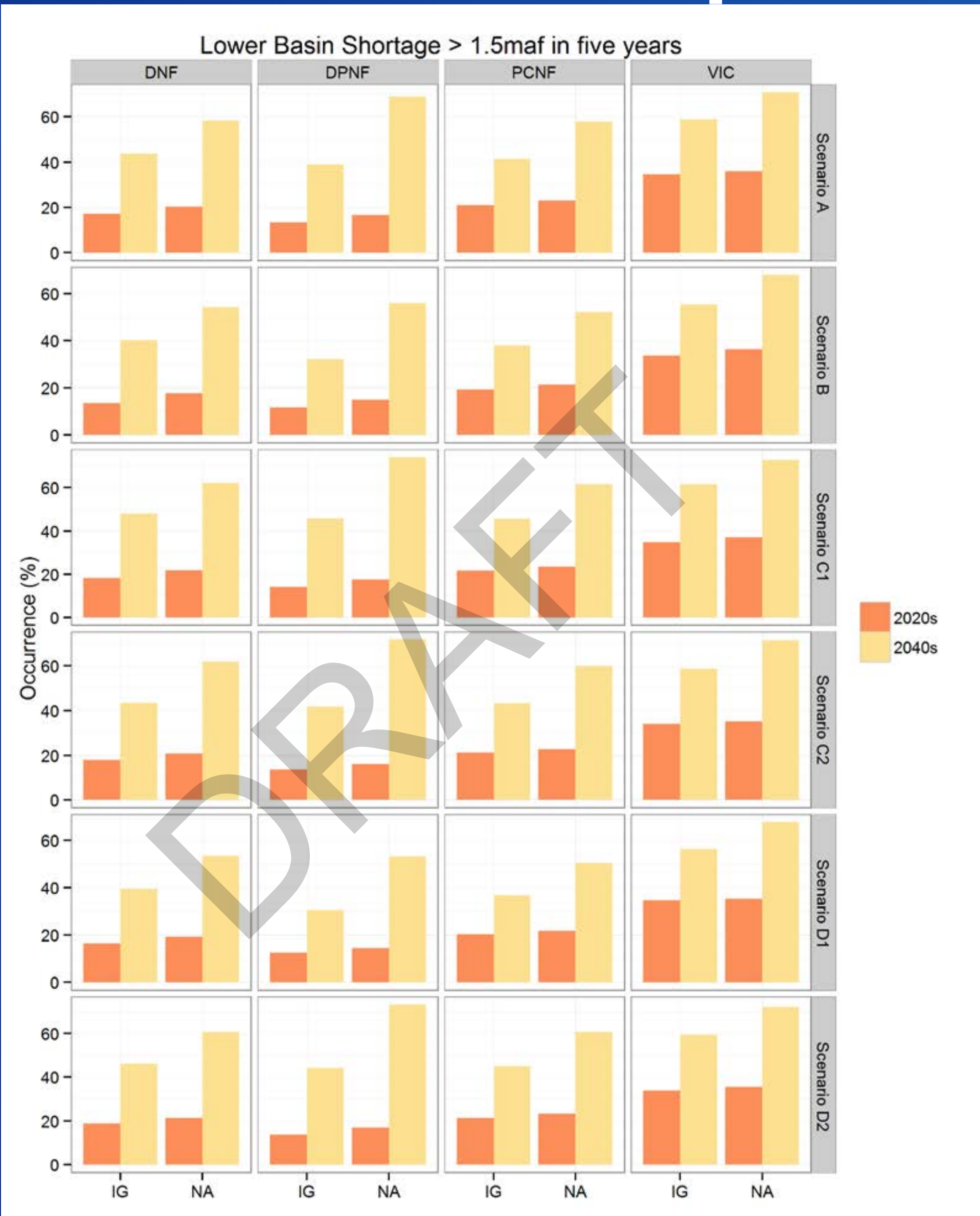
Lower Basin Shortage >1.0maf in 2 years

VIC ~20-25% occurrence for all demand and operation scenarios in 2020s

VIC ~45% occurrence for all demand and interim operations in 2040s
~65% in same period with no-action operations

RECLAMATION

Imported Water



Lower Basin Shortage >1.5maf in 5 years

VIC ~25-30% occurrence for all demand and operation scenarios in 2020s

VIC ~50% occurrence for all demand and interim operations in 2040s
~65% in same period with no-action operations

RECLAMATION

Imported Water

State Water Project

SWP exports to southern water users

Uses three future periods:

- 2012-2040
- 2041-2070
- 2071-2099

These data were obtained from the climate impacts assessment and use CMIP3 climate projections

*an ongoing basin study using CMIP5 projections may be able to update these findings

Imported Water

State Water Project

					Percent Change from CT_NoCC	
Measure	**Period**	**CT_NoCC**	**CT_Q5**	**CAT12**	**CT_Q5**	**CAT12**
SWP Exports – Banks Pumping Plant (TAF / year)	2012-2040	2,663	2,653	2,680	0%	1%
	2041-2070	2,859	2,677	2,563	-6%	-10%
	2071-2099	2,982	2,982	2,780	2,594	-13%

