DEVELOPMENT AND APPLICATION OF OTHER PERFORMANCE ASSESSMENT TOOLS

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RECLAMATION

Hydropower Generation and Use and Greenhouse Gas (GHG) Emissions Models

- **LTGen** – simulates CVP facilities
- **SWP_Power** – simulates SWP facilities
- Tools were enhanced to compute GHG emissions associated with changes in power generation and use

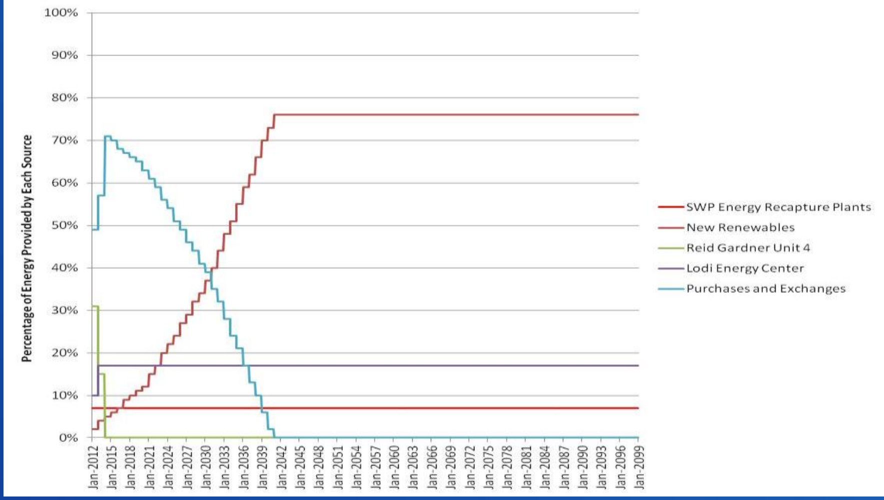
Central Valley Project (LTGen)		State Water Project (SWP_Power)	
Pumping Facilities	Hydropower Facilities	Pumping Facilities	Hydropower Facilities
North of Delta			
Red Bluff	Trinity	none	Oroville
Corning	Lewiston		Thermalito
Tehama Other	Carr		
Folsom	Spring Creek		
Contra Costa	Shasta		
	Keswick		
	Folsom		
	Nimbus		
	New Melones		
South of Delta			
C. W. Jones	CVP San Luis	SWP Banks	SWP San Luis
CVP Banks	O'Neill	SWP San Luis	Alamo
O'Neill		SWP Dos Amigos	Mojave
CVP San Luis		Buena Vista	Devil's Canyon
San Felipe		Teerink	Warner
CVP Dos Amigos		Chrisman	Castaic
DMC Intertie		Edmonston	
San Luis Other		Pearblossom	
DMC Other		Oso	
Misc		South Bay	
		Del Valle	
		Las Perillas	
		Badger Hill	

RECLAMATION

Greenhouse Gas (GHG) Emissions Modeling

- **When power use exceeds generation:**
  - **SWP or CVP GHG emissions computed based on assumed power sources**

Energy Source	CO_2e ($mtCO_2e/GWh$)	Basis for Assumption
Reid Gardner Unit 4	1116	DWR State Water Project Operational Emissions Projections (DWR, 2012)
Lodi Energy Center	361	DWR State Water Project Operational Emissions Projections (DWR, 2012)
Purchases and Exchanges	427	DWR State Water Project Operational Emissions Projections (DWR, 2012)
SWP Energy Recapture Plants and New Renewables	0	DWR State Water Project Operational Emissions Projections (DWR, 2012)

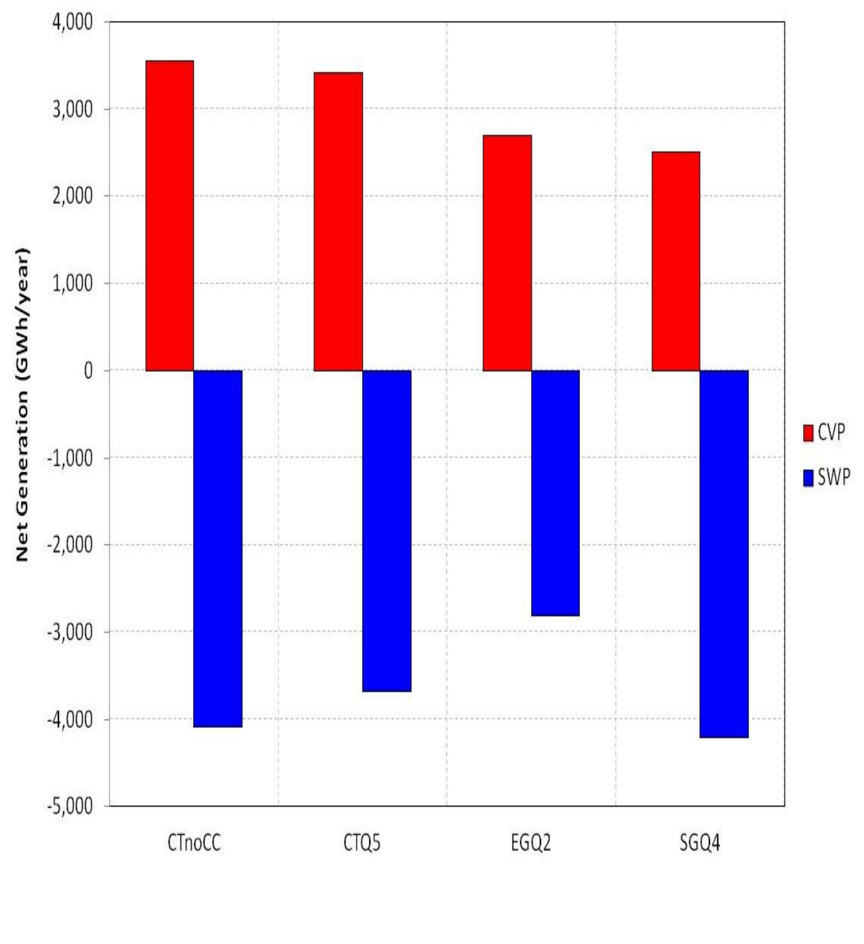


- **When power generation exceeds use:**
  - **Potential GHG offsets from avoided use of power on energy grid**

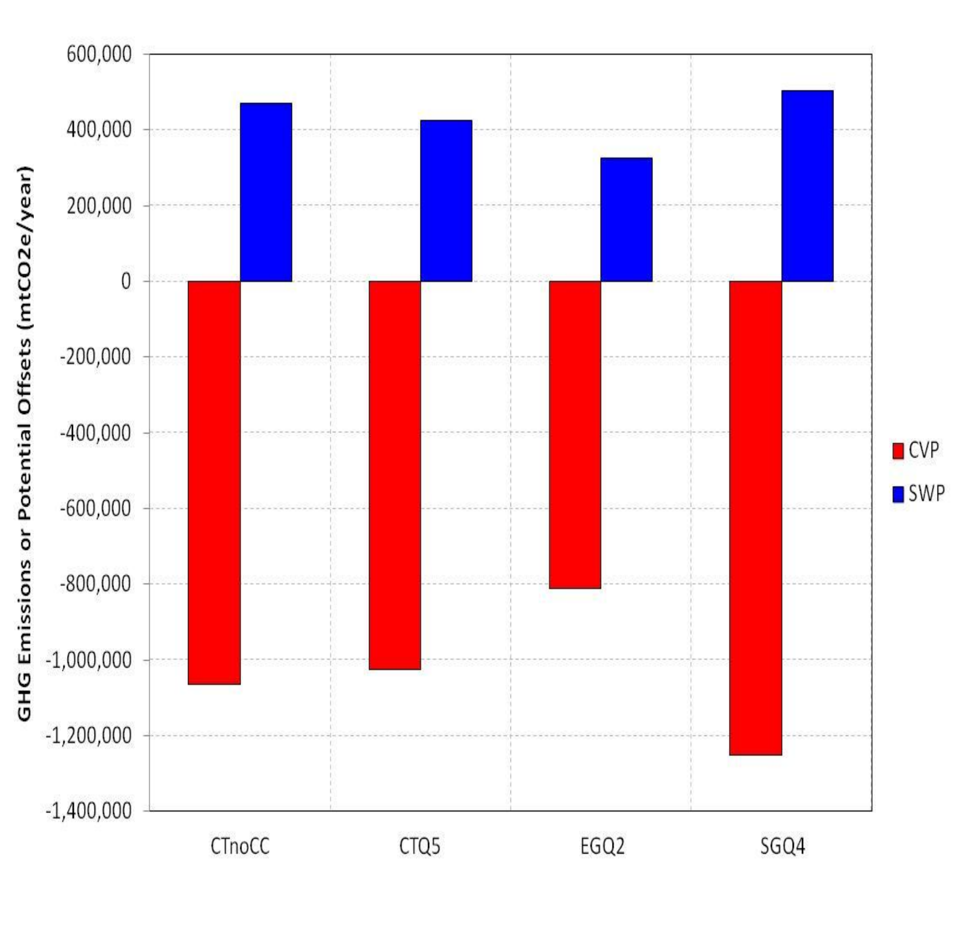
Energy Source	CO_2e ($mtCO_2e/GWh$)	Basis for Assumption
eGRID	299.9	US EPA eGRID2012 (US EPA, 2012)

