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Managing Water in the West

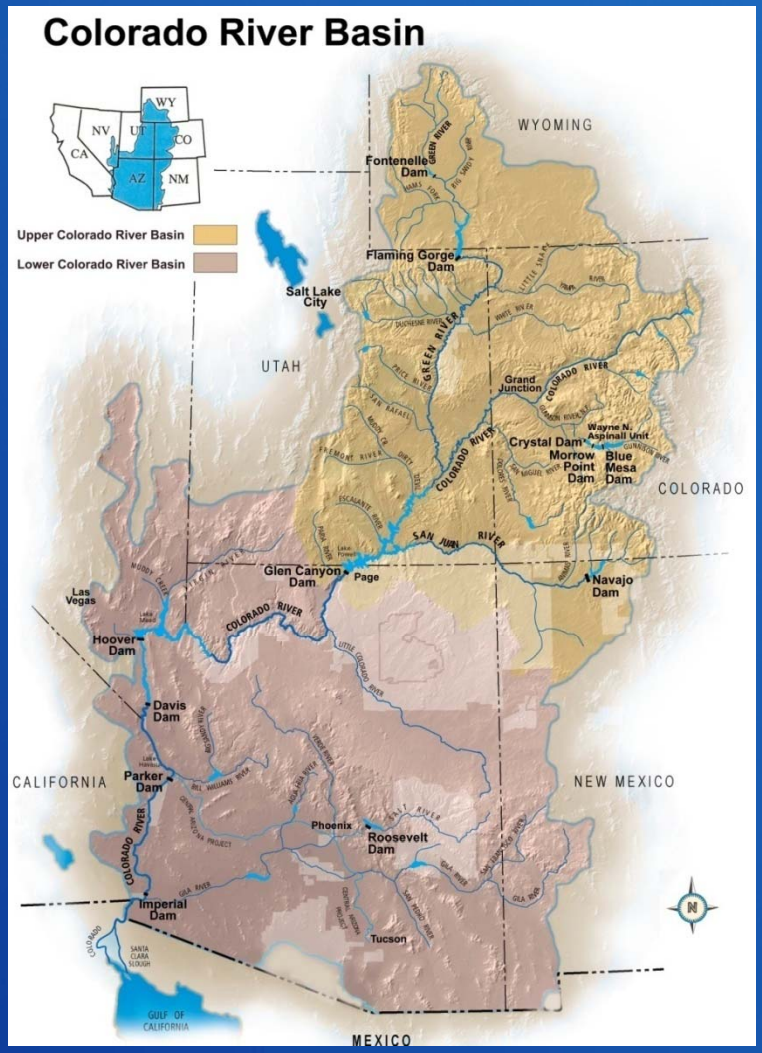
Colorado River Basin Water Supply and Demand Study

Public Outreach Meeting
September 23, 2010

U.S. Department of the Interior
Bureau of Reclamation

Agenda

- Welcome and Introductions
- Study Overview and Approach
- Study Status and Schedule
- Discussion and Follow-up



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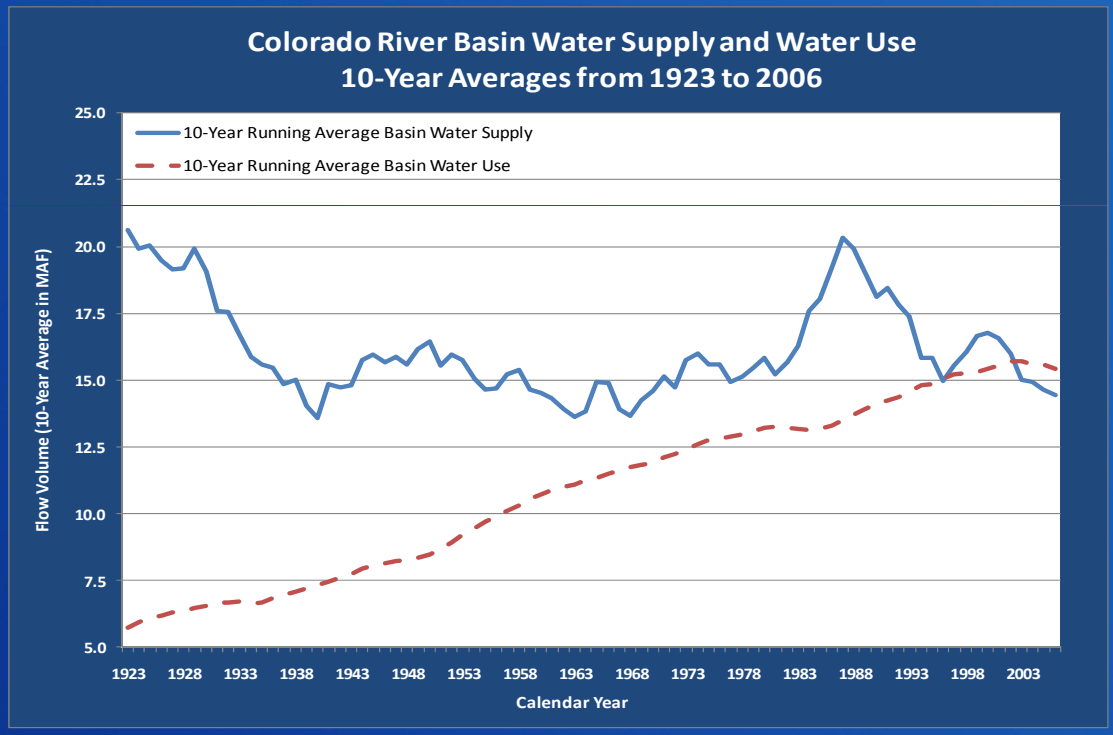
Colorado River Basin Water Supply and Demand Study

