

RECLAMATION

Managing Water in the West

Modeling to Support the Colorado River Basin Water Supply and Demand Study

**RiverWare User Group Meeting
August 28, 2013**



U.S. Department of the Interior
Bureau of Reclamation

Presentation Outline

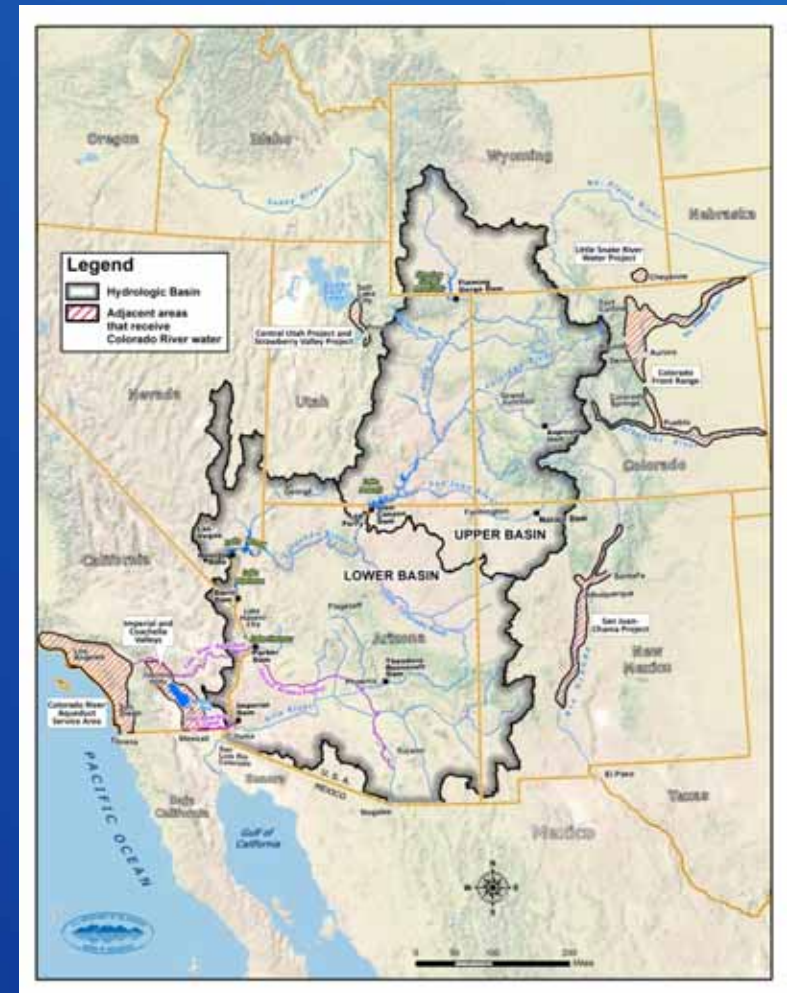
- Basin Study Overview
- Study Manager
- Modeling 'Dynamic' Portfolios



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Colorado River Basin Water Supply and Demand Study

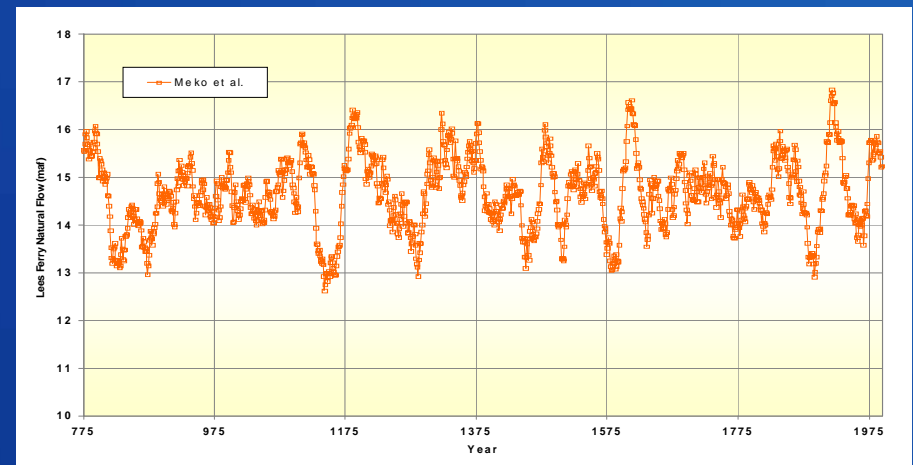
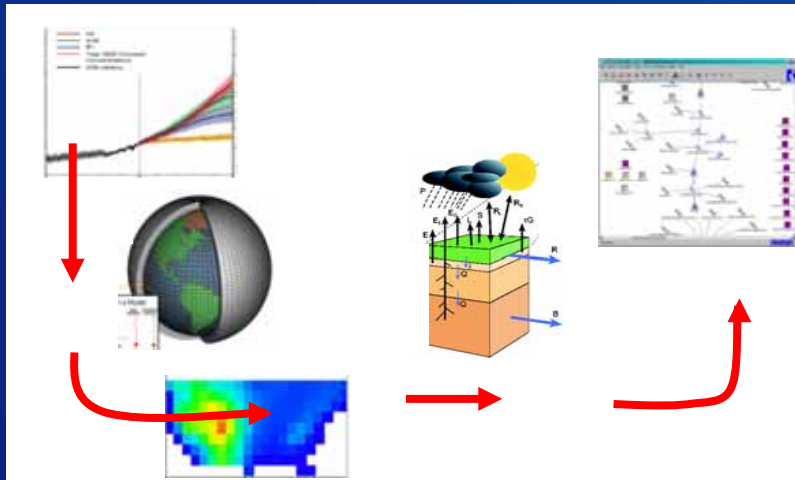
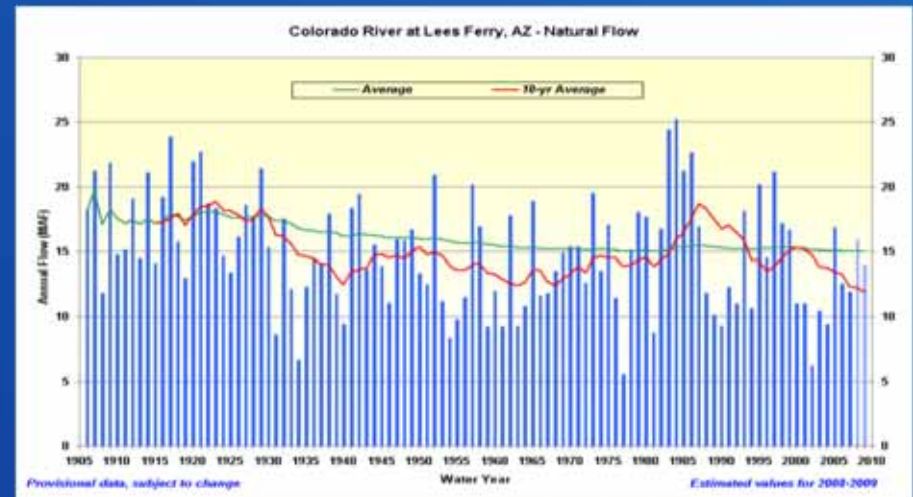
- **Study Objective**
 - Assess future water supply and demand imbalances over next 50 years
 - Develop and evaluate opportunities for resolving imbalances
- Study conducted by Reclamation and the Basin States in collaboration with stakeholders throughout the Basin
- A 3 year study that began in January 2010 and completed December 2012
- A planning study – did *not* result in any decisions, but provides the technical foundation for future activities