Baseline Results: Hydropower and GHG Emissions

Average Annual Net Energy Generation



Average Annual GHG Emissions

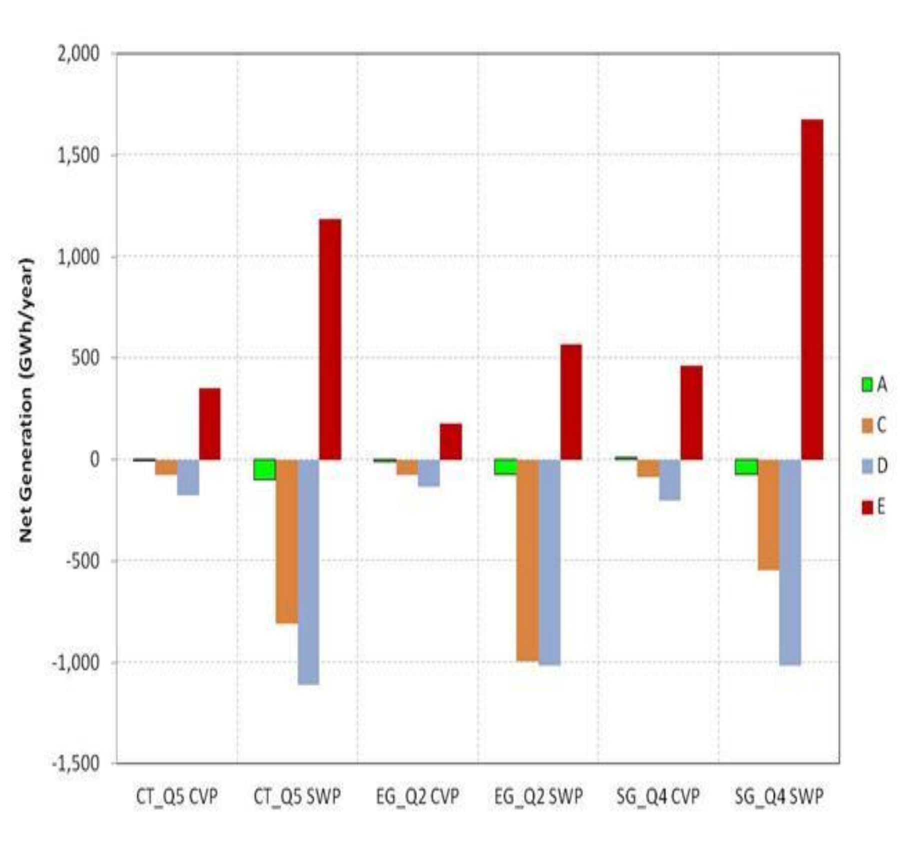


RECLAMATION

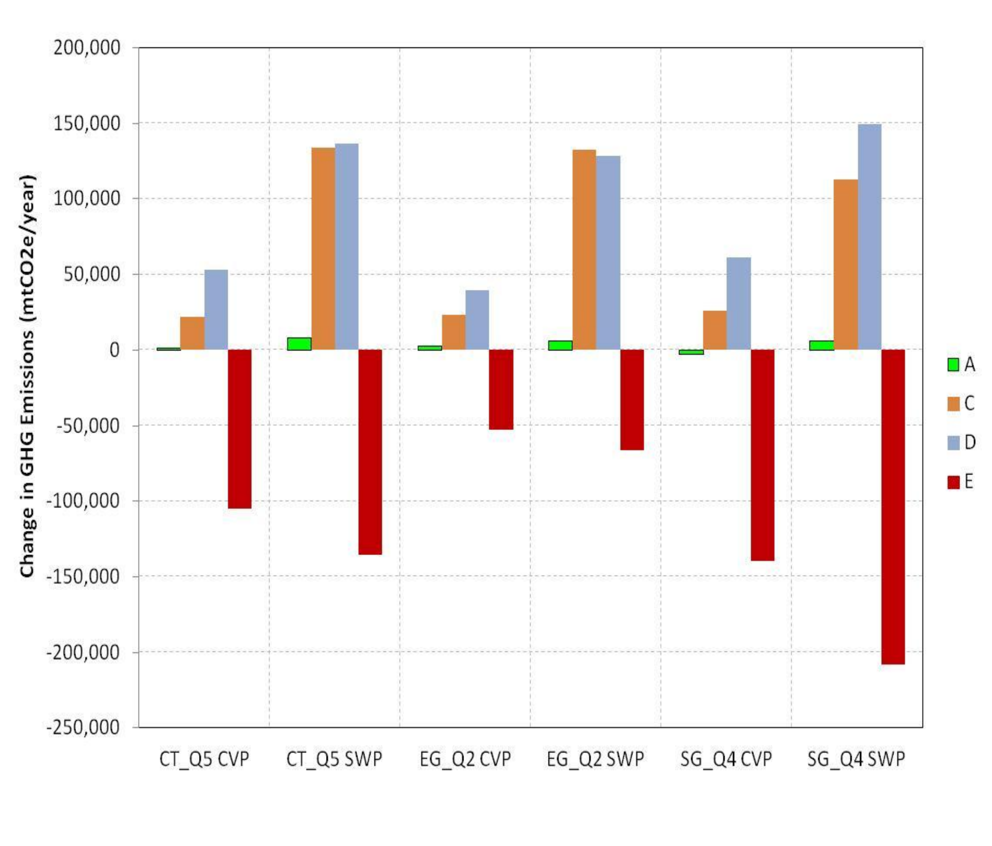
Portfolio Results: Hydropower and GHG Emissions

A: Aggressive Local Actions
C: Delta Conveyance and North-of-Delta Storage
D: Delta Conveyance and South-of-Delta Storage
E: Aggressive Local Actions, Enhanced Environmental Flows, and North-of-Delta Storage

Change in Average Annual Net Energy Generation



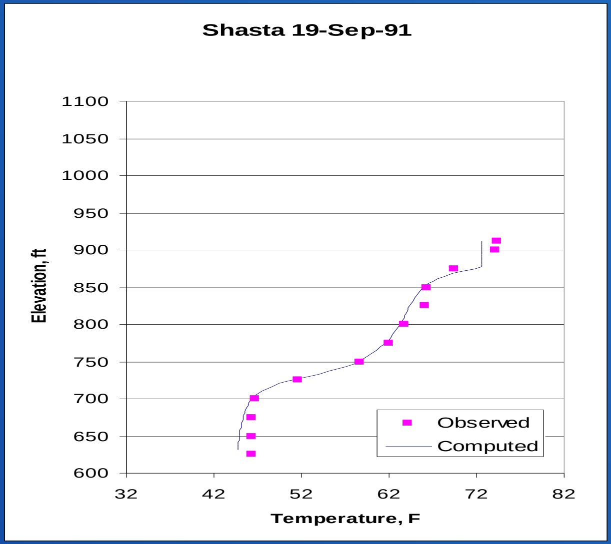
Change in Average Annual GHG Emissions

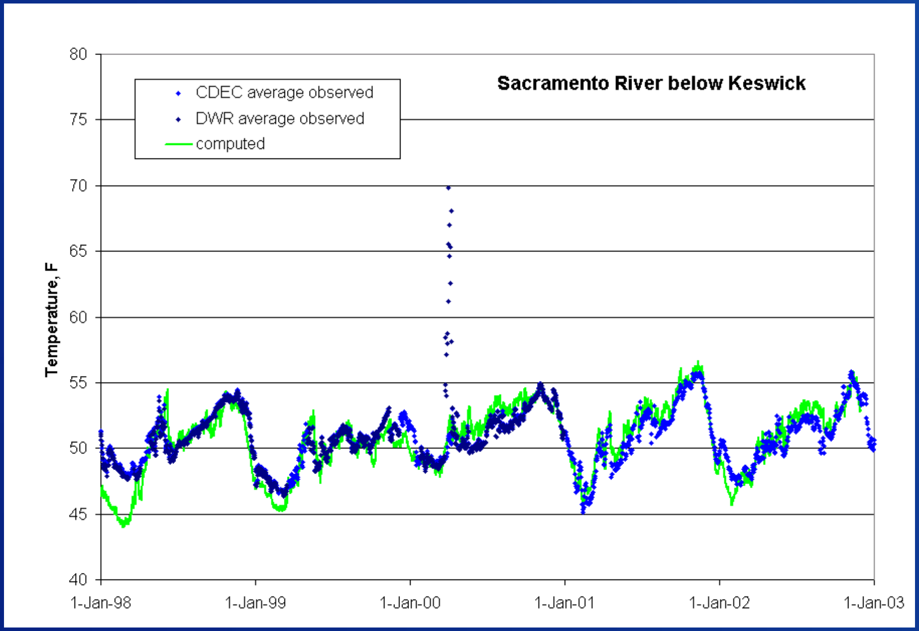


RECLAMATION

Water Temperature Models

- **Water Temperature Models**
  - Sacramento River Water Quality Model (SRWQM)
  - San Joaquin River HEC5Q Model





- **Models were updated to:**
  - Use CalLite outputs in place of CALSIM II outputs
  - Perform simulations using the 5 transient climate sequences

RECLAMATION

Sacramento River and San Joaquin River Temperature Models

- Developed by RMA using Corps' HEC5Q model.
- Sacramento River Temperature Model (a.k.a. SRWQM) has been in use for several years for both near-term forecasts and long-term planning scenarios.
- Previous versions of the San Joaquin River temperature model used for studying the thermal impacts of the San Joaquin River Restoration Program.

Sacramento River Temperature Model

- Simulates daily water temperature in the CVP facilities in the Trinity basin, Shasta Lake and Sacramento River upstream of Knights Landing.
- Model simulates Shasta Dam Temperature Control Device operations.
- Calibration was performed in 2002 using observed temperatures from 1998 - 2002.
- Modified to run 88-year transient climate planning simulations using CVP IRP CalLite outputs.

RECLAMATION

San Joaquin River Temperature Model

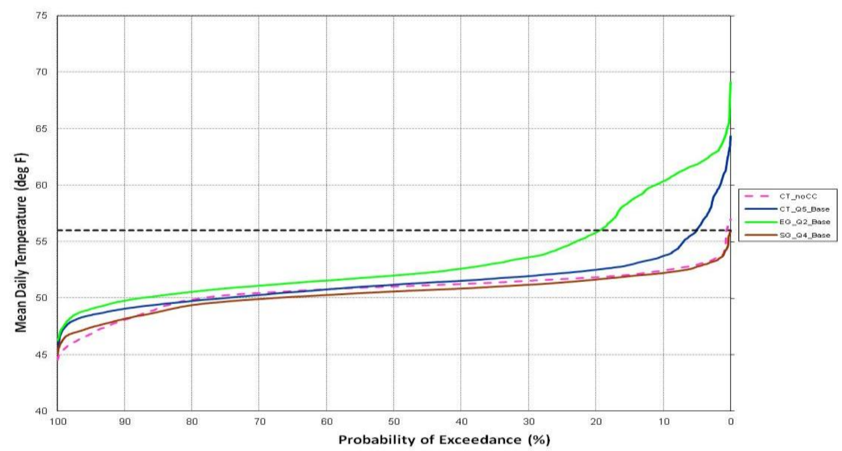
- Simulates daily water temperature in the San Joaquin River upstream of Vernalis to the rim reservoirs (Millerton, McLure, Don Pedro and New Melones) along with the tributaries and bypasses.
- Calibration was performed in 2007 using observed stream and reservoir temperatures data through 2007.
- Modified to run 88-year transient climate planning simulations using CVP IRP CalLite outputs.

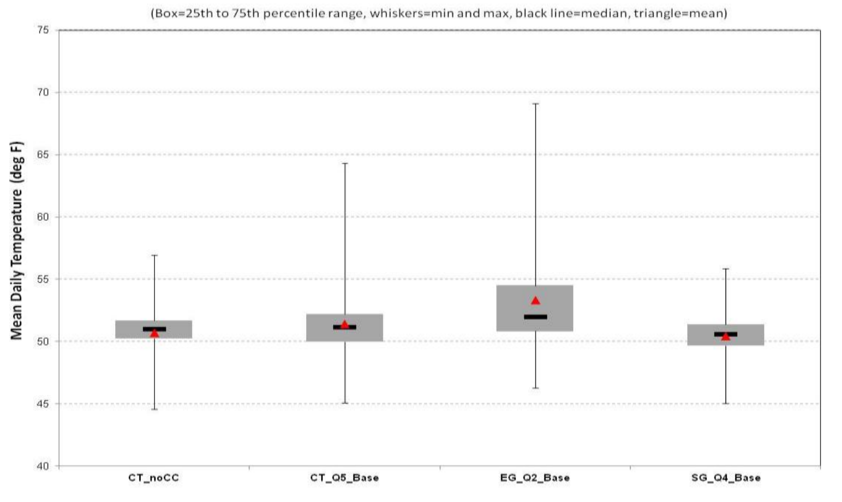
Incorporating Climate Change Effects into HEC5Q Meteorological Inputs

- SRWQM includes one meteorological zone and SJR HEC5Q Model includes four zones.
- Meteorological inputs processed from observed climate data are specified for each zone.
- For climate change scenarios, observed climate data modified by incremental changes in air temperature, rel. humidity and solar radiation, prior to meteorological pre-processing.
- Five sets of meteorological inputs processed for the five CVP IRP climate scenarios.