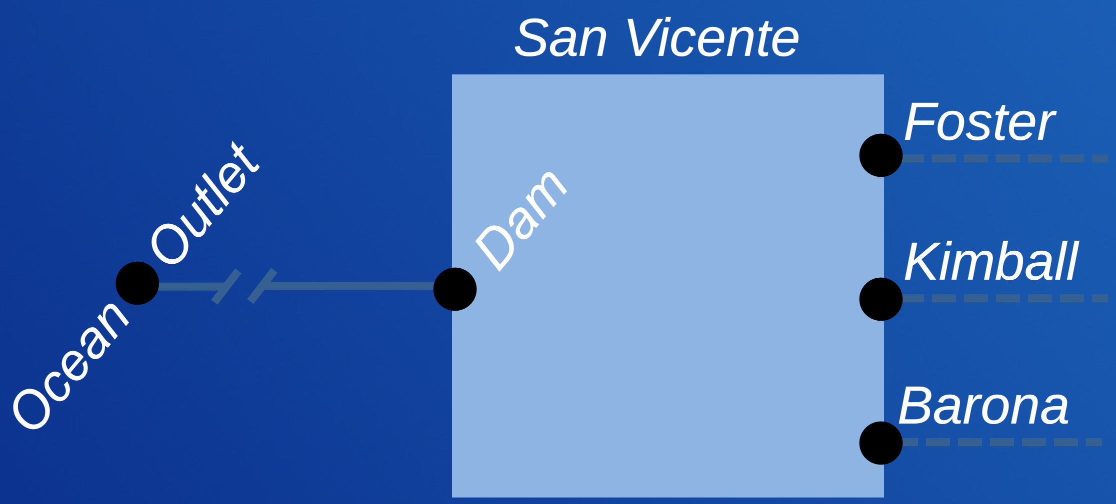
CT_Q5 → mean of climate projections

CAT12 → mean of climate projections from 12 models selected by State of CA

Local Surface Water

Identify local water sources

Identify key nodes – inflows, outflows, gauges

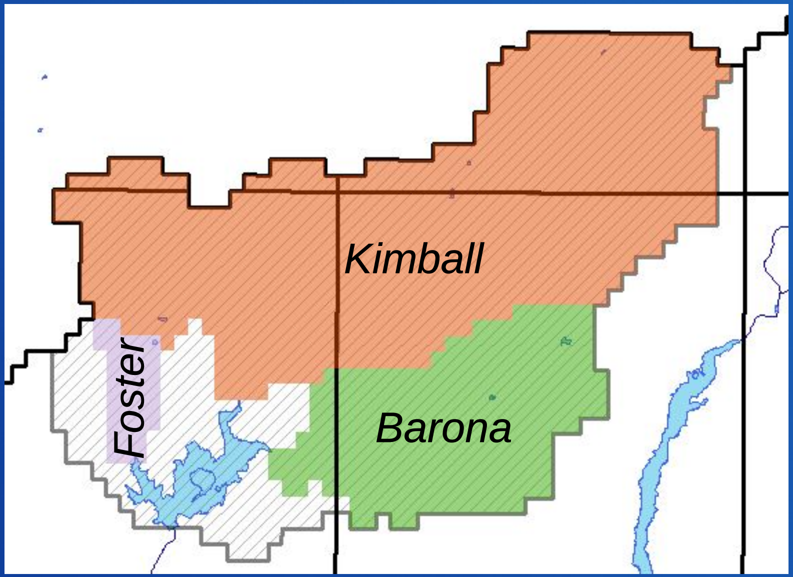


Local Surface Water

Identify local water sources

Identify key nodes – inflows, outflows, gauges

Delineate upstream basin



RECLAMATION

Local Surface Water

Identify local water sources

Identify key nodes – inflows, outflows, gauges

Delineate upstream basin

Route water using downscaled climate data

RECLAMATION

Local Surface Water

Identify local water sources

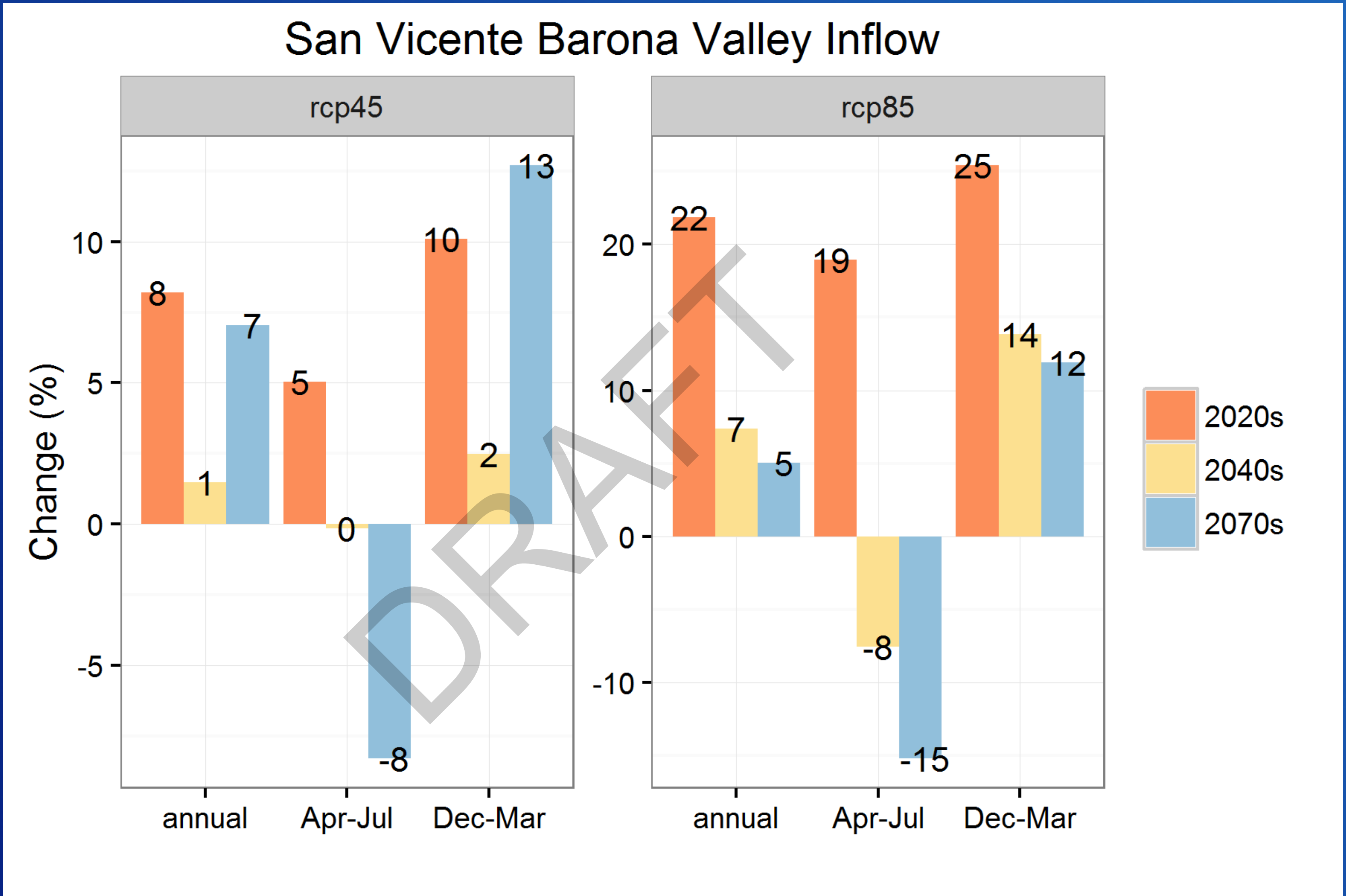
Identify key nodes – inflows, outflows, gauges

Delineate upstream basin

Route water using downscaled climate data

Examine period changes (e.g. 1990s vs 2040s)

Local Surface Water



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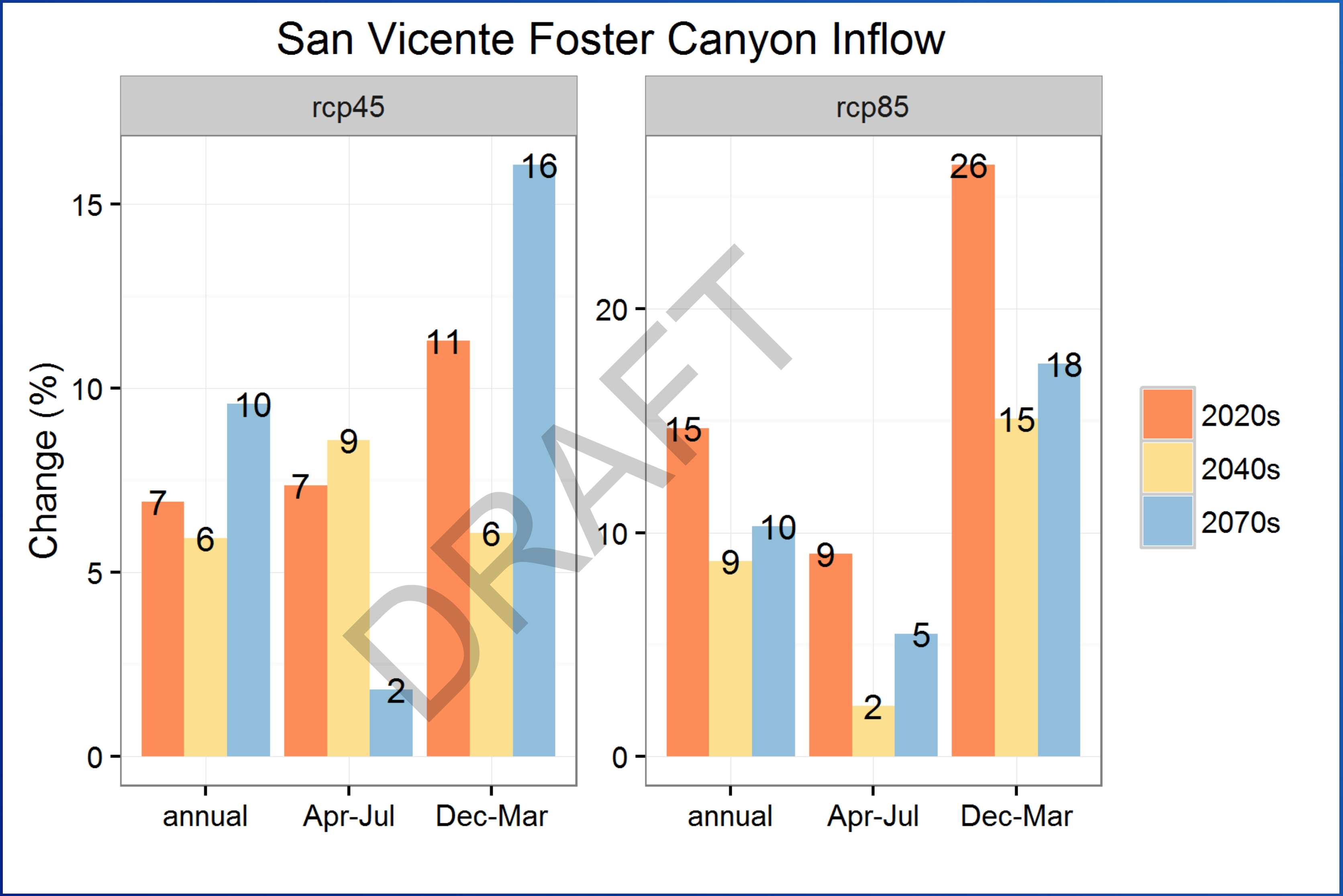
Local Surface Water