Objectives:

- Define current and future imbalances in water supply and demand
- Assess the system reliability and risks to all Basin resources
- Develop and evaluate adaptation and mitigation strategies



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Study Considerations

- Study area: Colorado River Basin and those adjacent areas of the Basin States that receive Colorado River water
- Estimated cost of $2 million for two years
- 50/50 cost share by Reclamation and the Non-Federal Cost-Share Partners

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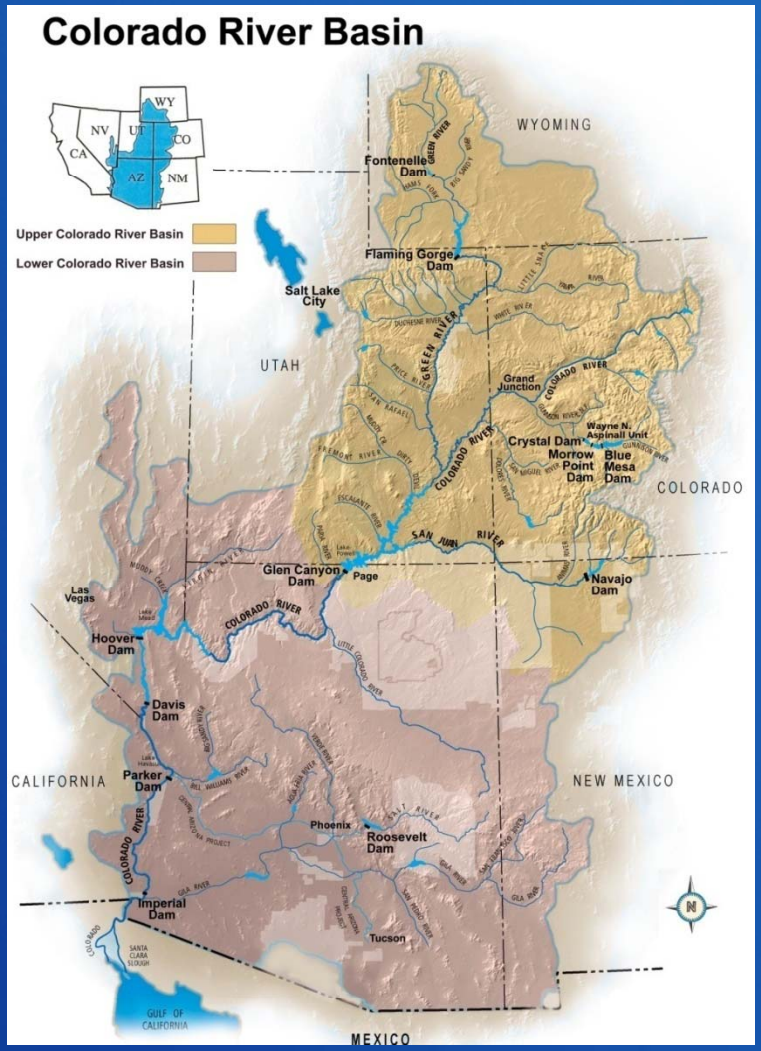
Cost-Share Partners