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Water Supply Scenarios*

- Observed Resampled
- Paleo Resampled
- Paleo Conditioned
- Downscaled GCM Projected



* Multiple realizations for each scenario

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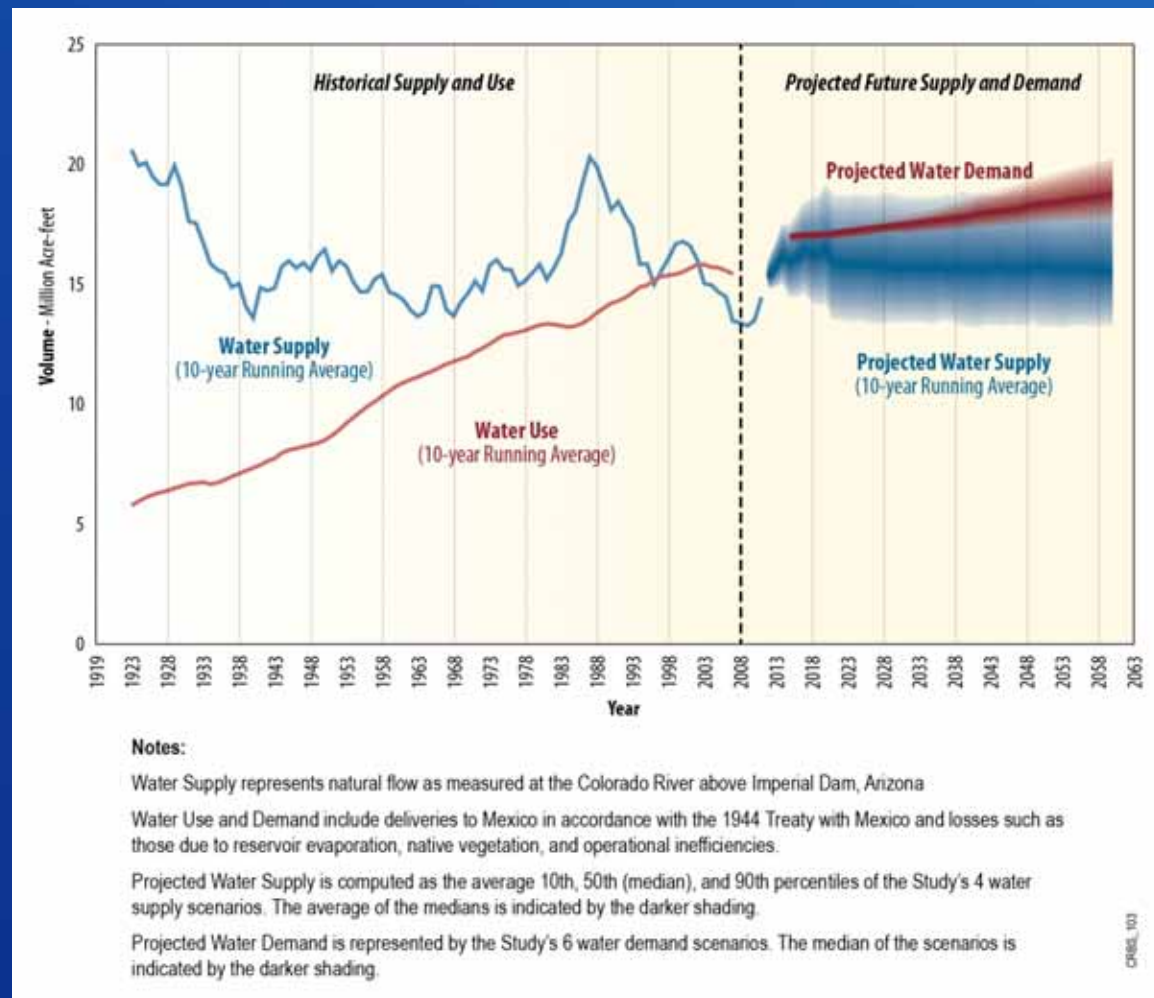
Water Demand Scenarios

- **Current Projected (A):** growth, development patterns, and institutions continue along recent trends
- **Slow Growth (B):** low growth with emphasis on economic efficiency
- **Rapid Growth (C1 and C2):** economic resurgence (population and energy) and current preferences toward human and environmental values
 - C1 – slower technology adoption
 - C2 – rapid technology adoption
- **Enhanced Environment (D1 and D2):** expanded environmental awareness and stewardship with growing economy
 - D1 – with moderate population growth
 - D2 – with rapid population growth

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Projected Future Colorado River Basin Water Supply and Demand

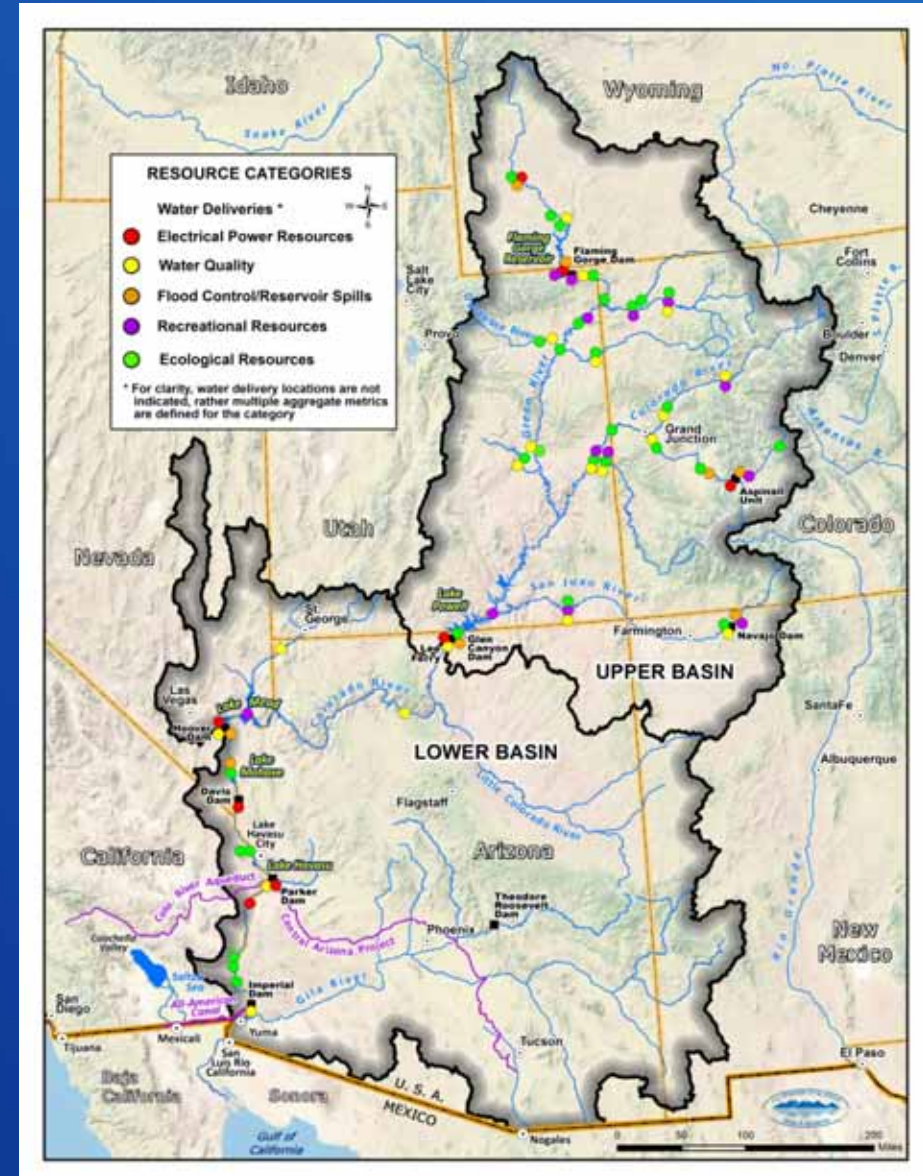
- Average supply-demand imbalances by 2060 are approximately 3.2 million acre-feet
- This imbalance may be more or less depending on the nature of the particular supply and demand scenario
- Imbalances have occurred in the past and deliveries have been met due to reservoir storage