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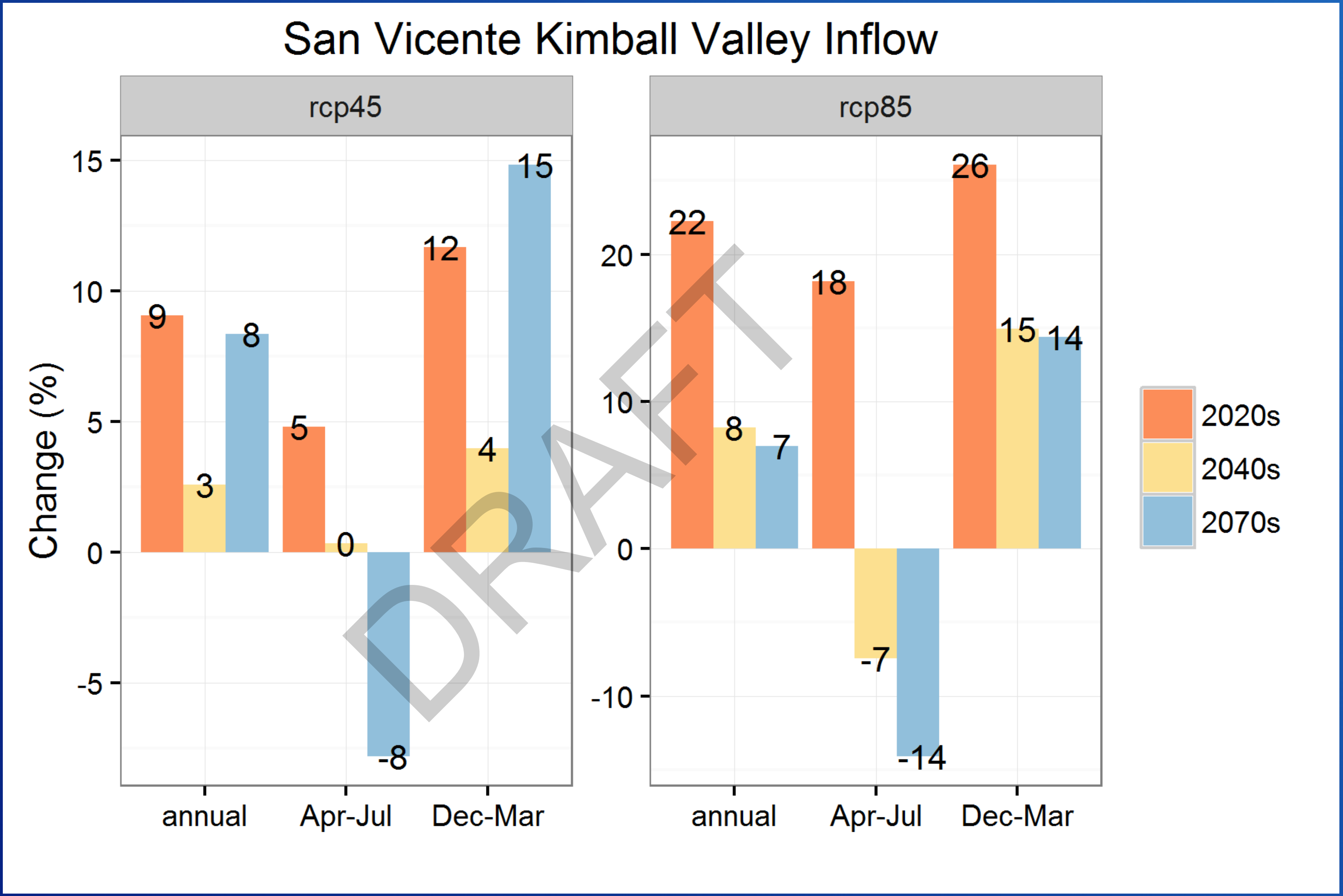
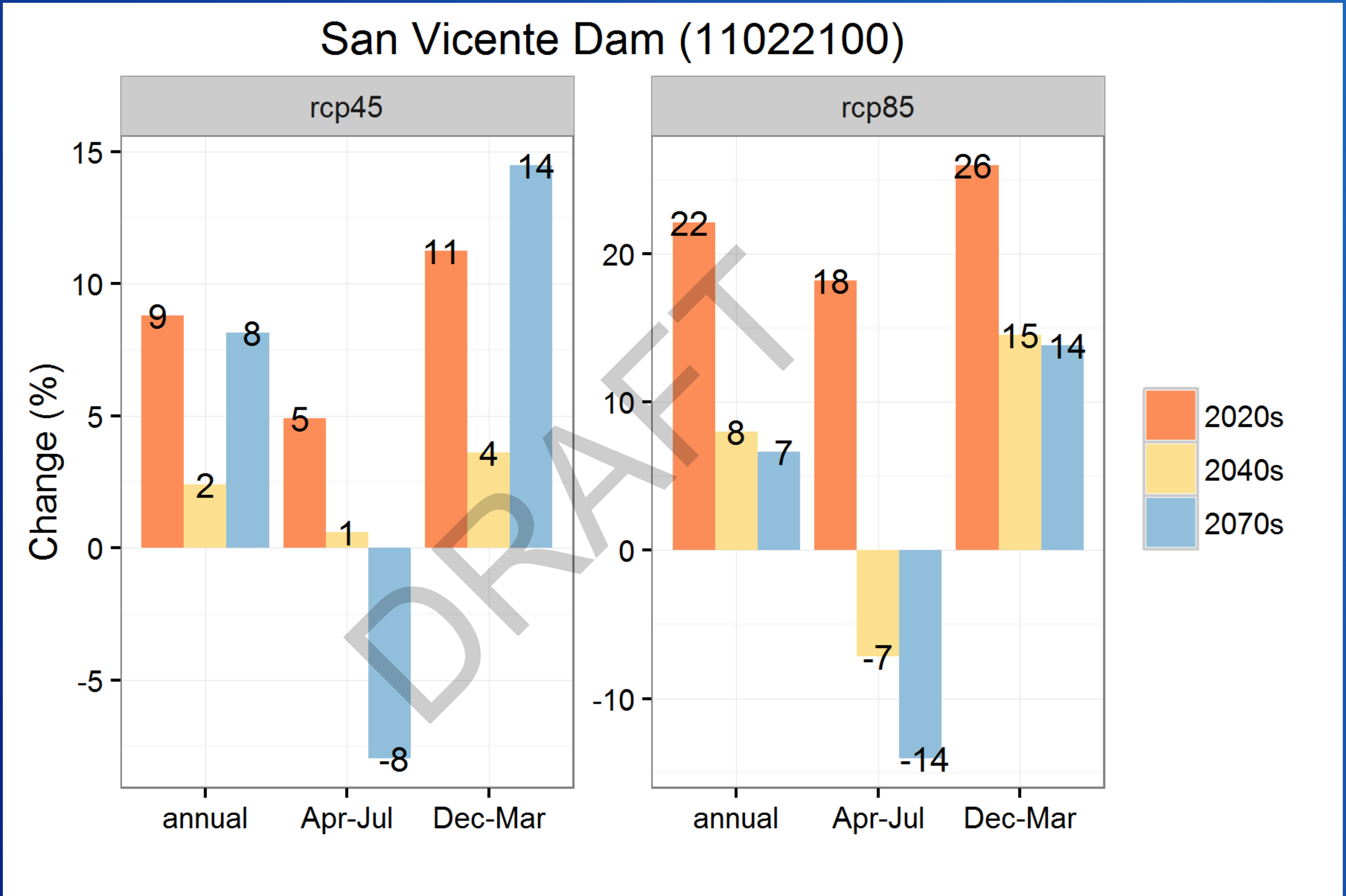