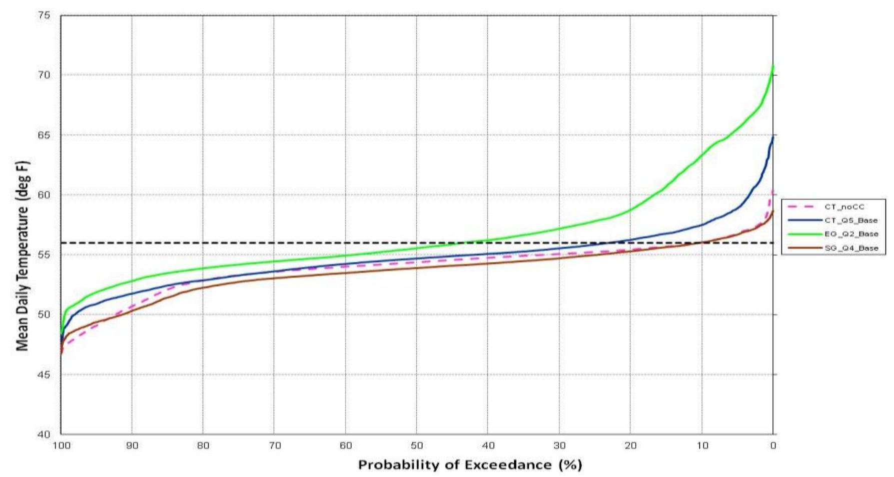
Baseline Results: Sacramento River Temperature

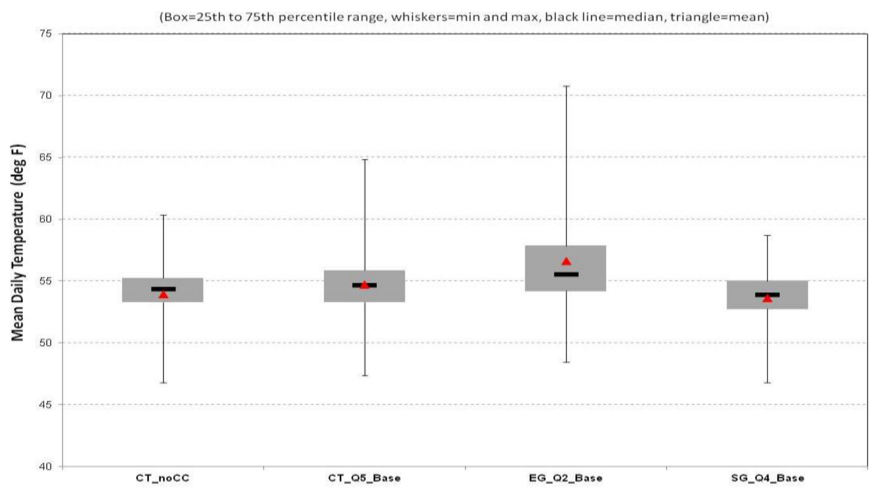
Keswick – July to September





Jellys Ferry – July to September

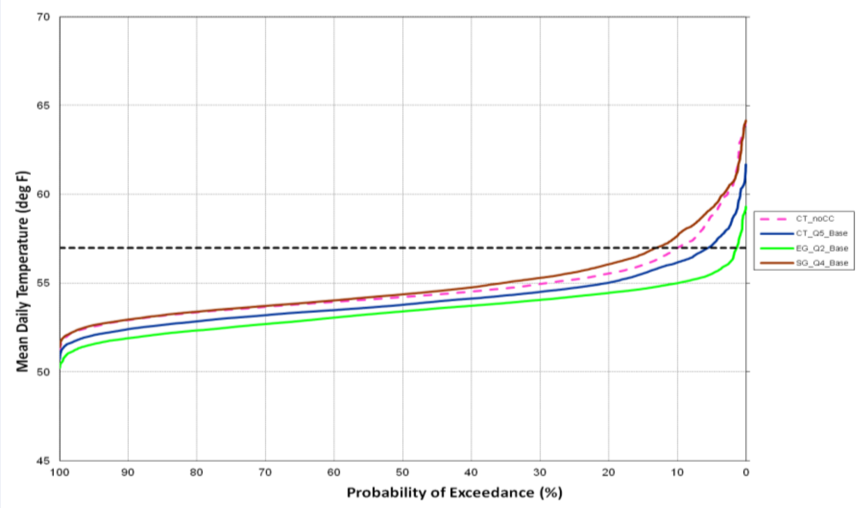


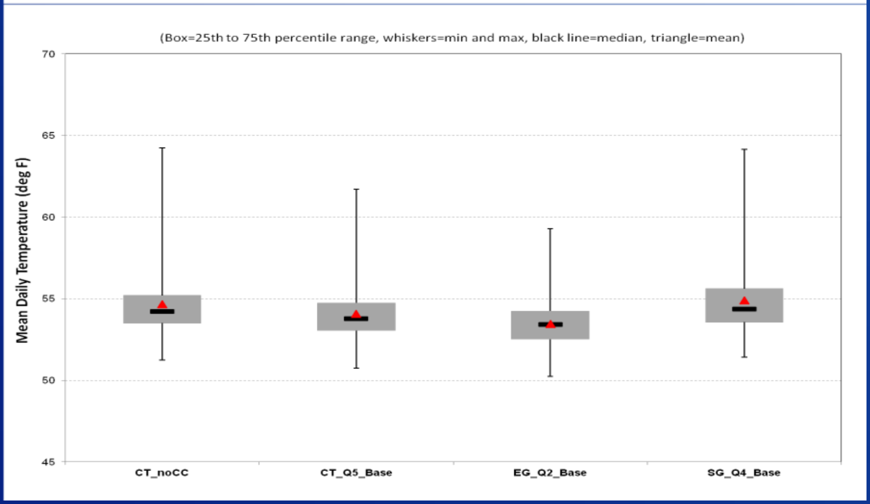


RECLAMATION

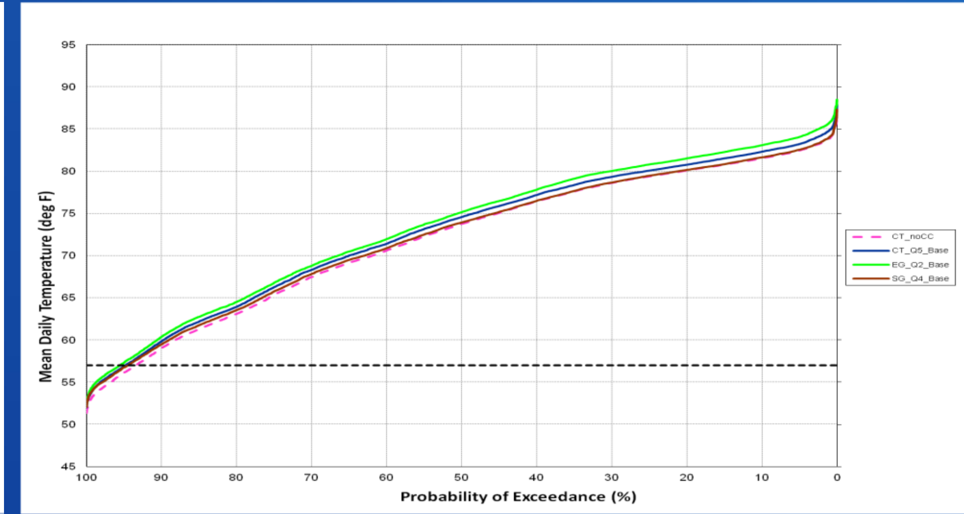
Baseline Results:
San Joaquin River Temperature