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System Reliability Analysis

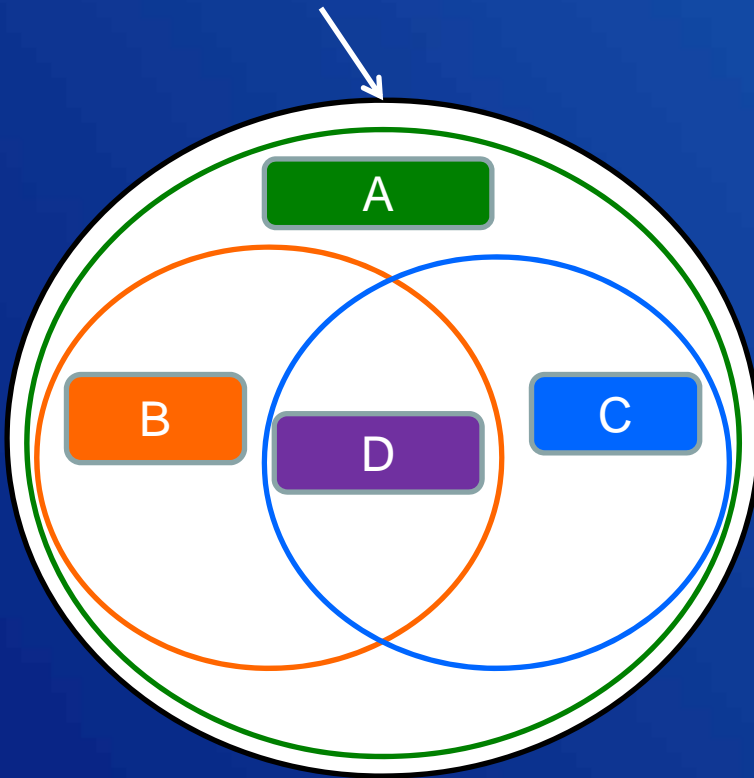
- Simulate the state of the system over the next 50 years for each scenario, with and without options and strategies
- Use metrics and vulnerabilities to quantify impacts to Basin resources
- **Resource Categories**
 - Water Deliveries
 - Electrical Power Resources
 - Water Quality
 - Flood Control
 - Recreational Resources
 - Ecological Resources



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Summary of Portfolios

Universe of options considered



Option Selection

- Least restrictive resulting in a highly inclusive set of option preferences
- Considers the largest set of options

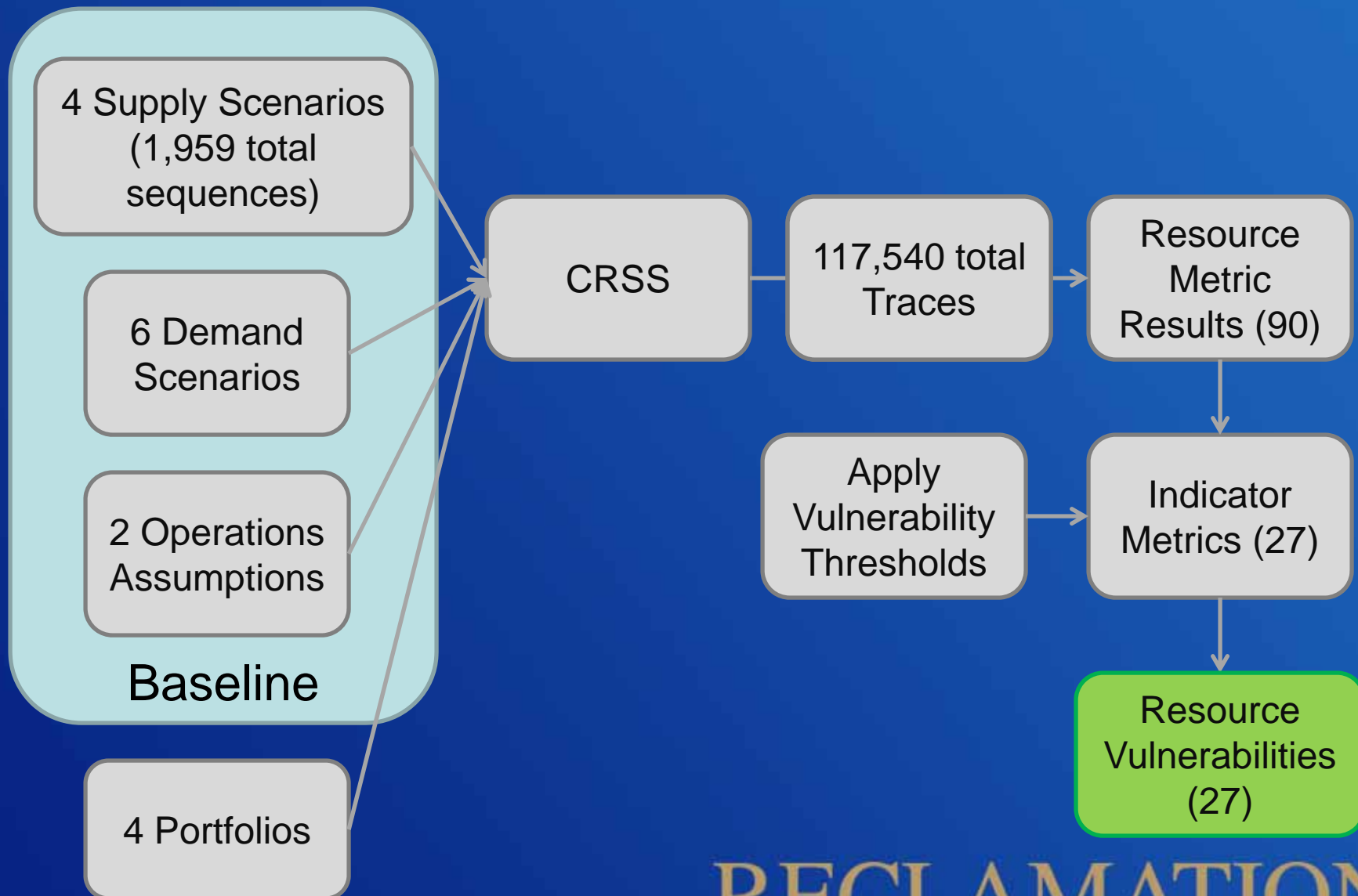
- Low-risk strategy in the long-term with high reliability
- High technical feasibility
- Excludes options with high permitting, legal and policy risks