Local Surface Water



RECLAMATION

Local Surface Water

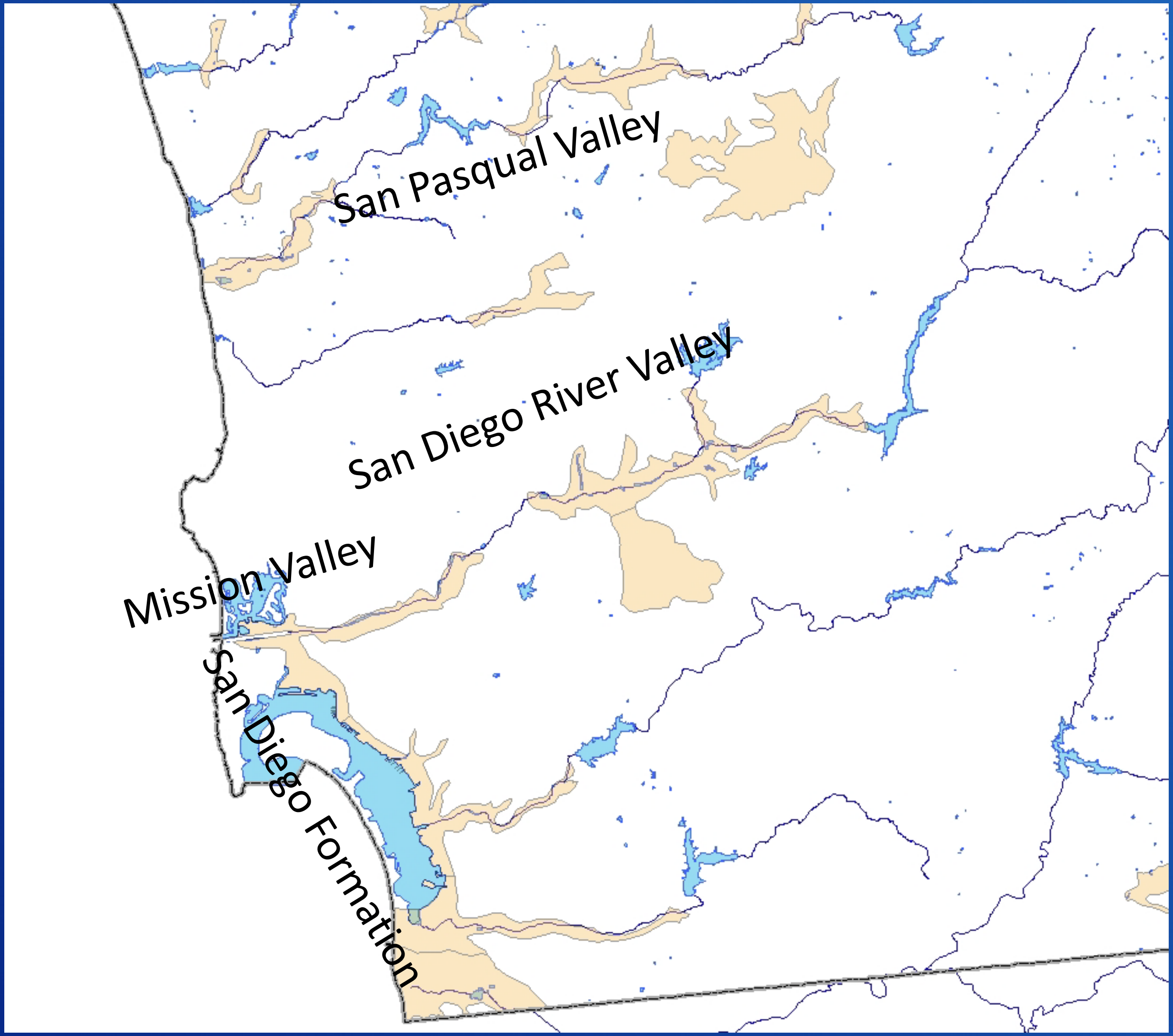
San Vicente Inflow and Outflow

Naturalized flows from VIC hydrologic model forced with climate projections

Increases in annual runoff of ~10% for all future periods
Increases in December – March runoff ~15%
Decreases in April – July runoff ~5-10%