- Arizona Department of Water Resources
- (California) Six Agency Committee
- Colorado Water Conservation Board
- New Mexico Interstate Stream Commission
- Southern Nevada Water Authority
- Utah Division of Water Resources
- Wyoming State Engineer's Office
- Reclamation's Upper and Lower Colorado Regions



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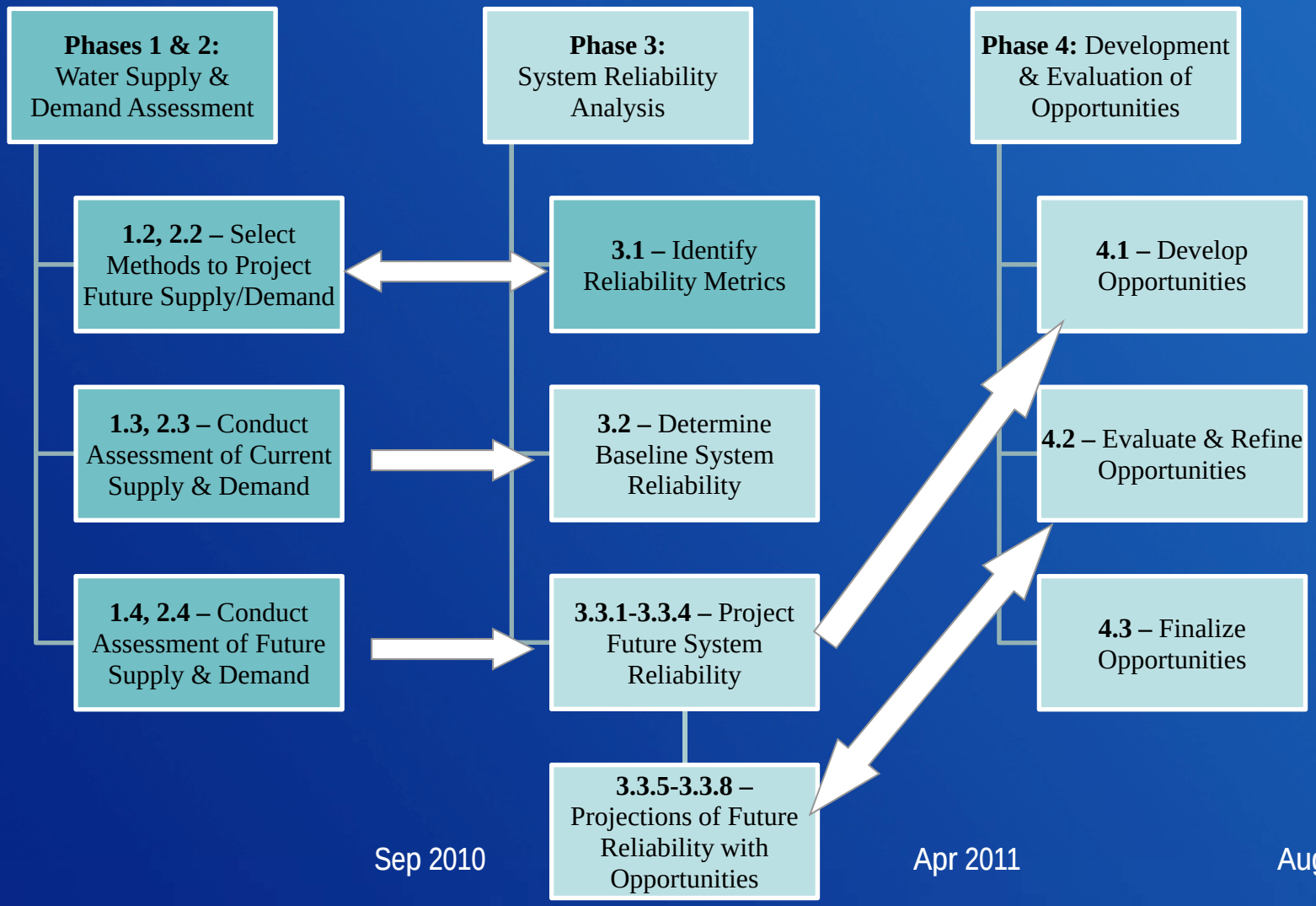
Plan of Study: Study Phases