- Prioritizes options that have low environmental impacts and long-term flexibility
- Excludes options with high permitting risk

- High technical feasibility and long-term reliability
- Low energy intensity
- Excludes options with high permitting, legal, and policy risk
- Considers smallest set of options

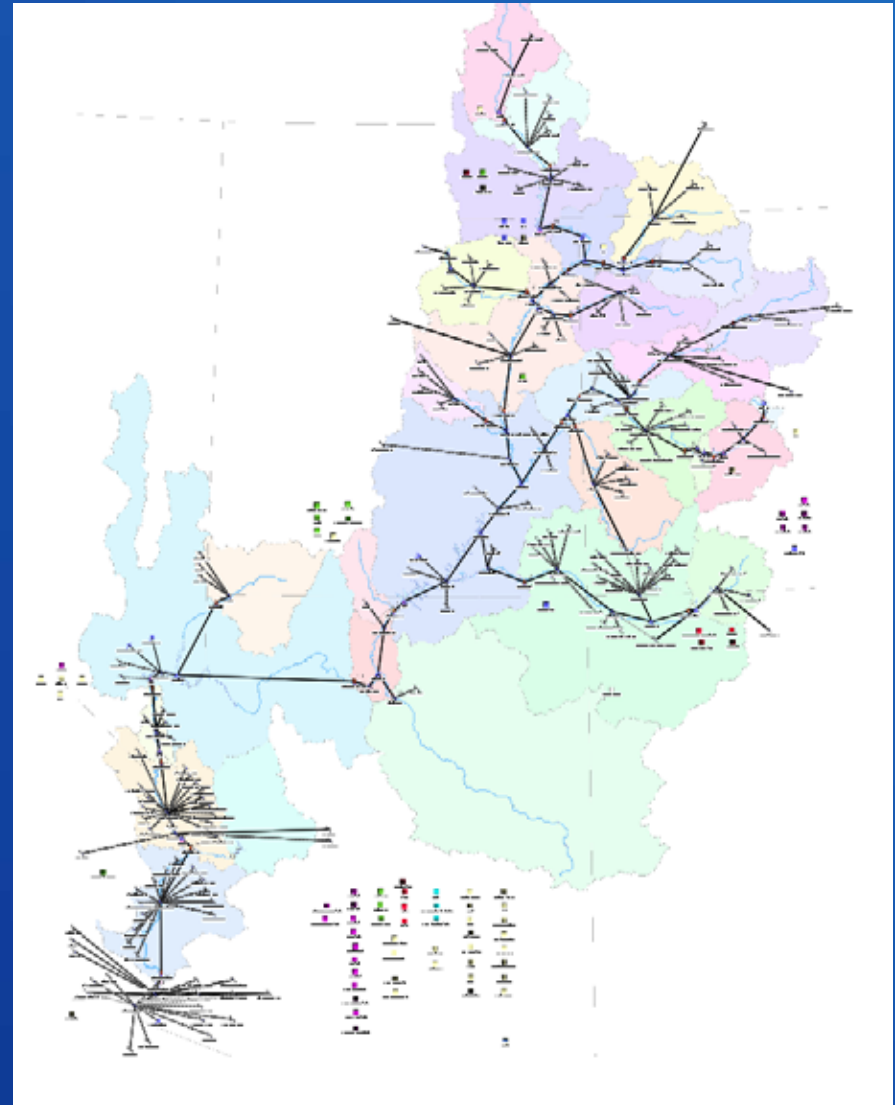
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System Reliability Analysis Approach



Colorado River Simulation System (CRSS)

- Reclamation's official Basin-wide long-term planning model
- Implemented in RiverWare™
- Simulates operations at 12 reservoirs and deliveries to over 500 individual 'water users' at a monthly time-step
- Model logic reflects reservoir operations
- Gives a range of potential future system conditions



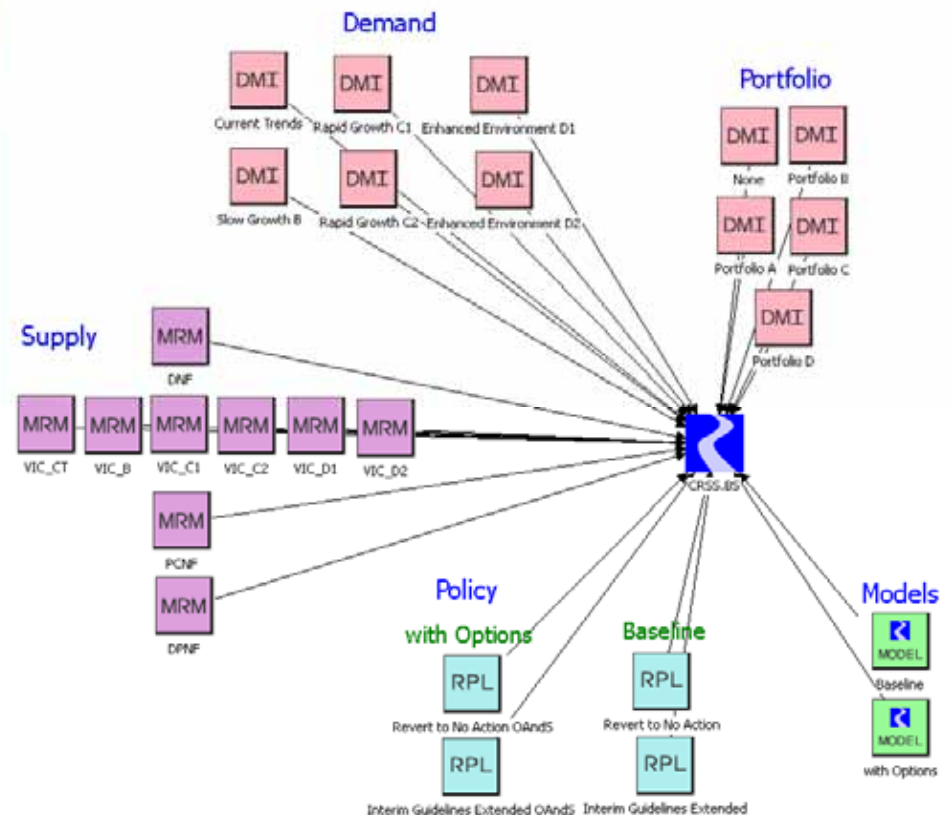
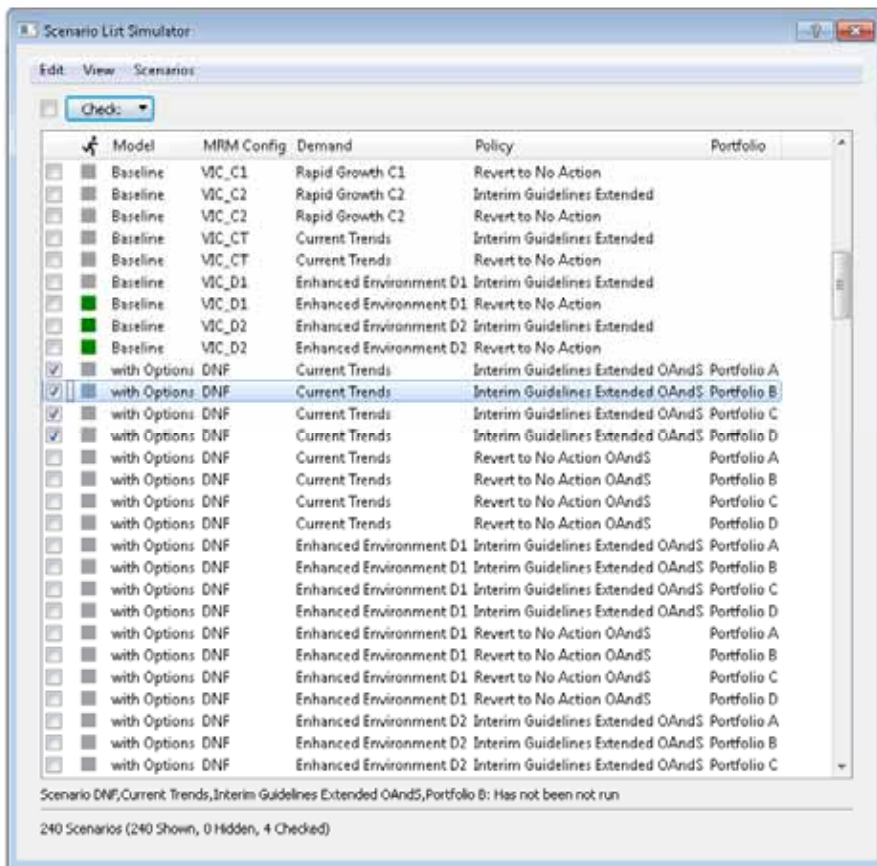
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CRSS Enhancements