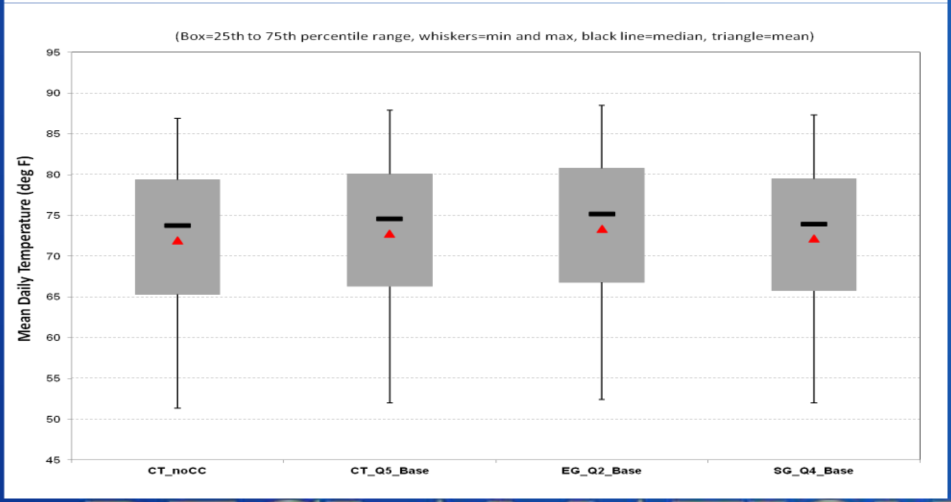
Lost Lake – August to November





Gravelly Ford – August to November



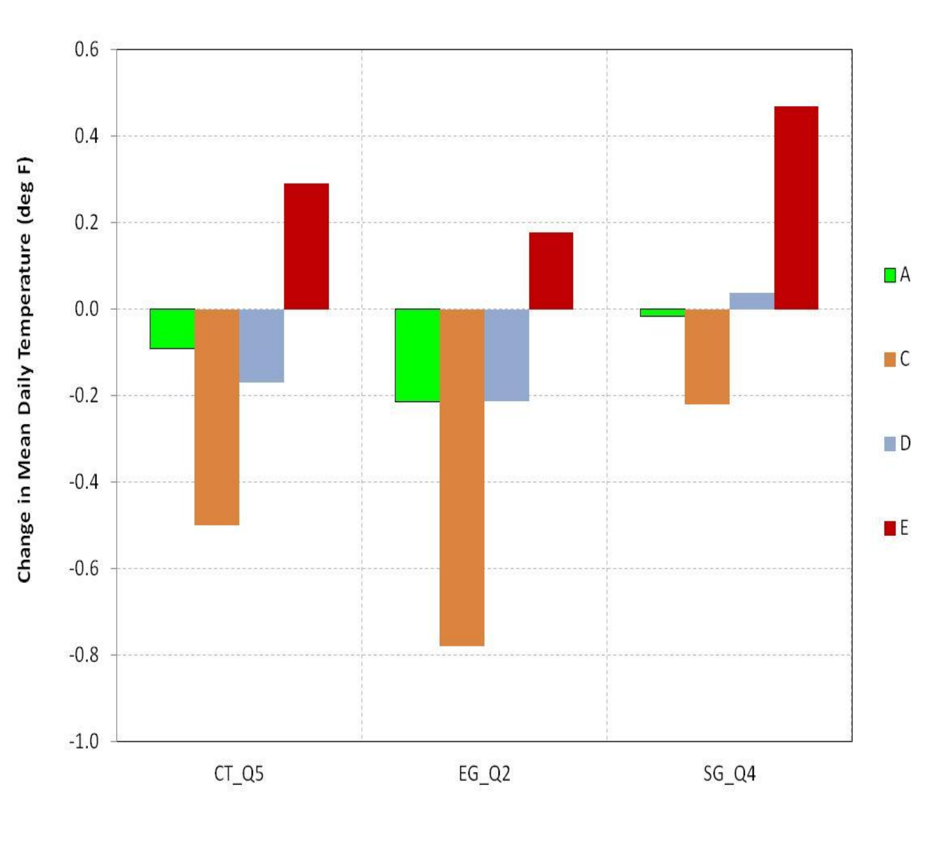


RECLAMATION

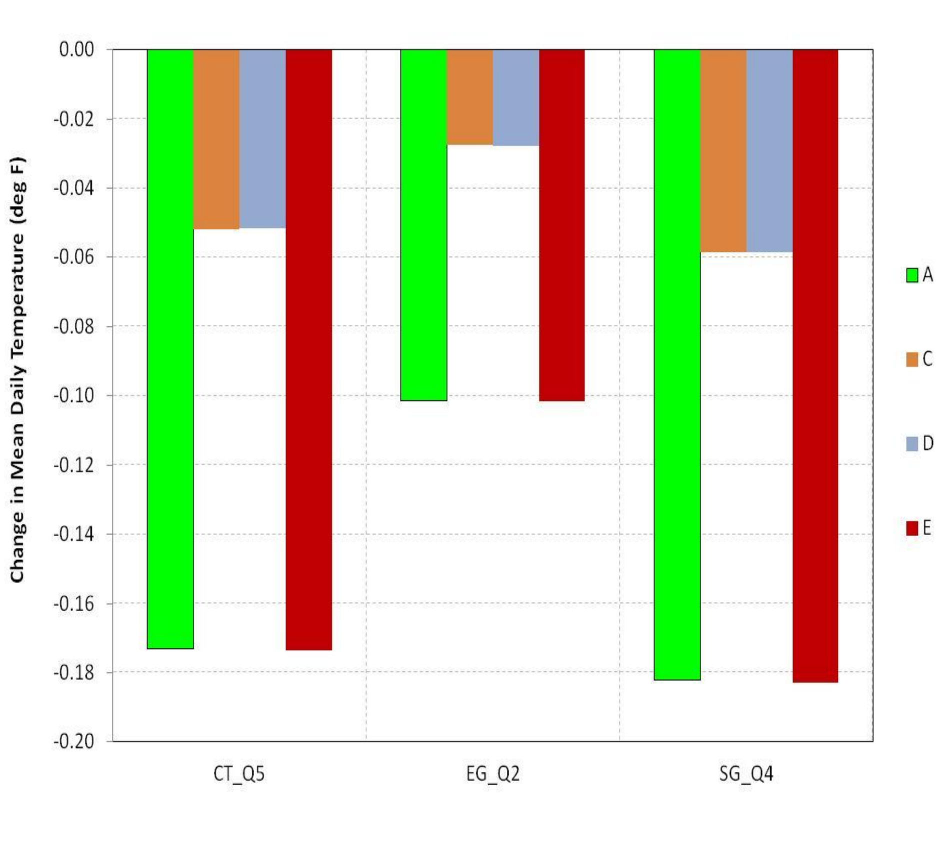
Portfolio Results: River Temperature

A: Aggressive Local Actions
C: Delta Conveyance and North-of-Delta Storage
D: Delta Conveyance and South-of-Delta Storage
E: Aggressive Local Actions, Enhanced Environmental Flows, and North-of-Delta Storage

Sacramento River at Jellys Ferry



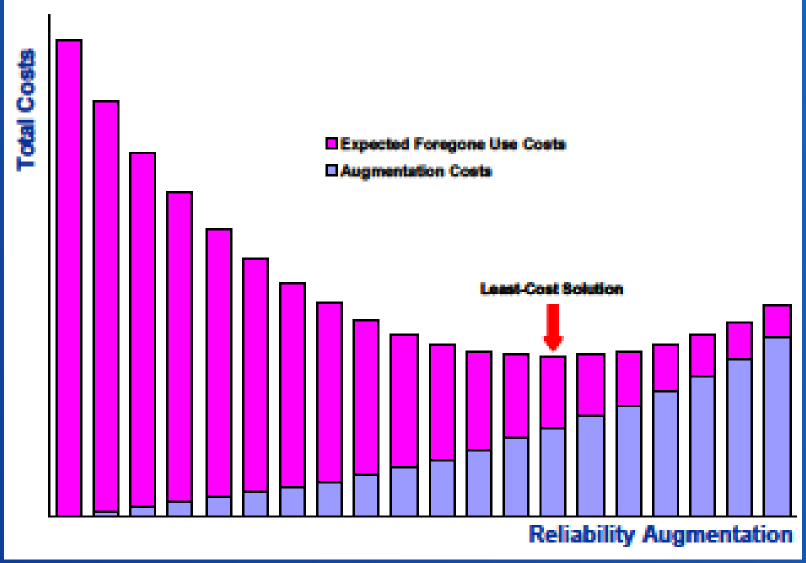
San Joaquin River at Gravelly Ford



RECLAMATION

Economics Models

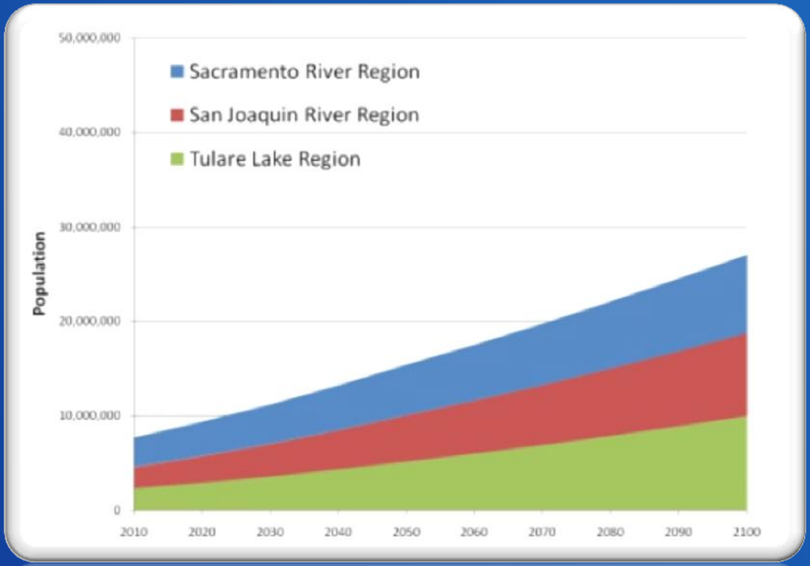
- Economic Models
  - LCPSIM - analyzes M&I economics in the South Bay Region
  - OMWEM - analyzes M&I economics in other regions
  - SWAP - analyzes agricultural economics in the Central Valley
  - SBWQM- analyzes water quality costs for SWP and CVP deliveries to South Bay Region
- Models were updated to
  - Use CalLite outputs
  - Model the level of development and scenarios specified in the analysis



RECLAMATION

Economics Model Development

- **Socioeconomic Scenarios**
  - Levels of development (2025, 2055, and 2085)
  - Slow growth, current trends, expansive growth
  - Scenario-based population
  - Energy and crop prices
  - Scenario-based land use
  - Climate-adjusted crop yield and water use
- **Model Integration**
  - CalLite outputs in place of CALSIM II outputs
  - Allow for trend analysis over 3 development scenarios and 3 levels of development (2025, 2055, and 2084)



RECLAMATION

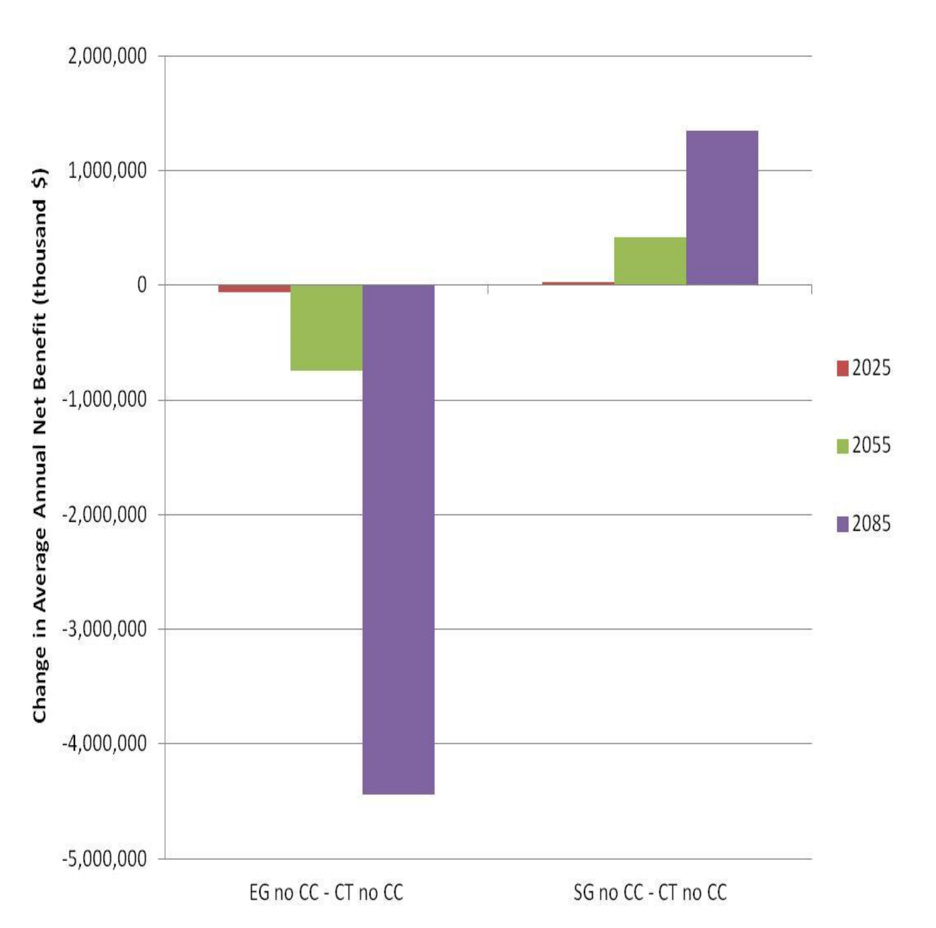
Least Cost Planning Simulation Model (LCPSIM)

- LCPSIM is an urban water supply economics simulation/optimization model with the objective of estimating the least cost regional water management plan.