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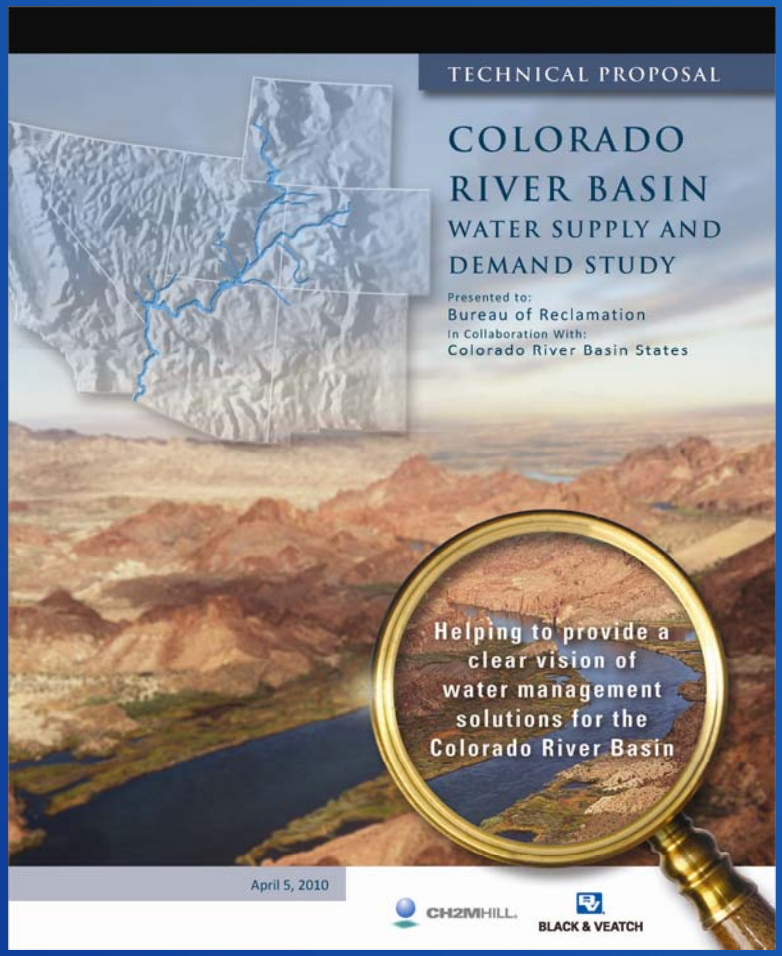
Contracted Services

- CH2MHill and Black and Veatch were awarded the "Part 1" contract in late April
- Five "work elements":
  - Overall support for the Study
  - Phases 1, 2, and 3.1 of the Plan of Study
  - Scoping remainder of Study



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Colorado River Basin Study
Outreach

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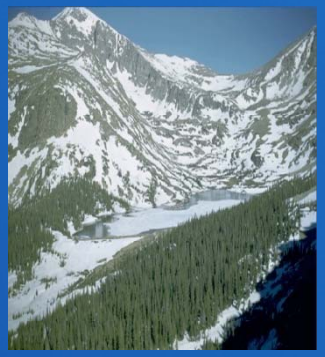
Sub-teams and Function

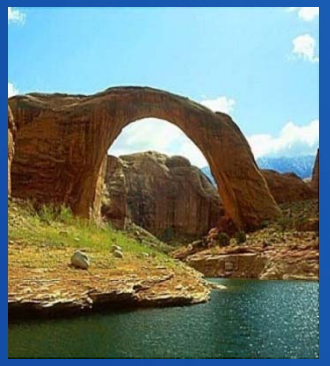
- 3 Sub-teams (“working groups”)
  - Water Supply, Water Demands, and Metrics
- Sub-teams are being led by Reclamation and the Contractor team
  - Members are from Basin States, Reclamation, Native American tribes and communities, and other stakeholders who offer data and expertise
- Sub-team Functions
  - Identify, review, and recommend technical methods and approaches
  - Provide data and information to assist in the development of draft work products
  - Interact with other Points-of-Contact (POCs) to collect data and share information