- Navajo ROD
- Flaming Gorge ROD
- State of Colorado water priorities
- Climate impacts on reservoir evaporation
- Demands modeling – data objects

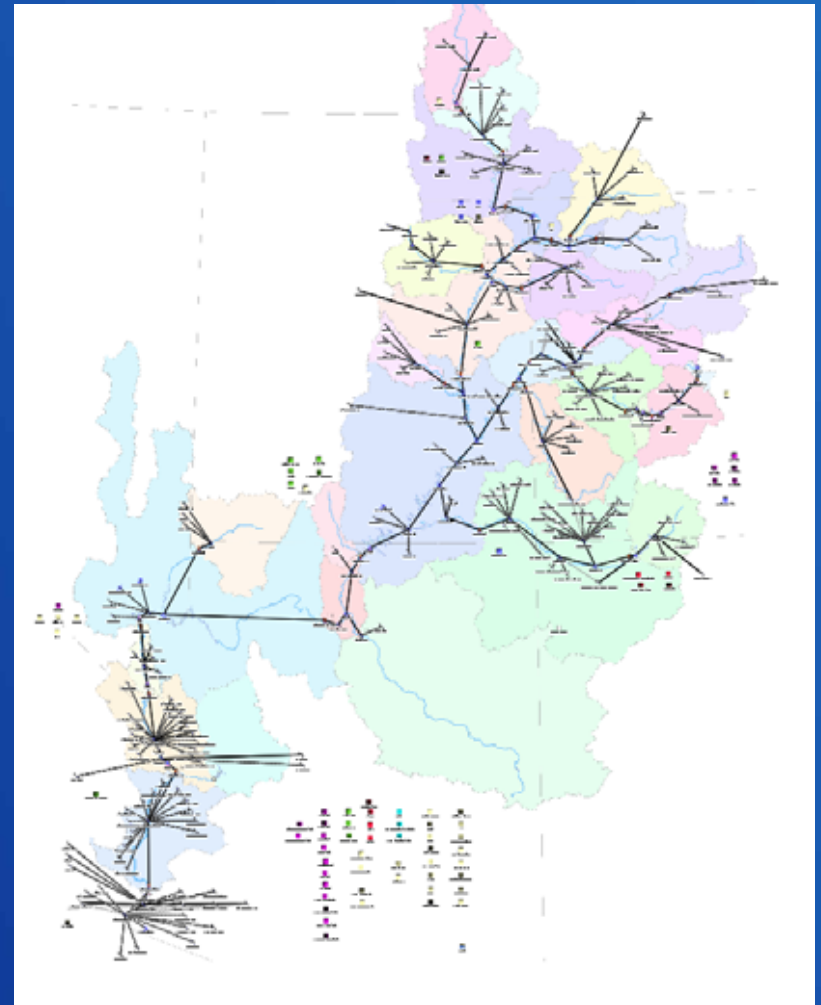
RiverWare™ Study Manager

- Manage input and output for all 240 scenarios
- Automate simulation process



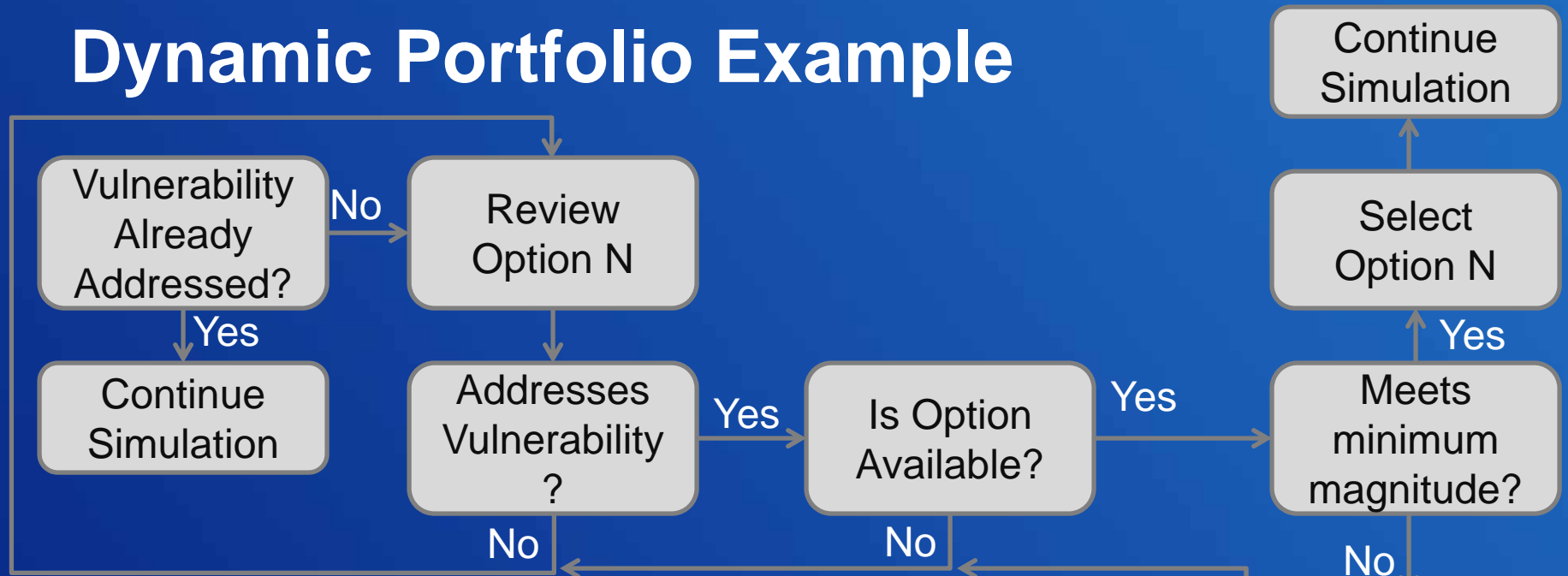
Approach to Implement and Analyze Portfolios