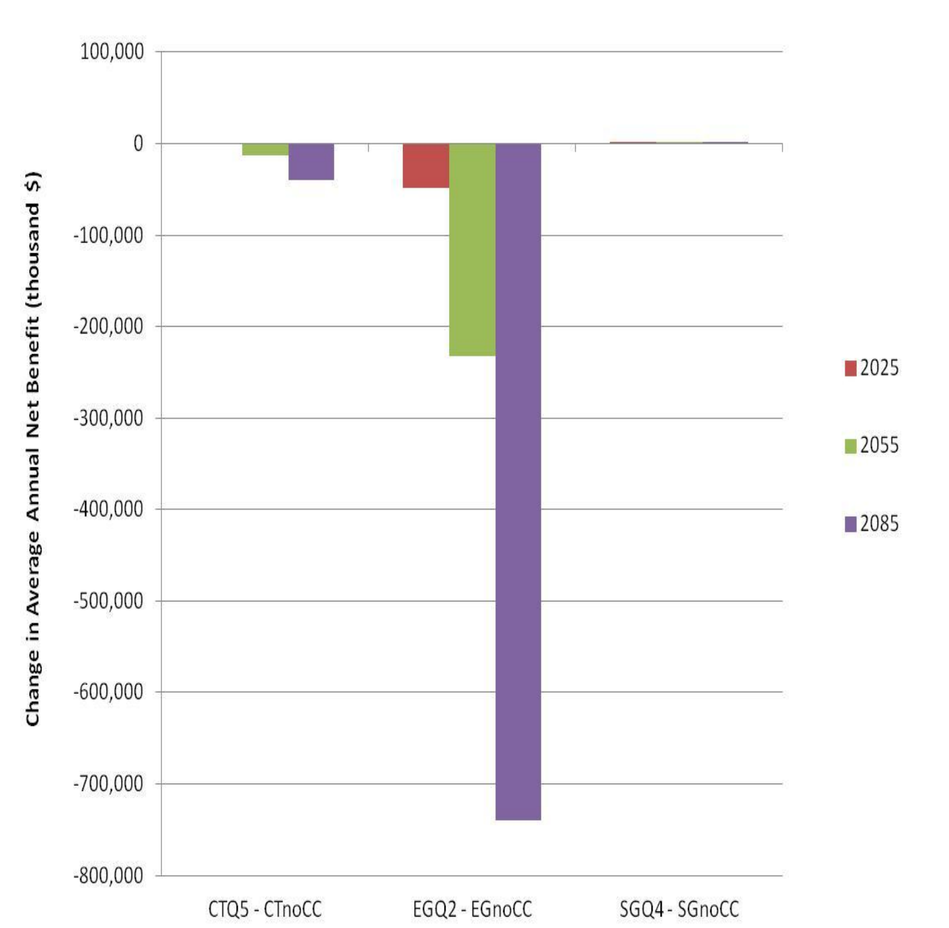
- LCPSIM is used to estimate the economic impact of changes to:
  - Imported water supply
  - Population
  - Power prices, etc.

Baseline Results:
South Bay Urban Economics (LCPSIM)

Changes Between Socioeconomic Scenarios



Changes Between Climate Scenarios



RECLAMATION

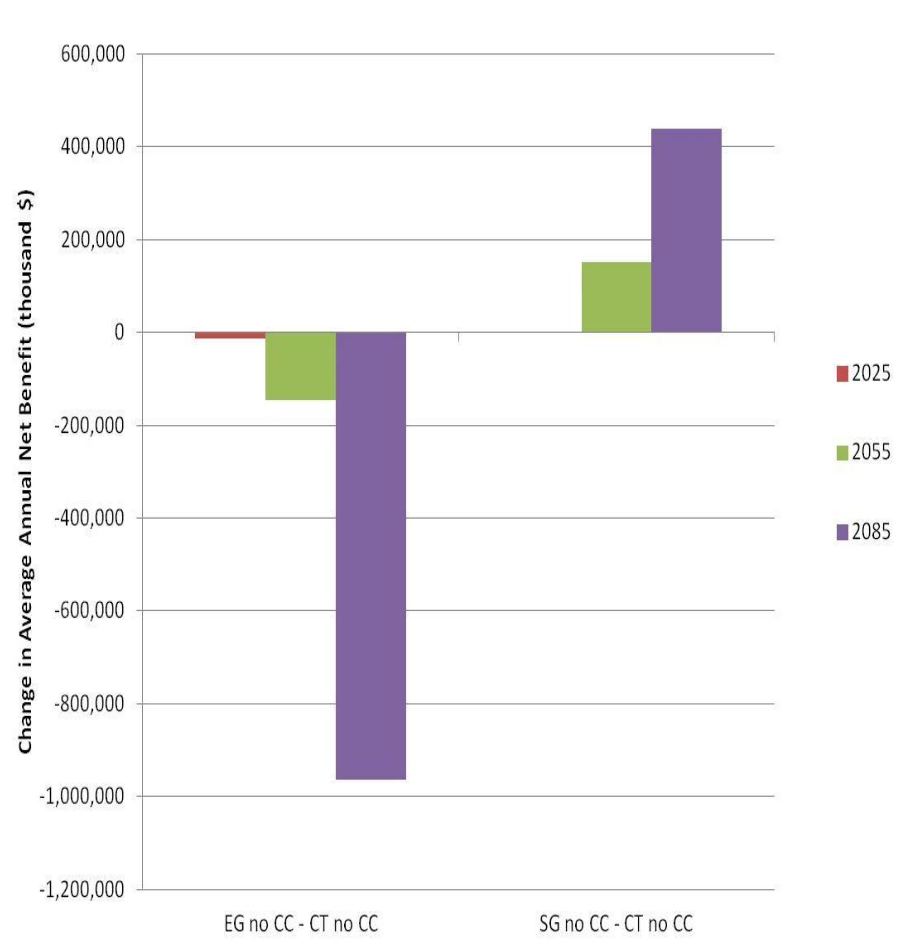
Other Municipal Water Economics Model (OMWEM)

- OMWEM estimates economic costs of changes in water supply for SWP and CVP municipal water supply areas not included in LCPSIM models
- The model provides analysis framework similar to LCPSIM
- The model increases understanding of water supply and shortage costs in these areas

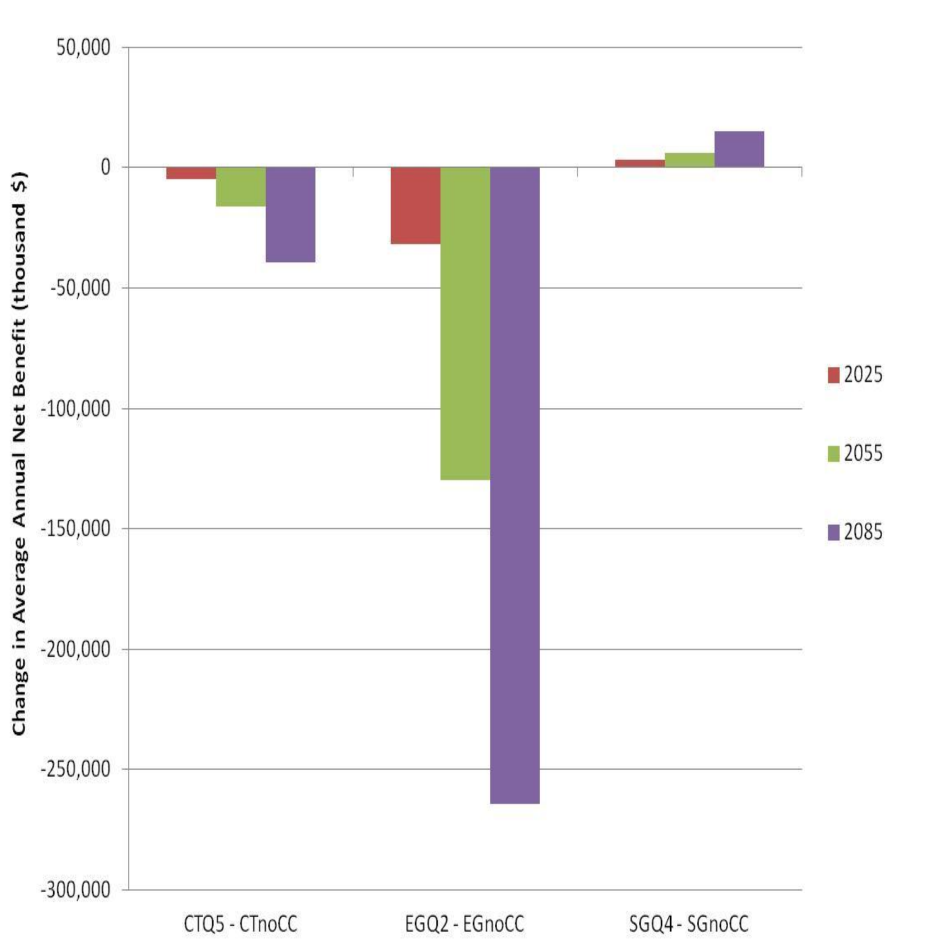
RECLAMATION

Baseline Results:
Other M&I Regions Economics (OMWEM)

Changes Between Socioeconomic Scenarios



Changes Between Climate Scenarios



RECLAMATION

Statewide Agricultural Production Model (SWAP)

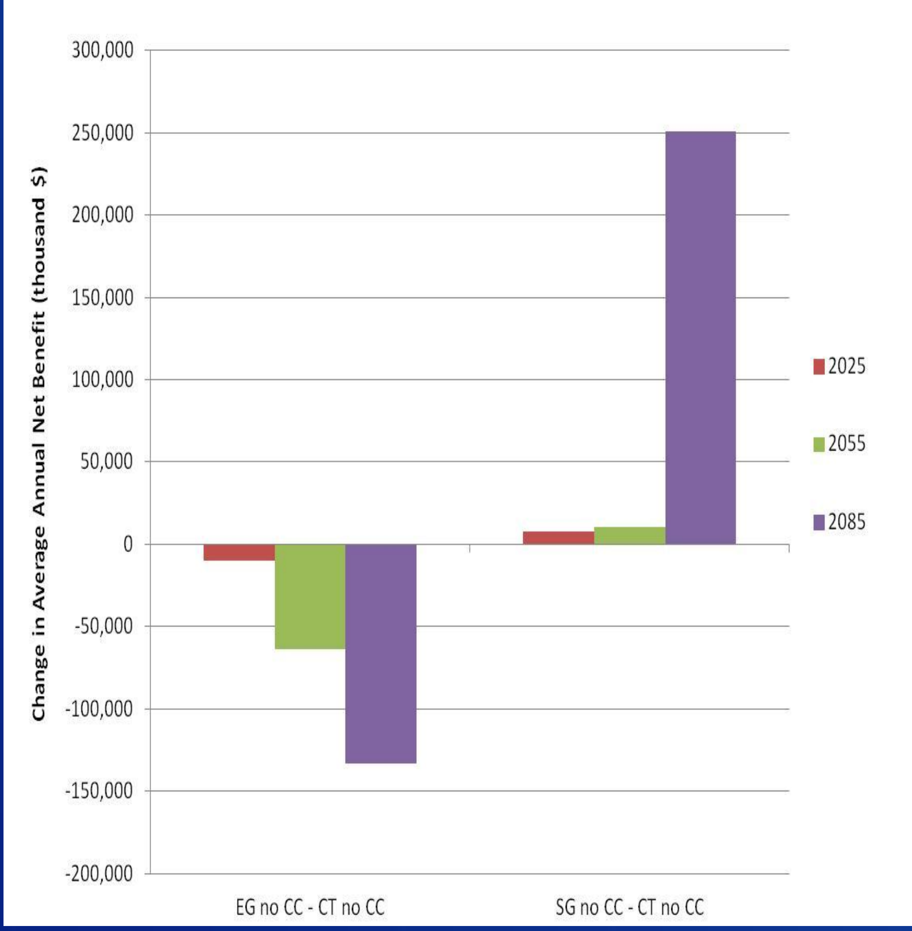
- SWAP is used to assess response of irrigated agriculture to changes in water supply and costs in 27 regions in the Central Valley