Pattern is consistent across San Diego County in other watersheds

Local Groundwater



RECLAMATION

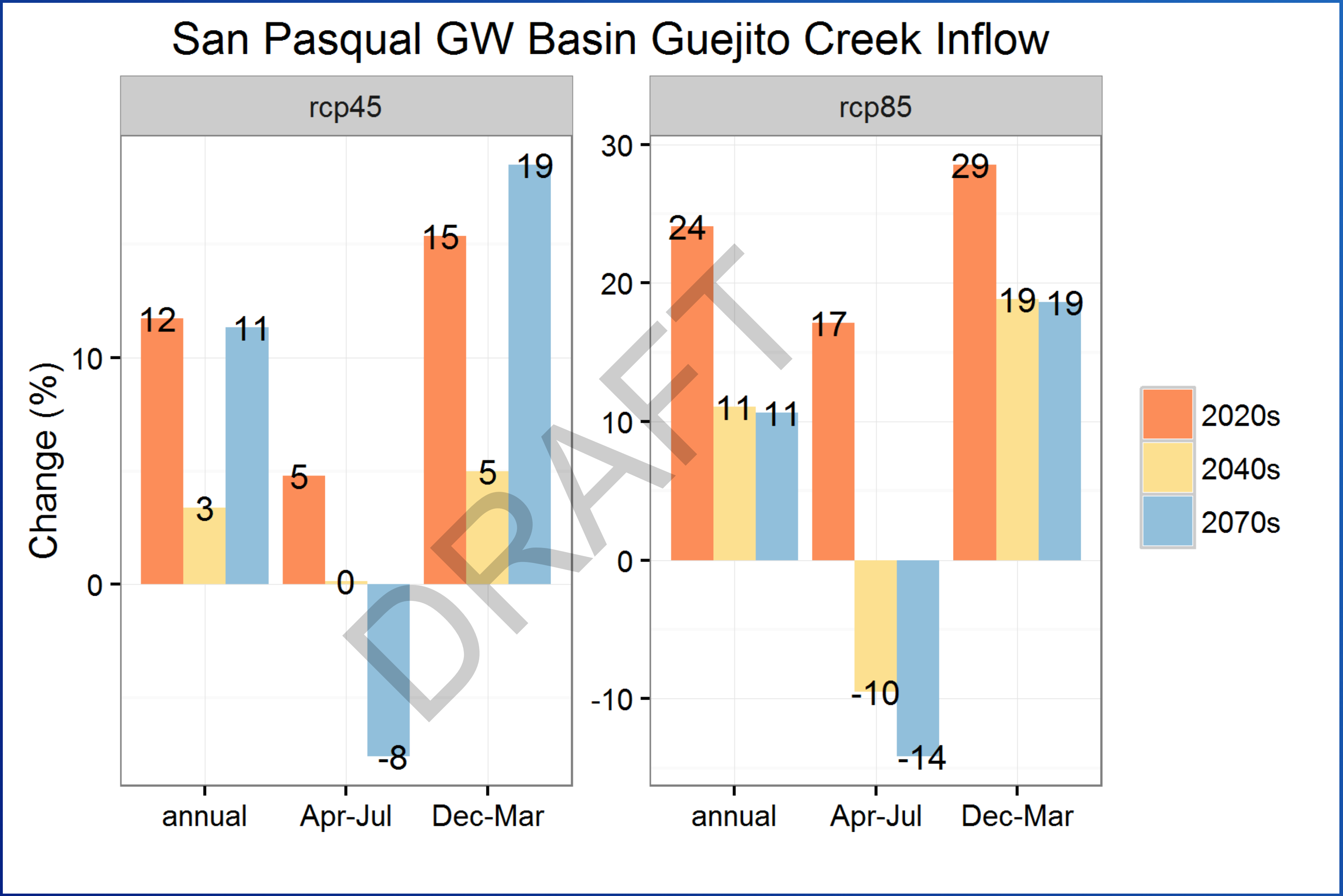
Local Groundwater

Two approaches to groundwater impacts analysis:

Streamflow infiltration is the primary source of runoff for the basins of interest →
used same method as for surface water by identifying where river enters the groundwater basin

Examined the frequency of periodic recharge events using groundwater well data

Local Groundwater



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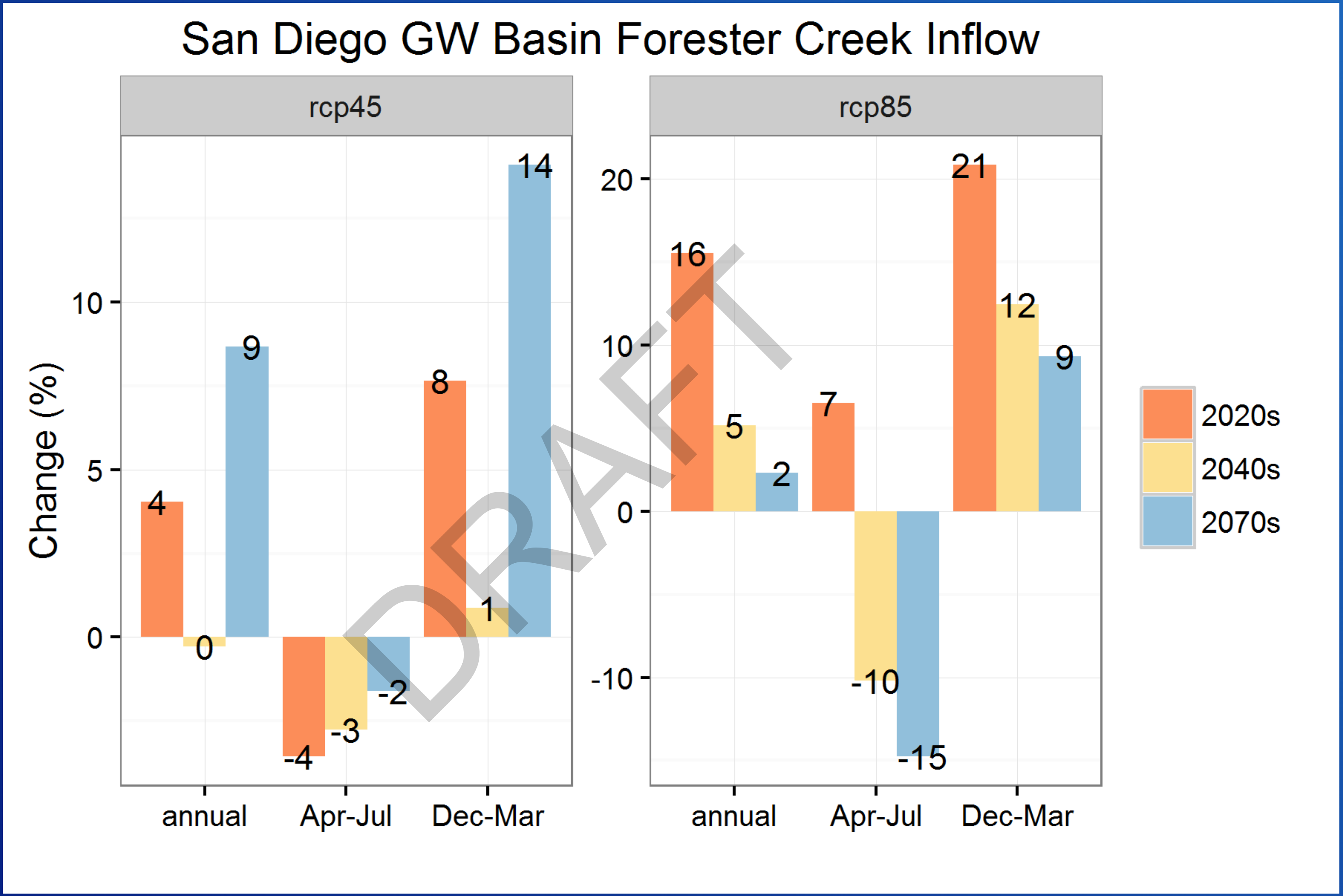
Local Groundwater