- Inputs to CRSS included option timing, yield, and cost
- Options were implemented, based on cost-effectiveness, when signposts indicated an approaching vulnerability
 - This dynamic approach avoids implementing options when not needed
 - Signposts were informed by vulnerable conditions (those conditions that frequently led to vulnerabilities)
- All portfolios were assessed across all future conditions

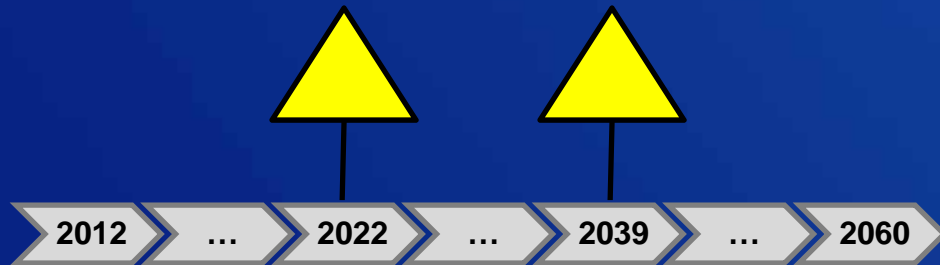


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Dynamic Portfolio Example



Option	Year Available	Magnitude [KAF]	Addresses Vulnerability 1	Addresses Vulnerability 2
A	2031	200	No	Yes
B	2021	75	Yes	No
C	2045	150	Yes	Yes



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Dynamic Portfolios In CRSS

Open Object - Portfolios

File Edit View Slot Account

Object Name: Portfolios

Data Object

Slots Description

December, 2011

Slot Name	Value	Units	
(U) FirstOptionAvailable	24:00	January 31, 2016	FullDateTime
CurrentPortfolio	1.00	NONE	
NextOption1	0.00	NONE	
NextOption2	0.00	NONE	
NextOption3	0.00	NONE	
NextOption4	0.00	NONE	
(U) MinVolumeThreshold	100,000.00	acre-ft	
Portfolio1			
Portfolio2			
Portfolio3			
Portfolio4			

Portfolios.CurrentPortfolio

File Edit View TimeStep I/O Adjust

CurrentPortfolio

Value: 1 NONE

Scroll: Dec 2011

	NONE	
12-2011	1.00	I
01-2012	1.00	I
02-2012	1.00	I
03-2012	1.00	I
04-2012	1.00	I
05-2012	1.00	I
06-2012	1.00	I
07-2012	1.00	I
08-2012	1.00	I
09-2012	1.00	I
10-2012	1.00	I
11-2012	1.00	I
12-2012	1.00	I
01-2013	1.00	I
02-2013	1.00	I
03-2013	1.00	I
04-2013	1.00	I
05-2013	1.00	I
06-2013	1.00	I
07-2013	1.00	I
08-2013	1.00	I
09-2013	1.00	I
10-2013	1.00	I
11-2013	1.00	I
12-2013	1.00	I

Show: Description

Dynamic Portfolios In CRSS

Portfolios.Portfolio1

File Edit Row Column View Adjust

Portfolio1

Value: 200000 acre-ft

	Option Number NONE	Year Available NONE	Magnitude acre-ft	Addresses UBShort NONE	Addresses LFDeficit NONE	Addresses MeadPE NONE	Addresses LBShort: NONE	Addresses LBShort: NONE
0: Aq Cons-Transfer 2	2.00	2,021.00	200,000.00	1.00	1.00	1.00	1.00	1.00
1: Aq Cons-Transfer 3	3.00	2,026.00	200,000.00	1.00	1.00	1.00	1.00	1.00
2: M & I Conservation 1	18.00	2,016.00	200,000.00	1.00	1.00	1.00	1.00	1.00
3: Aq Cons-Transfer 4	4.00	2,026.00	200,000.00	1.00	1.00	1.00	1.00	1.00
4: Desal-Yuma	47.00	2,021.00	100,000.00	0.00	0.00	1.00	1.00	1.00
5: M & I Conservation 2	19.00	2,021.00	200,000.00	1.00	1.00	1.00	1.00	1.00
6: Aq Cons-Transfer5	5.00	2,026.00	200,000.00	1.00	1.00	1.00	1.00	1.00
7: Desal-SoCal groundwater	37.00	2,021.00	20,000.00	0.00	0.00	1.00	1.00	1.00
8: M & I Conservation 3	20.00	2,031.00	200,000.00	1.00	1.00	1.00	1.00	1.00
9: M & I Conservation 4	21.00	2,041.00	200,000.00	1.00	1.00	1.00	1.00	1.00
10: M & I Conservation 5	22.00	2,051.00	200,000.00	1.00	1.00	1.00	1.00	1.00
11: Desal-Salton Sea1	34.00	2,026.00	200,000.00	0.00	0.00	1.00	1.00	1.00
12: Desal-Salton Sea2	35.00	2,031.00	200,000.00	0.00	0.00	1.00	1.00	1.00
13: Desal-Salton Sea3	36.00	2,036.00	100,000.00	0.00	0.00	1.00	1.00	1.00
14: Desal-Pacific Ocean-MX	33.00	2,026.00	56,000.00	0.00	0.00	1.00	1.00	1.00

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Dynamic Portfolios In CRSS

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Slot Name	Value	Units		
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NextOption4	0.00	NONE		I
MinVolumeThreshold	100,000.00	acre-ft		
Portfolio1				
Portfolio2				
Portfolio3				
Portfolio4				

Portfolios.NextOption1

File Edit View TimeStep I/O Adjust

NextOption1

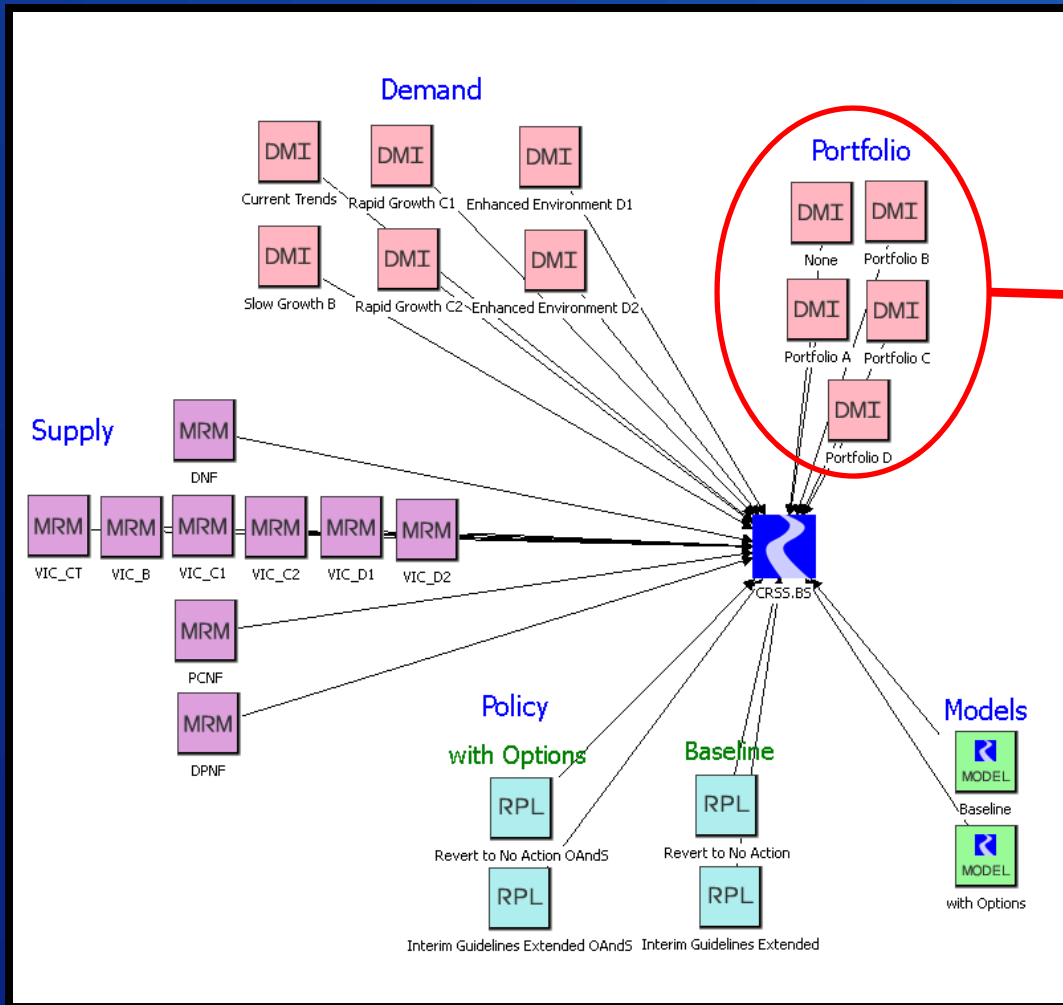
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Scroll: 2011 C.E.