- The objective of the model is to maximize the sum of producer and consumer benefits

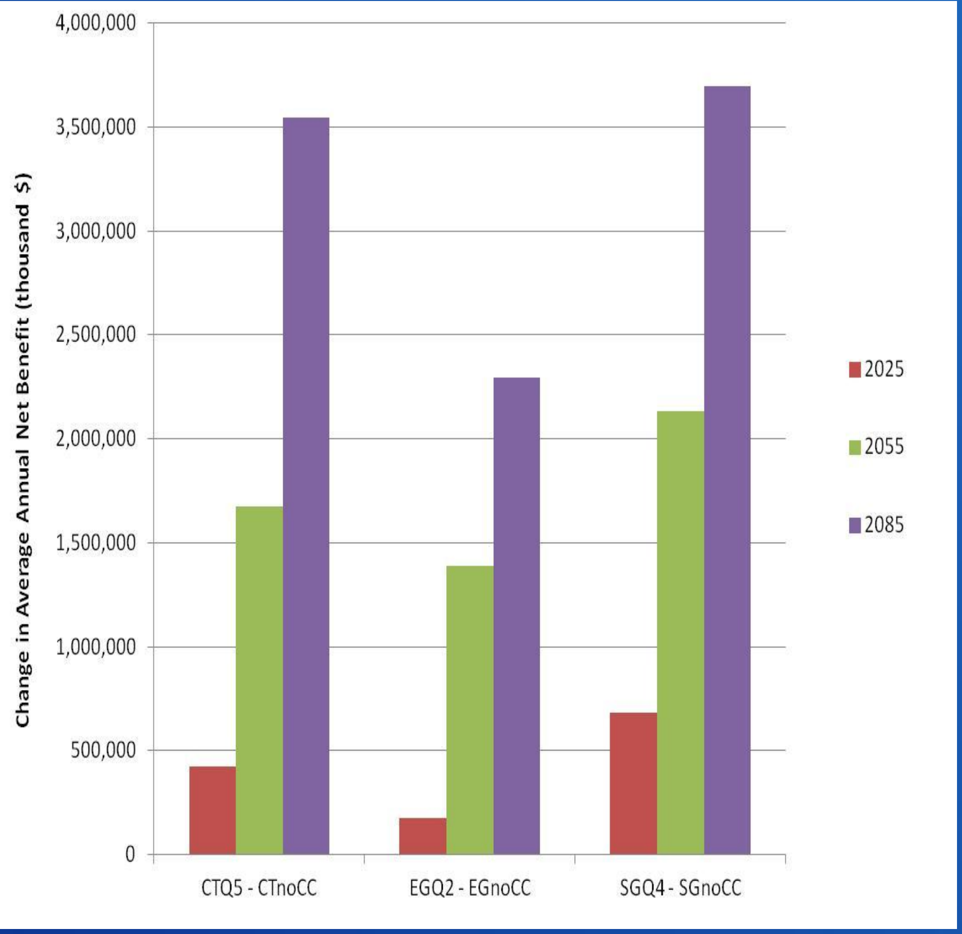
- Evaluates trade-offs among
  - Crop mix, land in production
  - Groundwater use
  - Irrigation efficiency

Baseline Results: Agricultural Economics (SWAP)

Changes Between Socioeconomic Scenarios



Changes Between Climate Scenarios



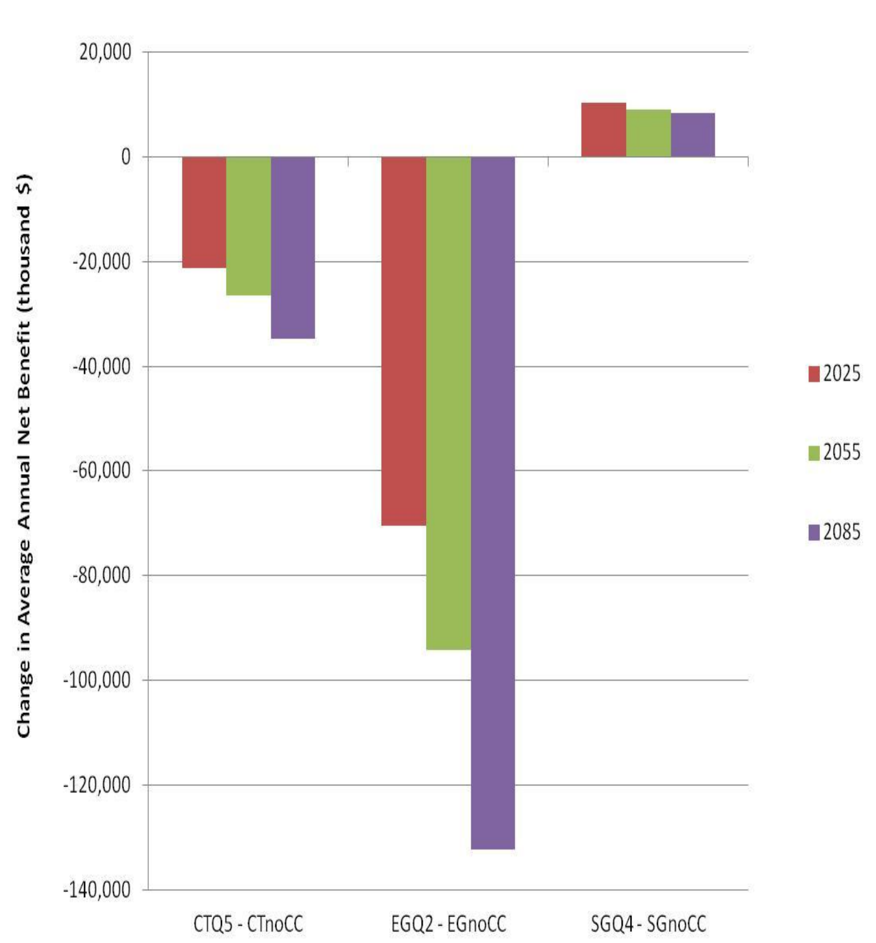
RECLAMATION

South Bay Water Quality Model (SBWQM)

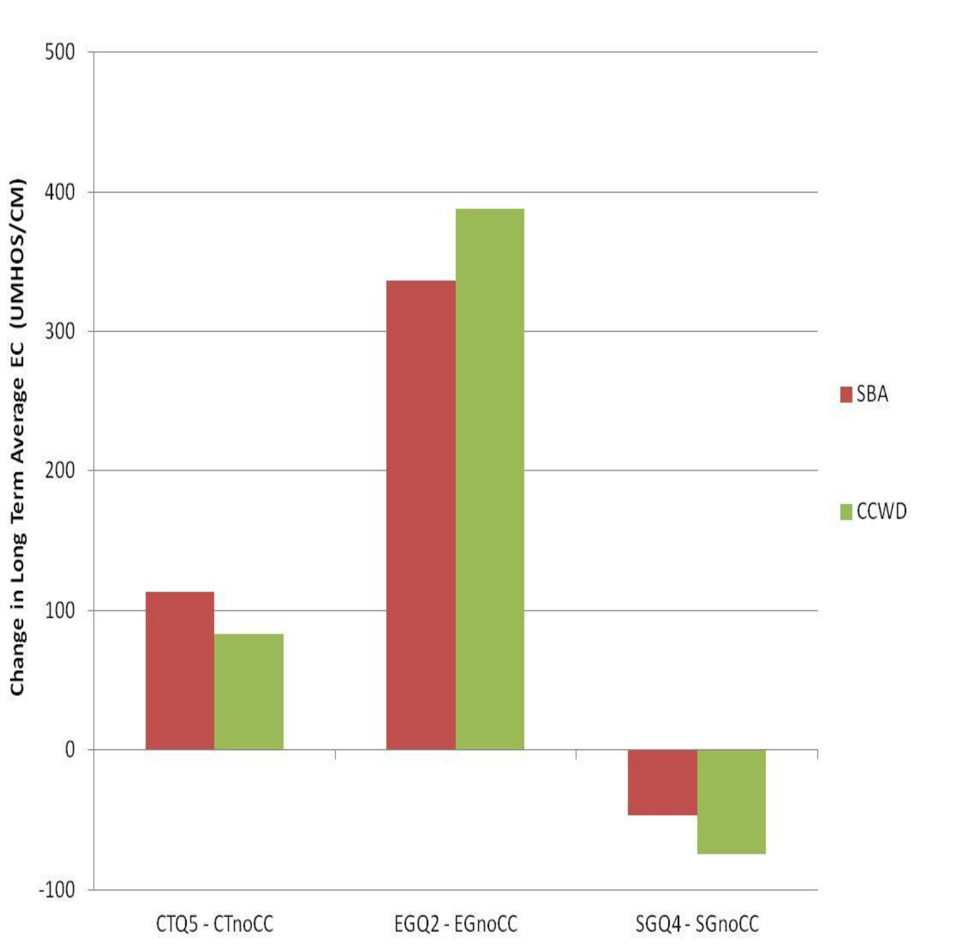
- SBWQM estimates residential salinity costs only as a function of water quality and useful life of residential fixtures, appliances, etc.
- Includes residential use in the South Bay region affected by project water supplies
- The model requires number of affected households and the characteristics of households in the South Bay region (e.g., appliances use)

Baseline Results:
South Bay Water Quality Economics (SBWQM)