Water Supply



Water Demand

Metrics



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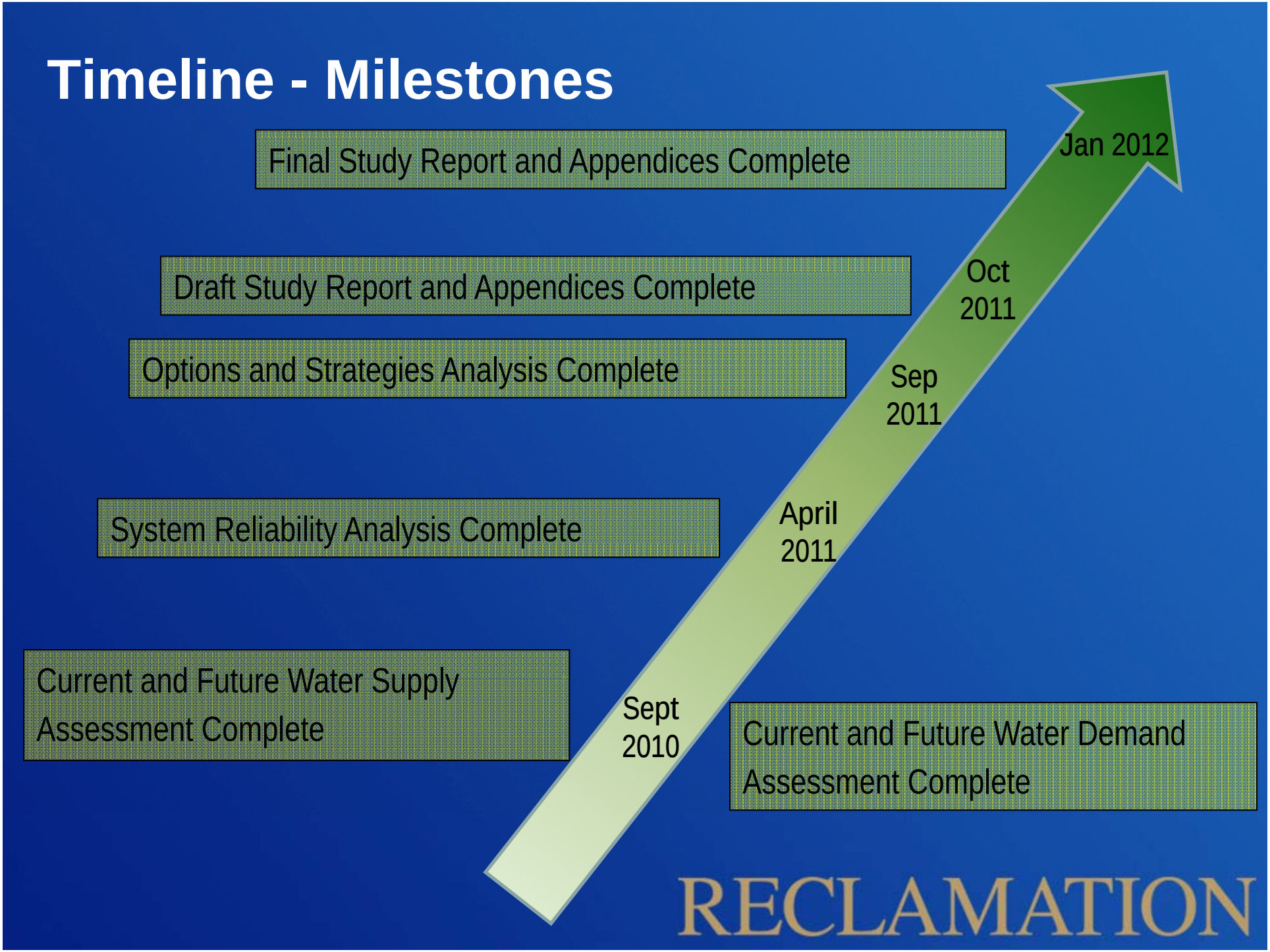
Timeline - Milestones