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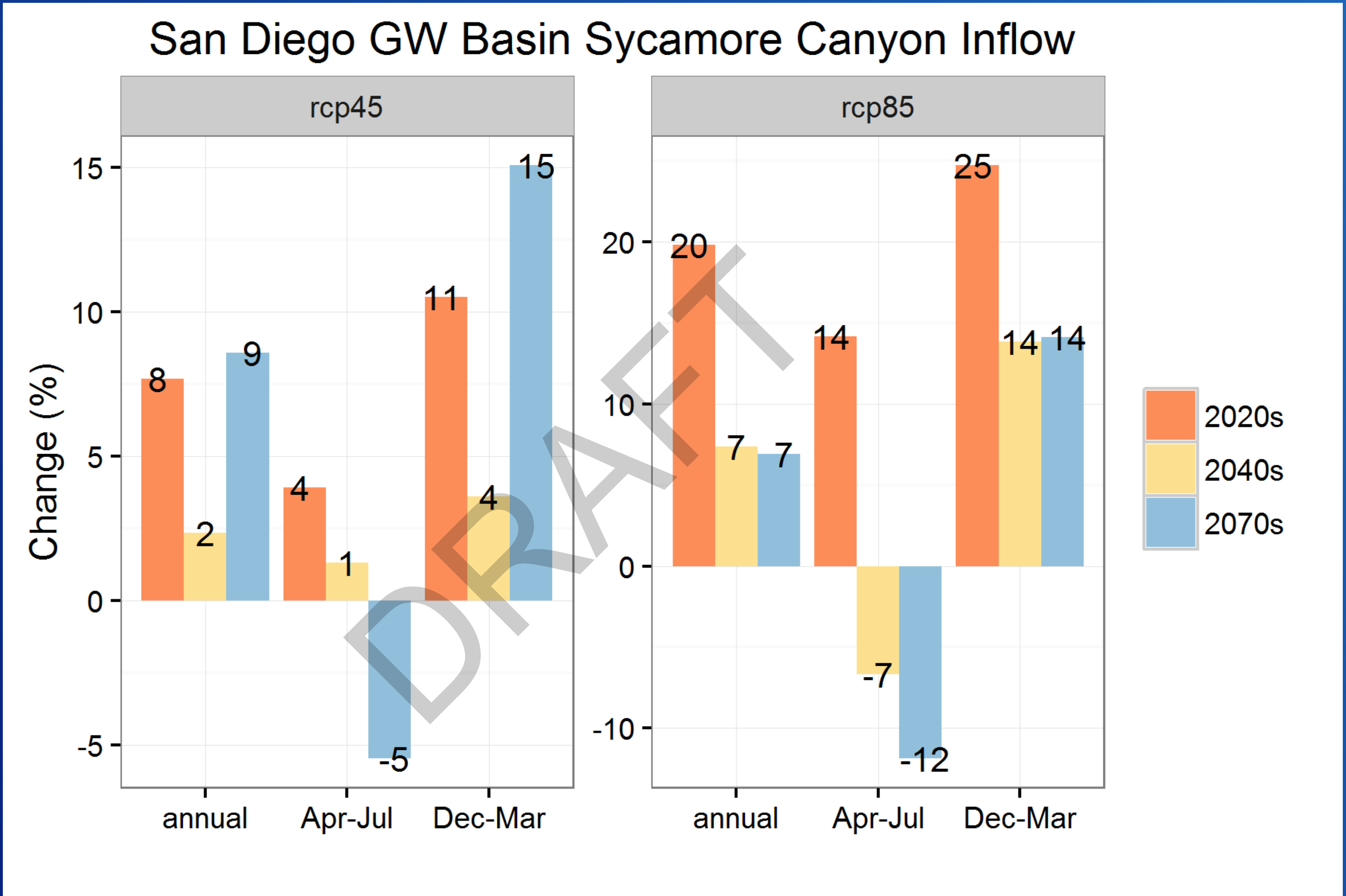
Local Groundwater



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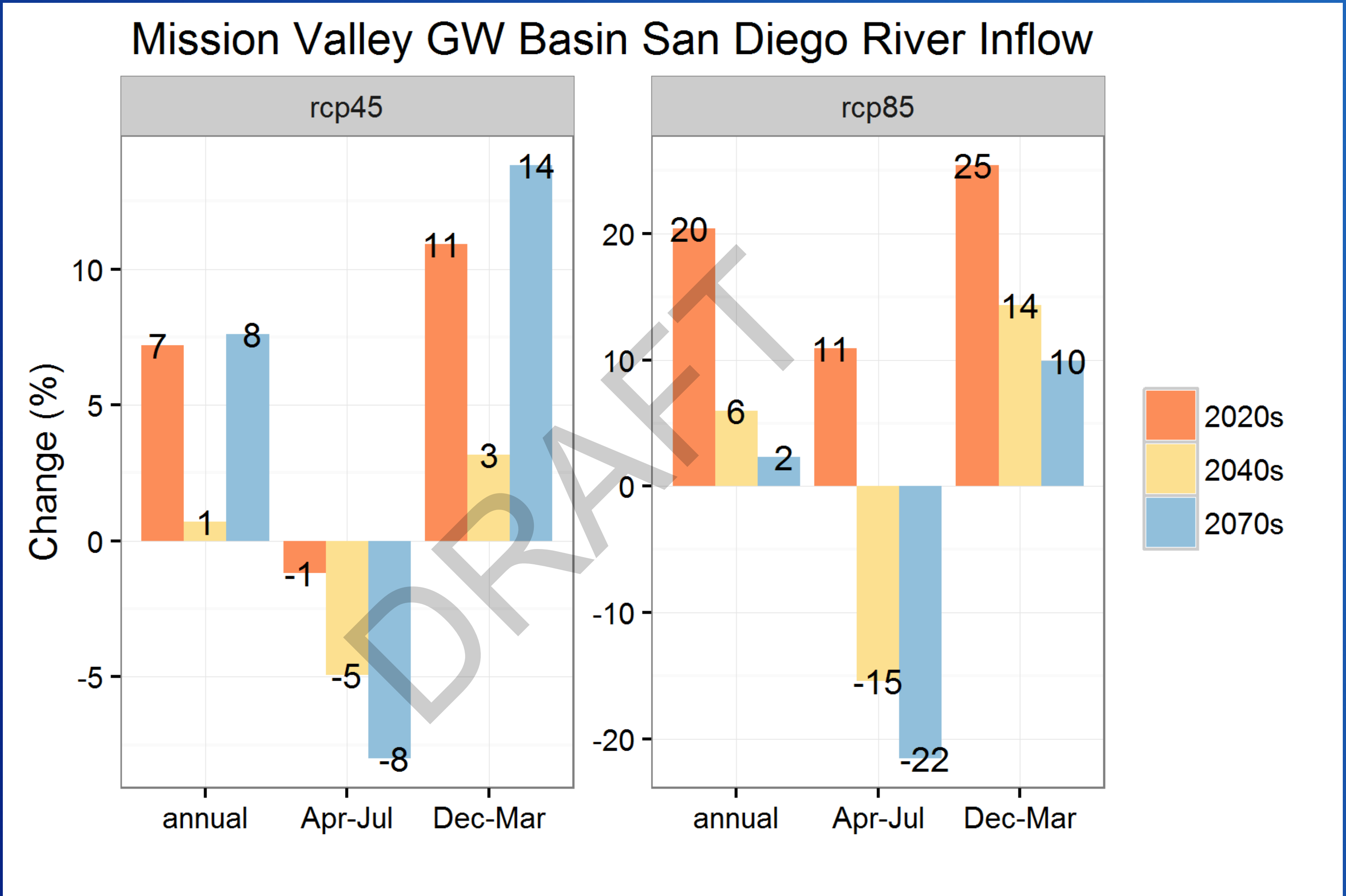
Local Groundwater