Changes between Climate Scenarios



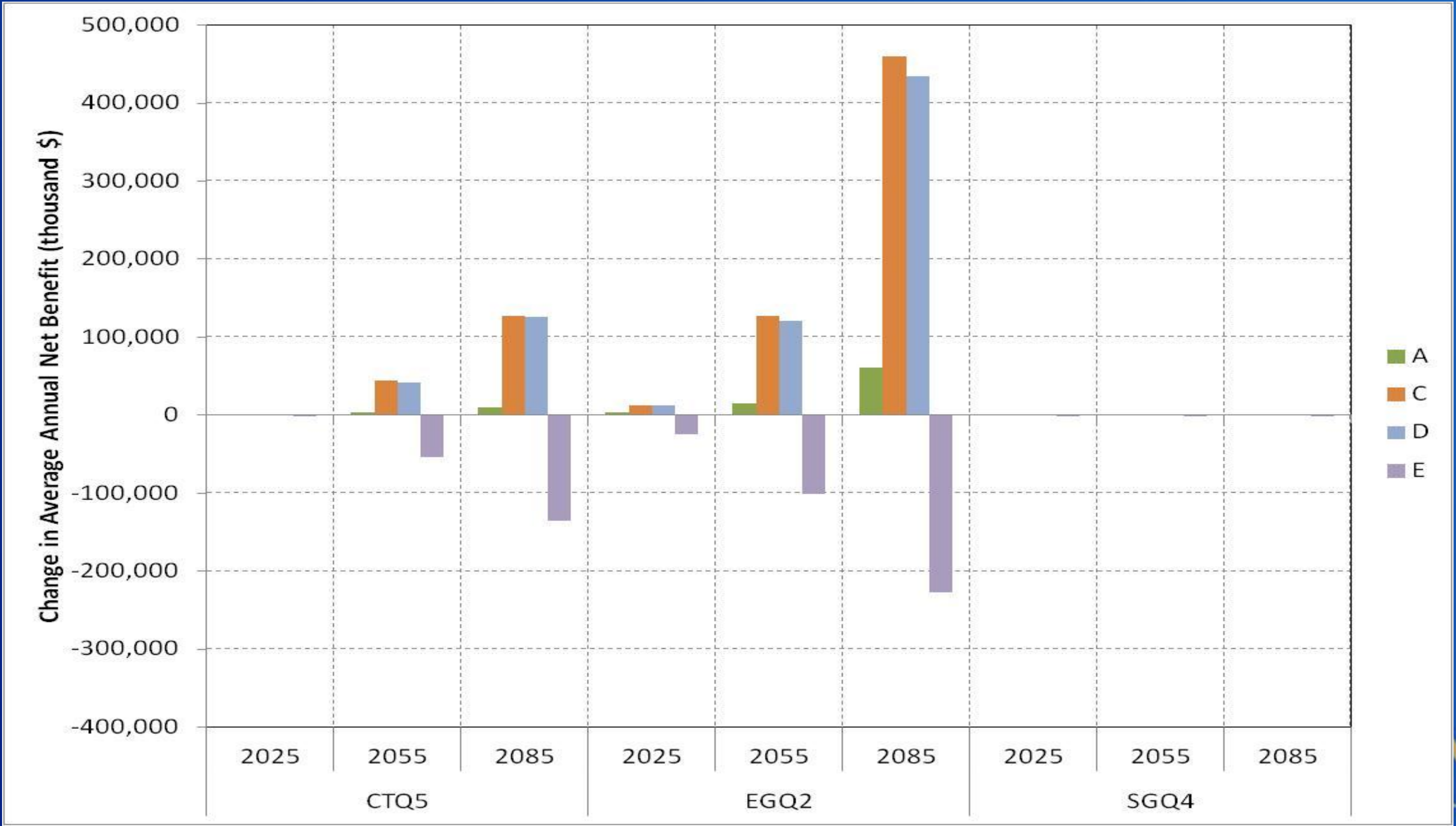
Changes in Long Term Average EC



RECLAMATION

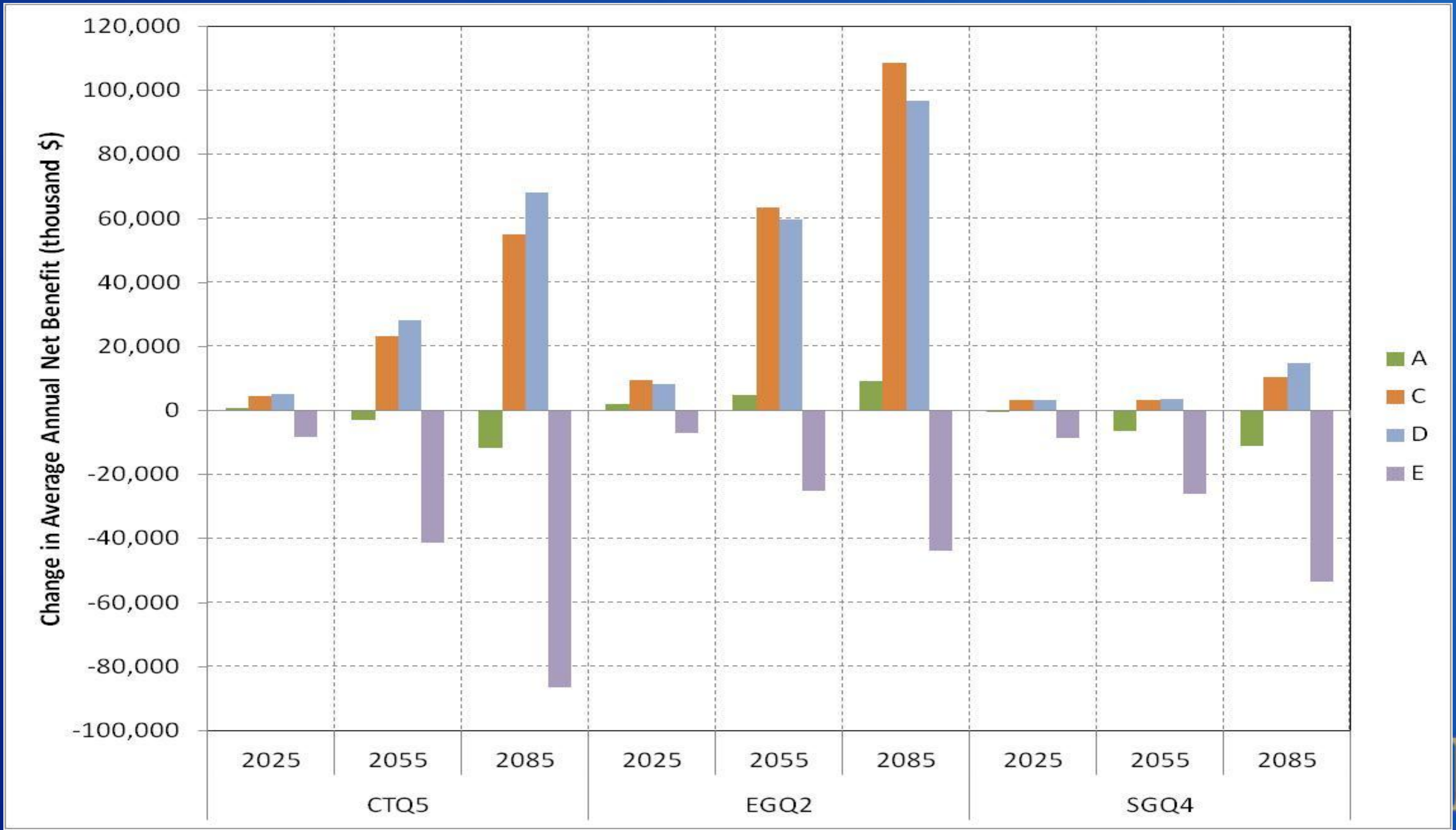
Portfolio Results:
South Bay Urban Economics (LCPSIM)

A: Aggressive Local Actions
C: Delta Conveyance and North-of-Delta Storage
D: Delta Conveyance and South-of-Delta Storage
E: Aggressive Local Actions, Enhanced Environmental Flows, and North-of-Delta Storage



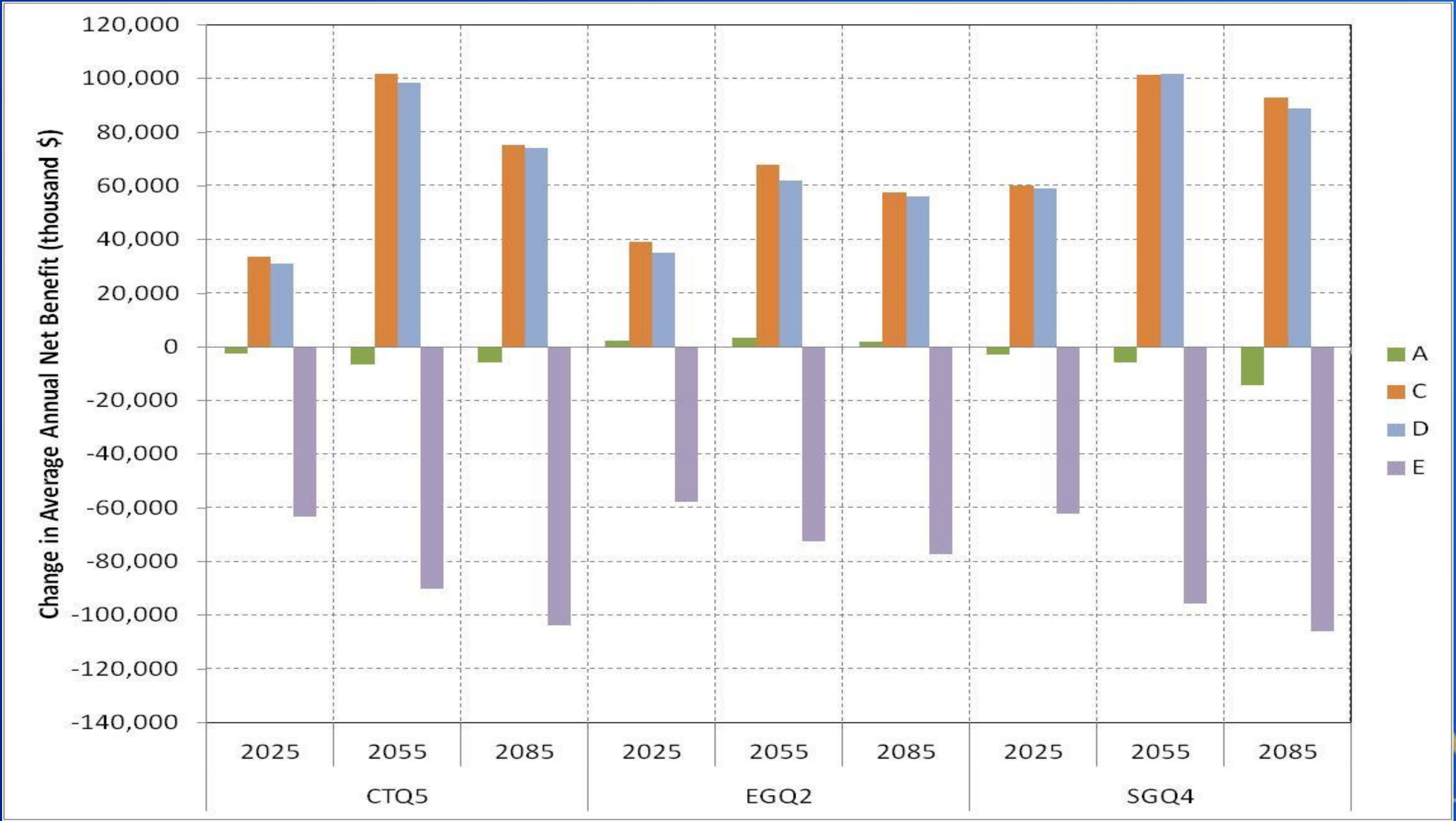
Portfolio Results:
Other M&I Regions Economics (OMWEM)