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2011	0.00	I 0
2012	0.00	R 245
2013	0.00	R 245
2014	0.00	R 245
2015	0.00	R 245
2016	18.00	R 235
2017	0.00	R 235
2018	0.00	R 235
2019	0.00	R 235
2020	0.00	R 235
2021	2.00	R 235
2022	47.00	R 235
2023	19.00	R 235
2024	24.00	R 235
2025	32.00	R 235
2026	3.00	R 235
2027	4.00	R 235
2028	5.00	R 235
2029	34.00	R 235
2030	11.00	R 235
2031	20.00	R 235
2032	35.00	R 235
2033	25.00	R 235
2034	0.00	R 235
2035	29.00	R 235
2036	36.00	R 235

Show: Description

Dynamic Portfolios In CRSS: Study Manager



Portfolios.CurrentPortfolio

File Edit View TimeStep I/O Adjust

CurrentPortfolio

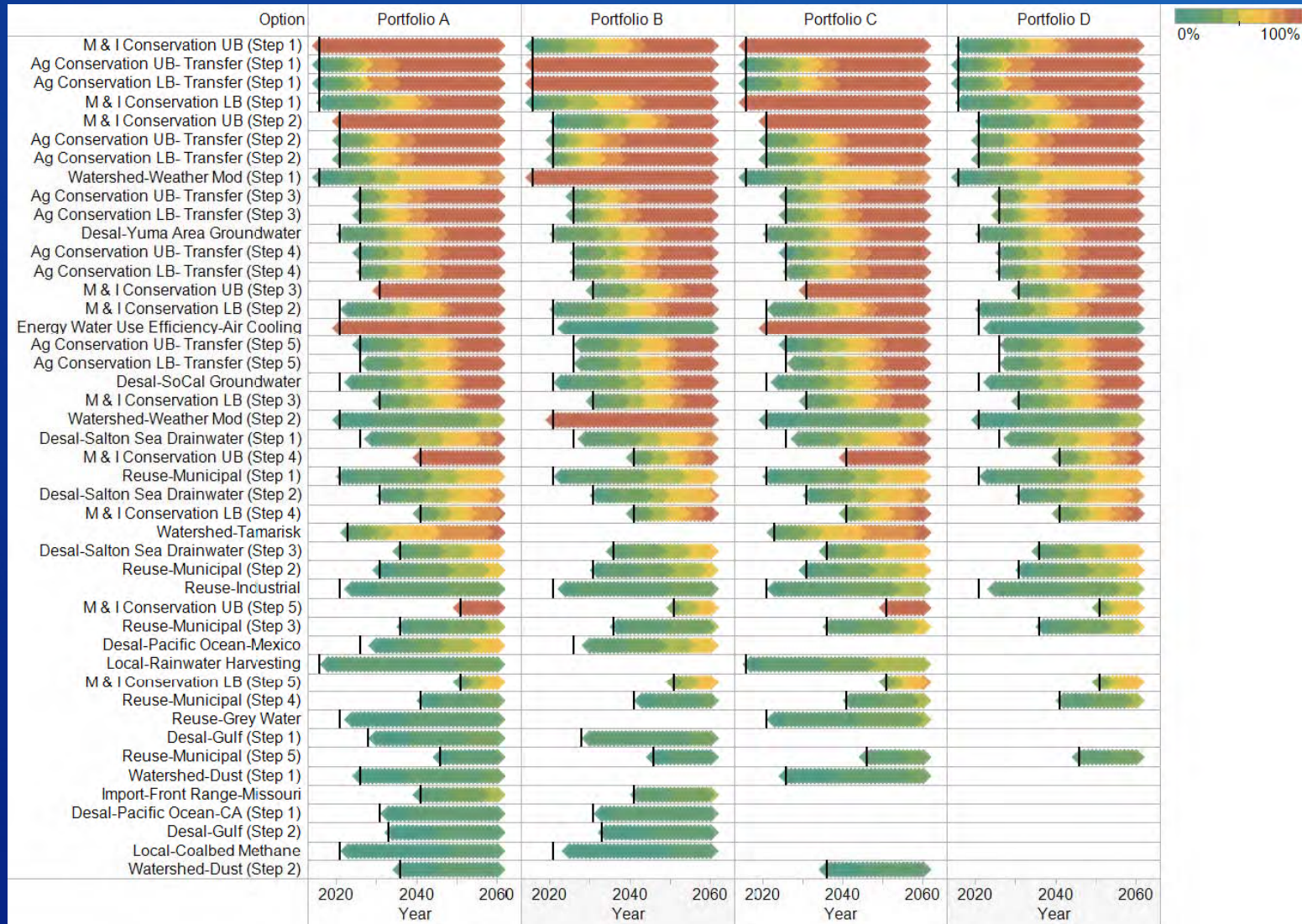
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Scroll: Dec 2011