RECLAMATION

Local Groundwater

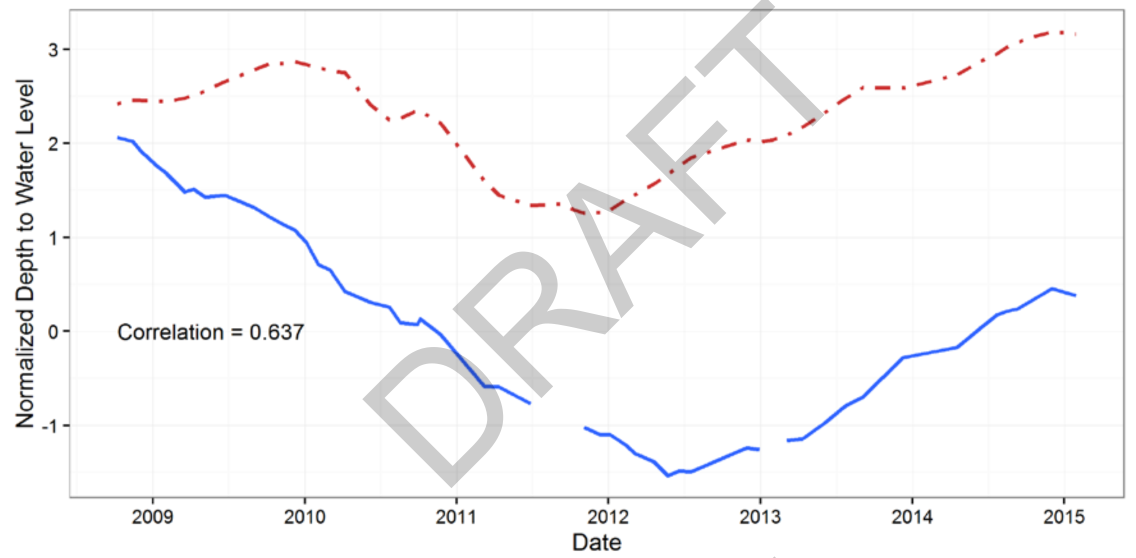
See same pattern as surface water:

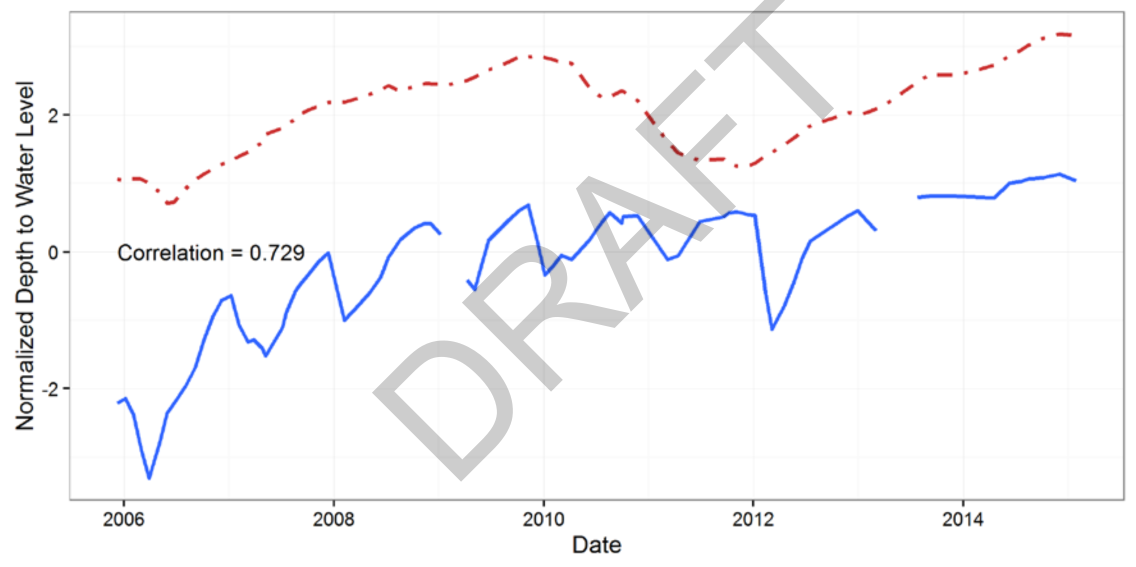
increases in annual streamflow

increases in winter streamflow

decreases in spring streamflow

Local Groundwater





Two local groundwater wells in the San Diego coastal aquifer

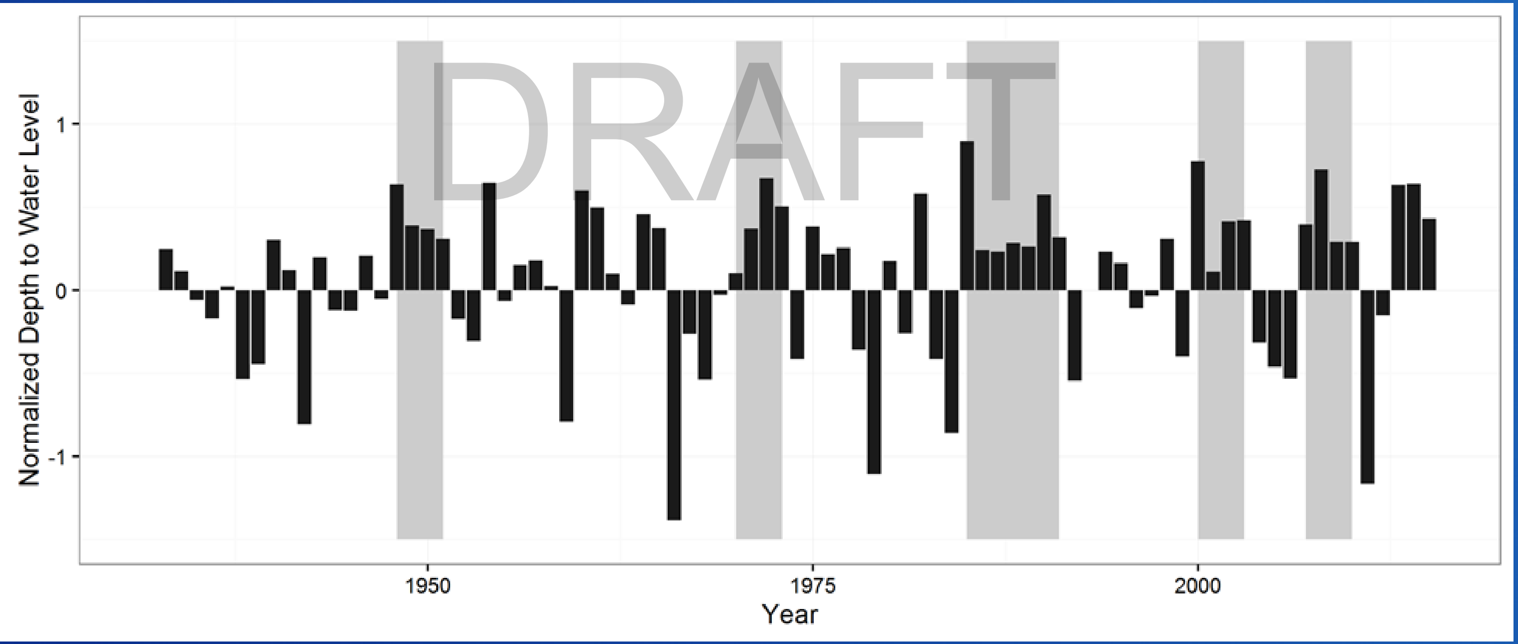
Compared to a long-term (>50yr) well located in LA County