A: Aggressive Local Actions
C: Delta Conveyance and North-of-Delta Storage
D: Delta Conveyance and South-of-Delta Storage
E: Aggressive Local Actions, Enhanced Environmental Flows, and North-of-Delta Storage



Portfolio Results: Agricultural Economics (SWAP)

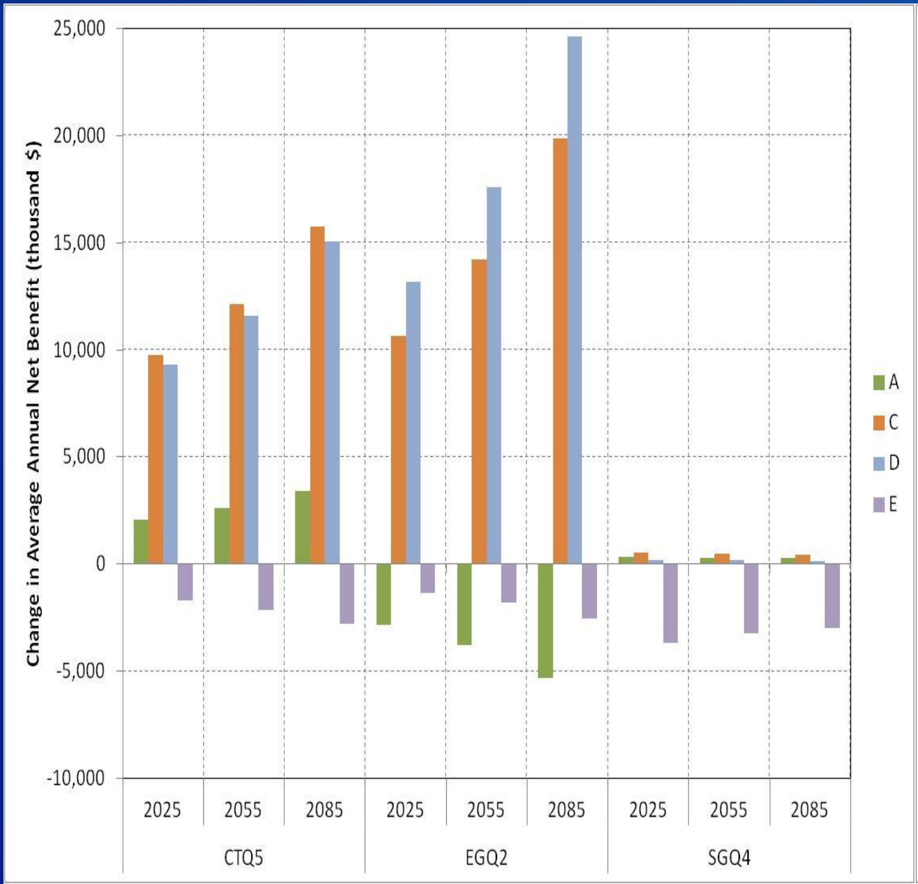
A: Aggressive Local Actions
C: Delta Conveyance and North-of-Delta Storage
D: Delta Conveyance and South-of-Delta Storage
E: Aggressive Local Actions, Enhanced Environmental Flows, and North-of-Delta Storage



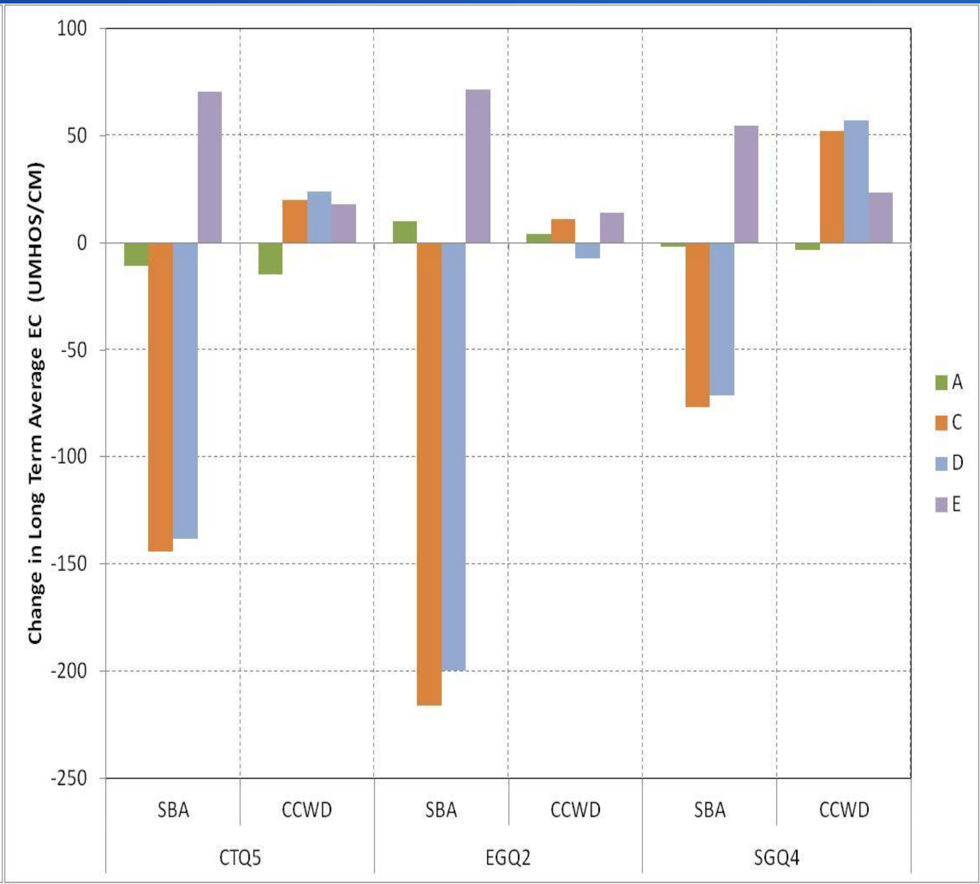
Portfolio Results:
South Bay Water Quality Economics (SBWQM)

A: Aggressive Local Actions
C: Delta Conveyance and North-of-Delta Storage
D: Delta Conveyance and South-of-Delta Storage
E: Aggressive Local Actions, Enhanced Environmental Flows, and North-of-Delta Storage

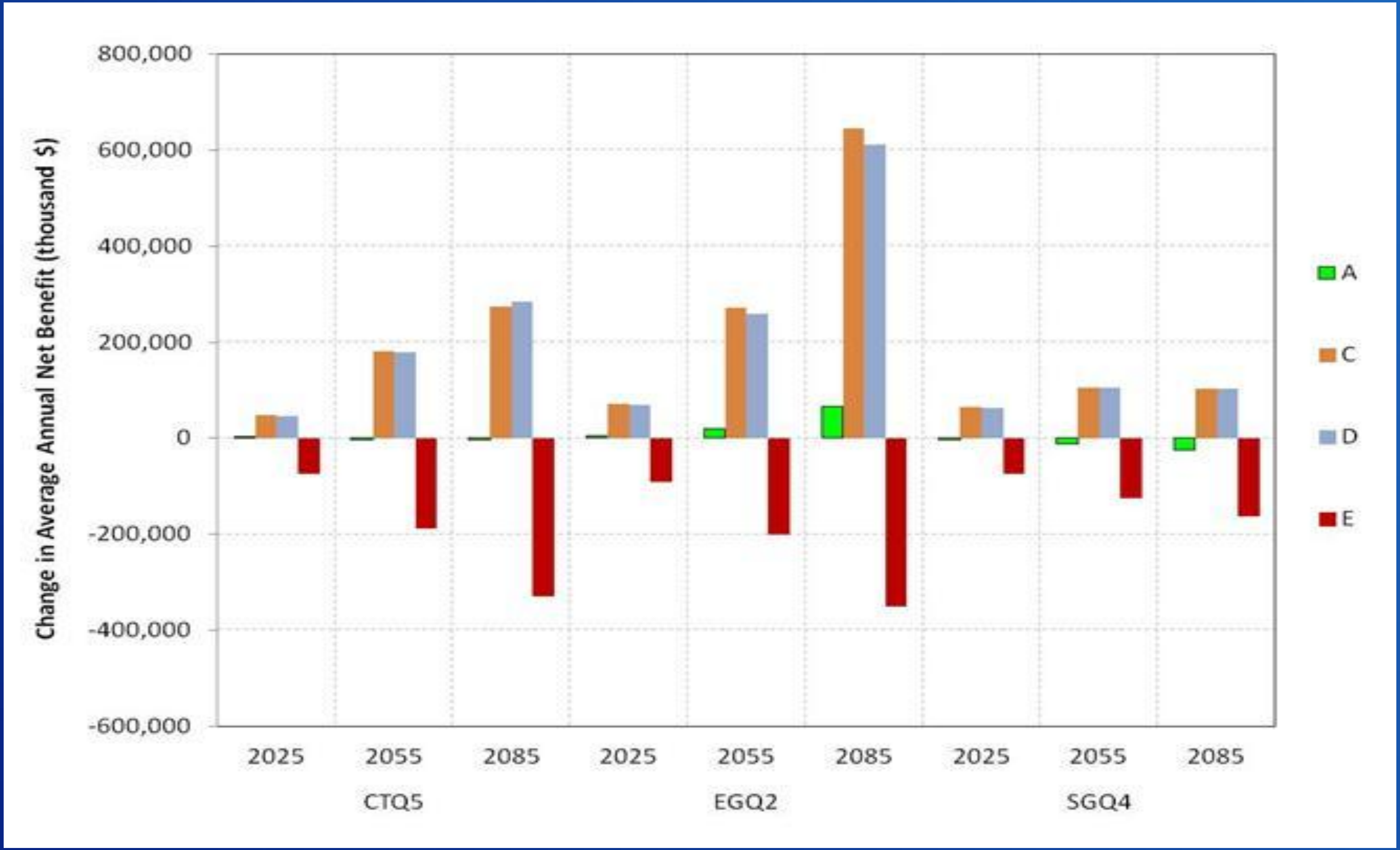
Changes in Water Quality Benefits



Changes in Long Term Average EC



Portfolio Results: Total Agricultural and Urban Economics



RECLAMATION

Portfolio Results: Potential Tradeoffs

- Portfolio A – aggressive local actions
  - Largest reductions in CVP unmet demands
  - Only small changes in Delta exports, outflows and salinity
- Portfolios C and D – Delta conveyance with NOD or SOD storage
  - Increased Delta exports and reduced unmet CVP demands
  - Reduced Delta outflows and increased Delta salinity
  - Increased economic benefits and a modest improvement in river water temperatures
  - Reduced net hydropower generation and increased GHG emissions
- Portfolio E – aggressive local actions, enhanced environmental flows with NOD storage
  - Reduced CVP unmet demands, increased Delta outflows and reduced Delta salinity
  - Reduced Delta exports
  - Increased net hydropower generation, reduced GHG emissions
  - Reduced economic benefits and a modest increase in river water temperatures

RECLAMATION