	NONE	
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06-2013	1.00	I
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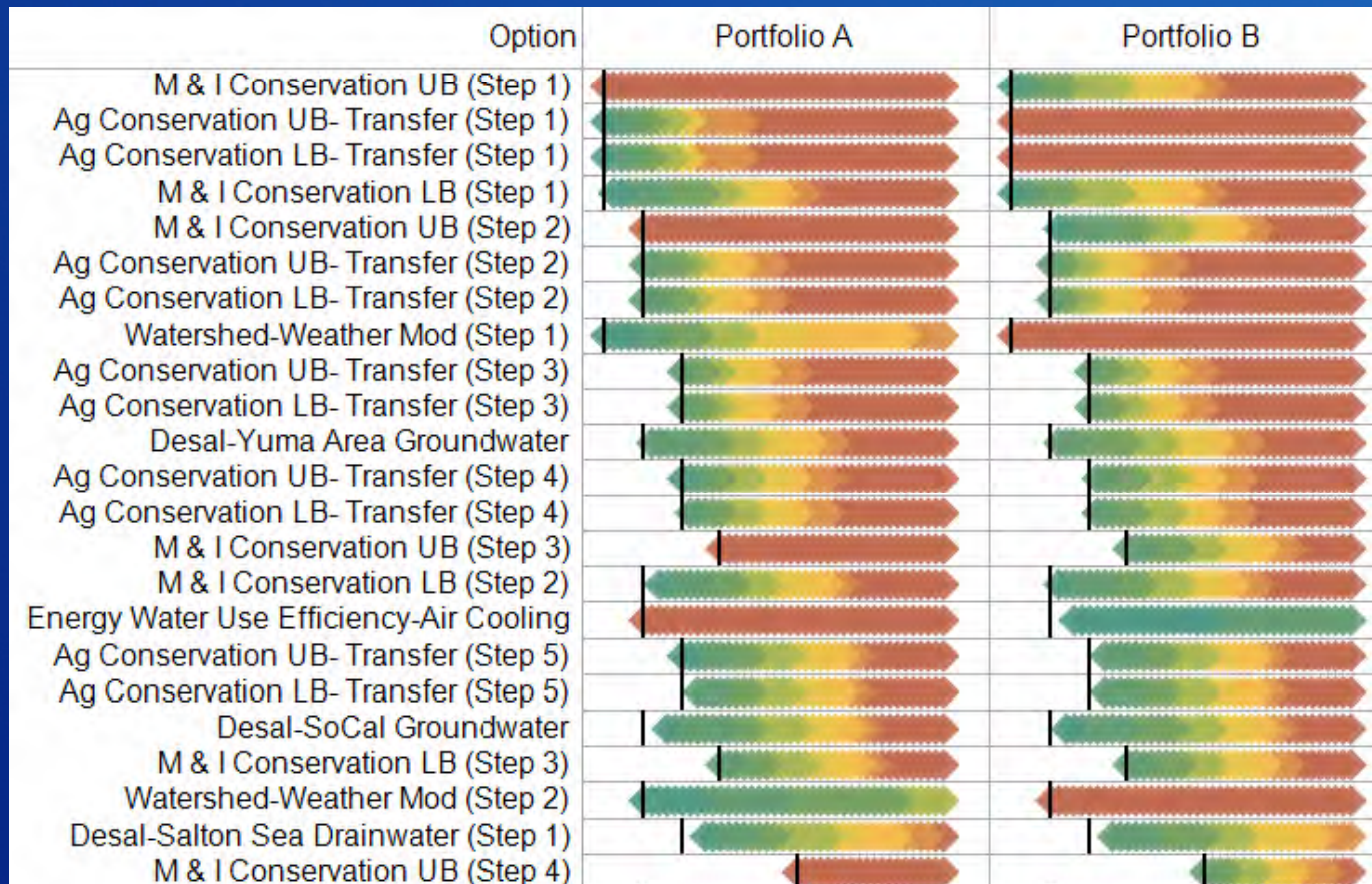
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Frequency of Option Implementation



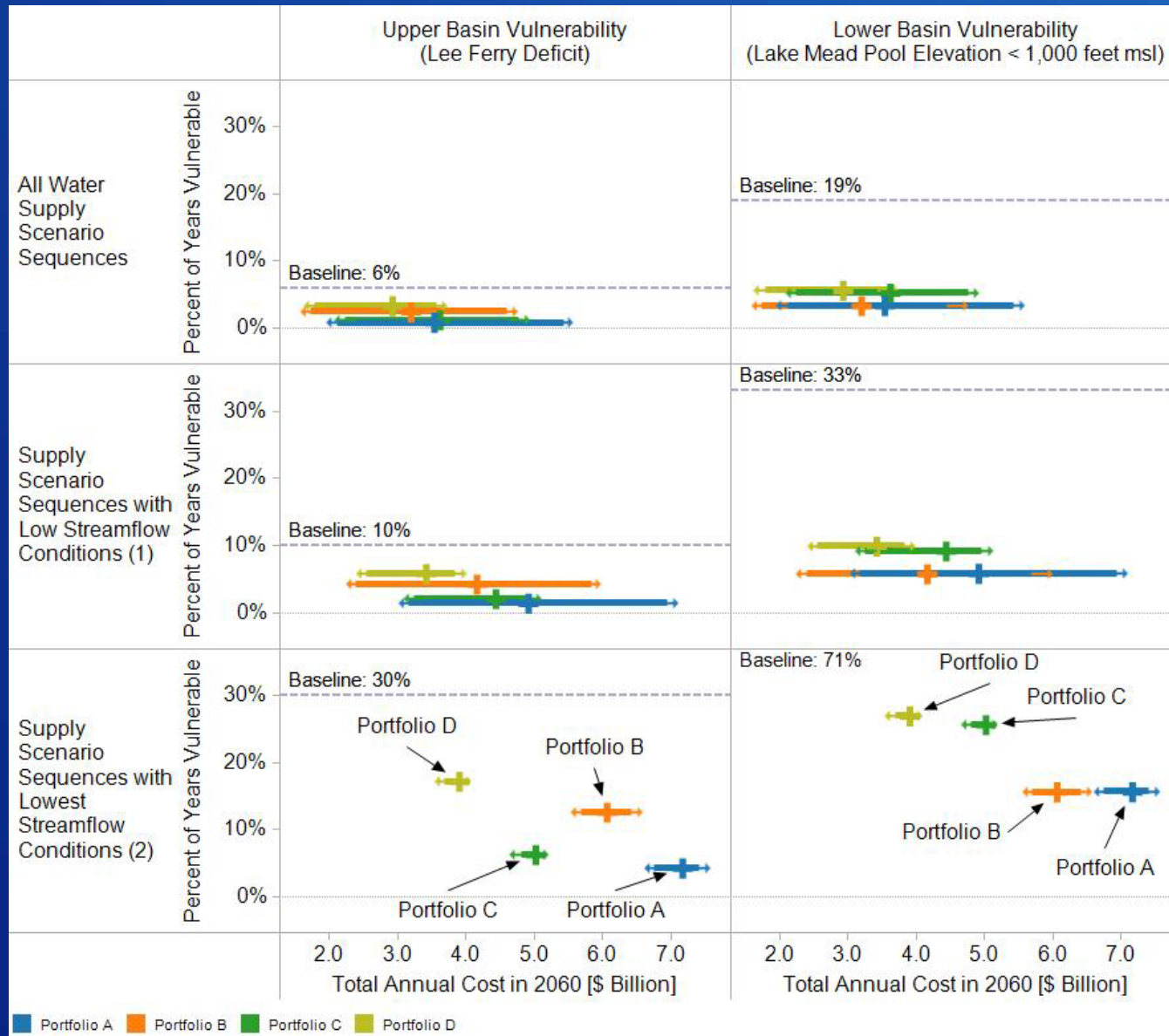
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Frequency of Option Implementation




Comparing Portfolio Results

Percent years vulnerable vs. cost (2041-2060)



Colorado River Basin Water Supply and Demand Study

A wide-angle photograph of a large reservoir, likely Lake Mead, situated in a deep canyon. The water is a deep blue-green color. In the center of the reservoir, a small boat is visible. The surrounding cliffs are rugged and brownish, with some sparse vegetation. The sky is clear and blue. The reservoir is surrounded by high, rocky hillsides.

Study Contact Information

- Website: <http://www.usbr.gov/lc/region/programs/crbstudy.html>
- Email: ColoradoRiverBasinStudy@usbr.gov
- Telephone: 702-293-8500; Fax: 702-293-8418

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