Reasonable correlation between the two

All three wells are in the same US climate division

Use the long-term well to look at recharge events

Local Groundwater



Annual groundwater level → ~March 1st

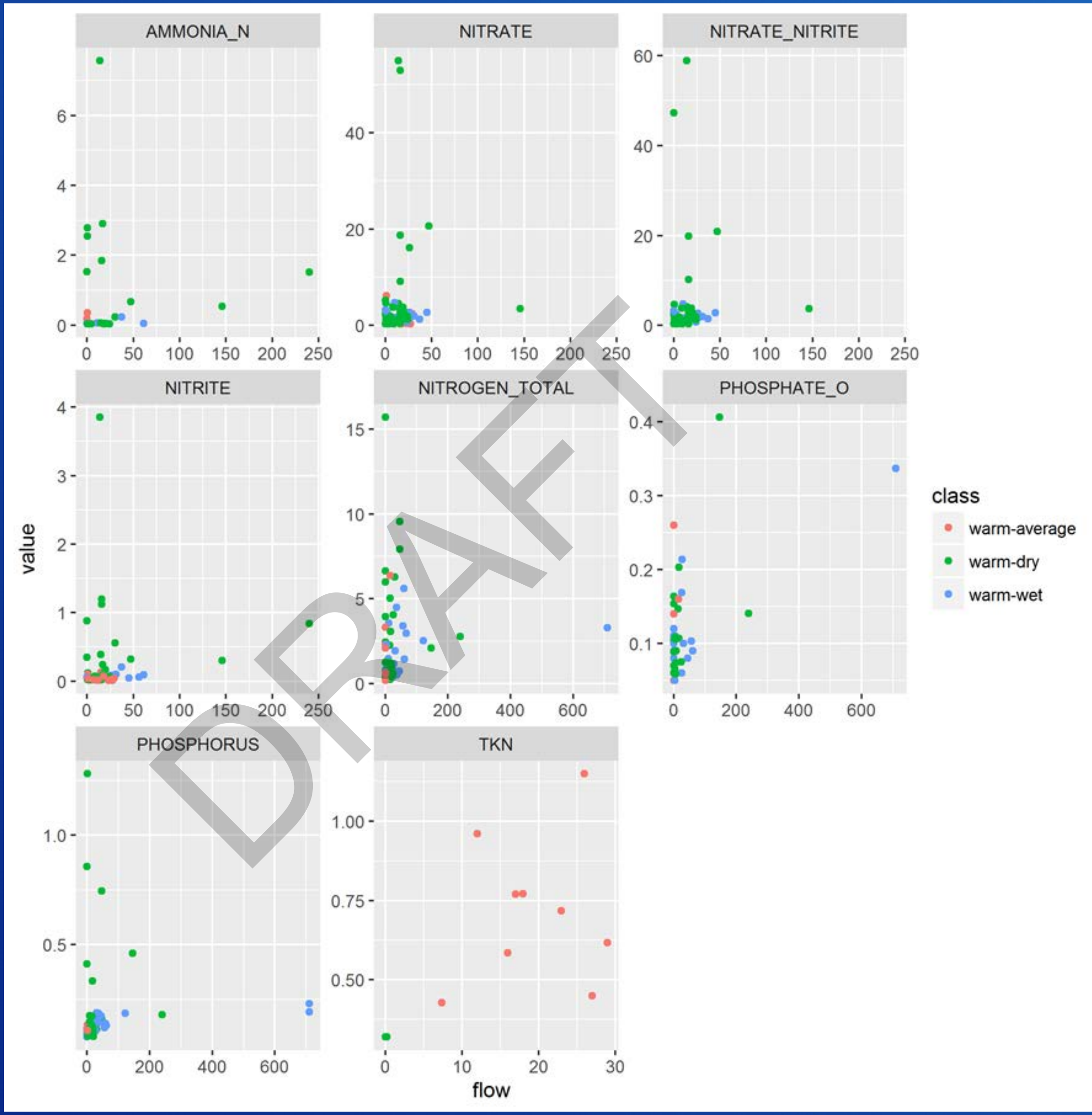
Recharge event → 4+ years of increasing groundwater

These events can be linked to seasonal precipitation and temperature

Future precipitation and temperature from climate projections can be used to see how frequency of recharge events may change

RECLAMATION

Water Quality



RECLAMATION

Climate Impacts Summary

Examined climate impacts on sources of imported water using past climate impacts assessments and basin studies

This may be updated to include the ongoing Sacramento-San Joaquin Basin Study

Examined surface water impacts at key locations in the study region

Moderate increases in annual streamflow
Decreases in spring streamflow
Increases in winter streamflow

‘Representative groundwater locations’ saw the similar changes

RECLAMATION

Climate Impacts Summary

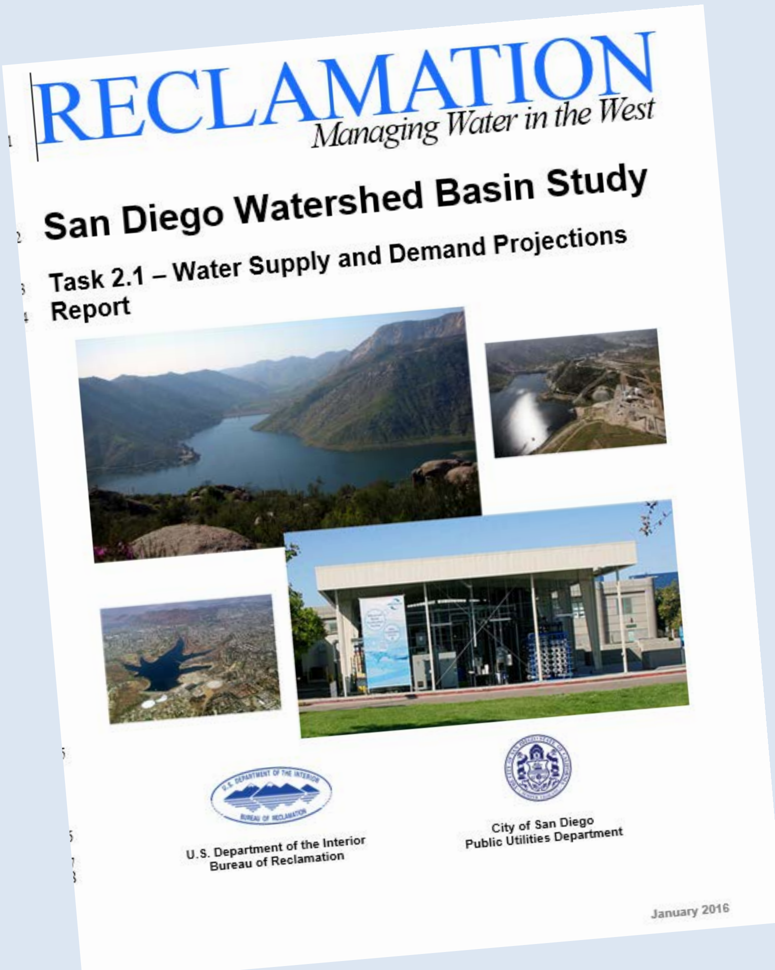
Ongoing work to examine periodic recharge events and their frequency of occurrence under climate change

Ongoing work into water quality impacts

Currently have a draft report describing these analyses and results in internal review

RECLAMATION

Next Steps



RECLAMATION
Managing Water in the West

San Diego Watershed Basin Study

Task 2.1 – Water Supply and Demand Projections Report

U.S. Department of the Interior
Bureau of Reclamation

City of San Diego
Public Utilities Department

January 2016

- Task 1 - Project Administration
- Task 2 -Planning/Design/Engineering
- Task 2.1 - Water Supply and Demand Projections
- Task 2.2 - Downscaled Climate Change and Hydrologic Modeling
- Task 2.3 - Existing Structural Response and Operations Guidelines Analysis
- Task 2.4 – Structural and Operations Concepts
- Task 2.5 – Trade-Off Analysis and Recommendations
- Task 2.6 – Final Report

Comments Due: February 12, 2016

- Website- http://www.usbr.gov/lc/socal/basinstudies/SDBasin.html
- Email Address-SDBasinstudy@usbr.gov

Questions?

San Diego Watershed Basin Study

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