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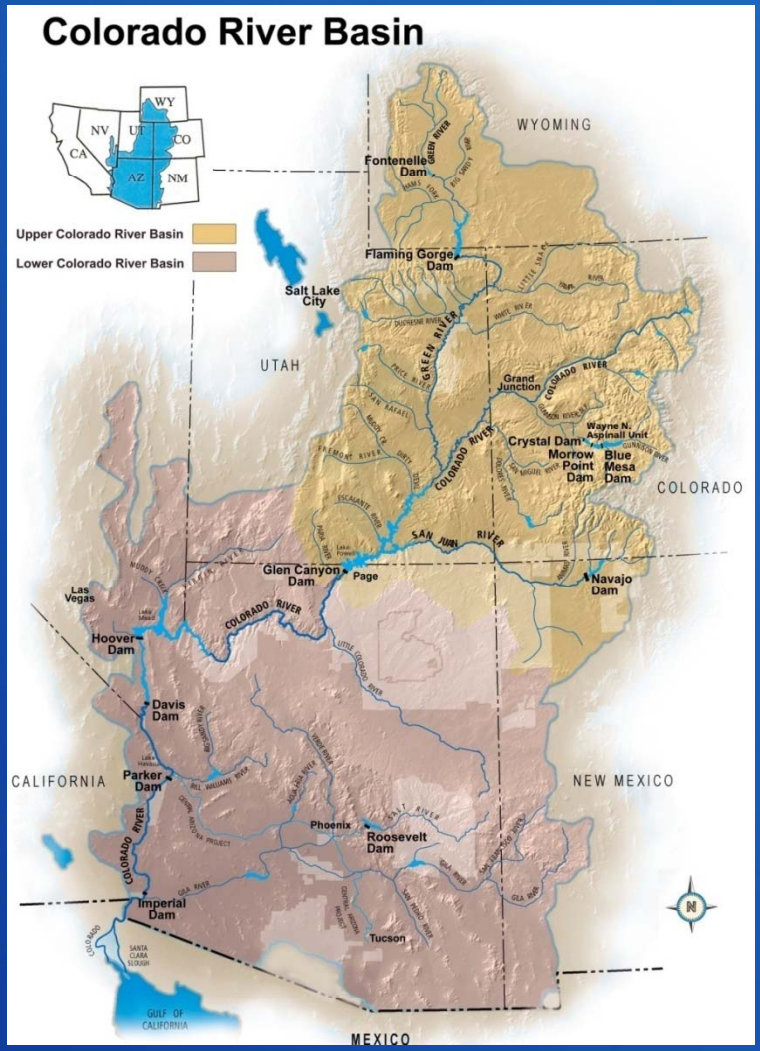
Colorado River Basin Water Supply and Demand Study

Approach to Incorporating Uncertainty



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Addressing an Uncertain Future

- Categorization of Uncertainty
  - Factors largely outside of the influence of management entities
  - Factors partially under influence by management entities
  - Factors mostly under influence by management entities
- Key Uncertainties to be Incorporated in this Phase
  - Hydroclimatic variability and change
  - Changes to magnitude and timing of water supply available to system
  - Changes to Basin water use and demands
- Uncertainty to be Addressed through a Scenario Approach

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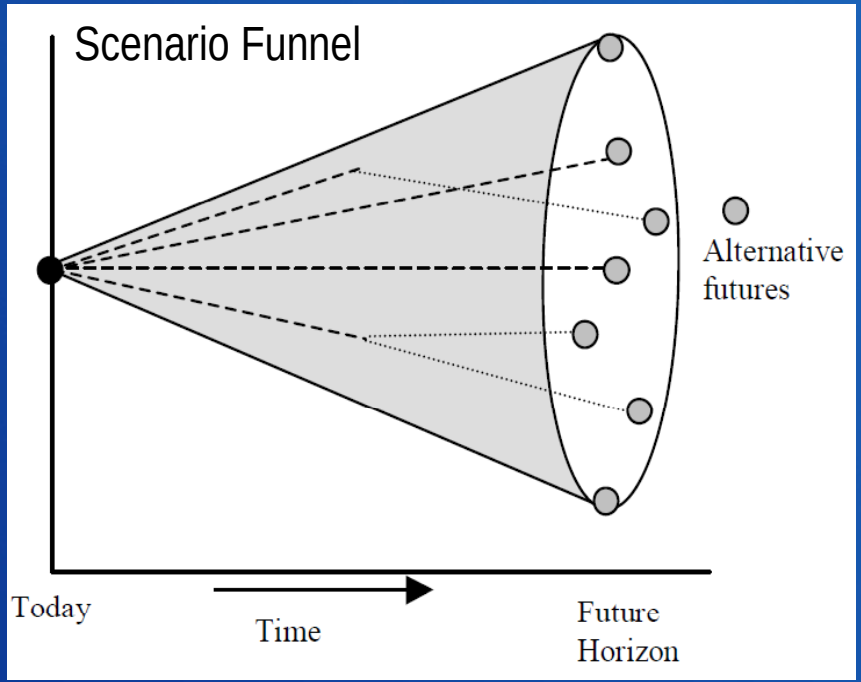
Scenario Approach

- The path of major influences on the Colorado River system is uncertain and can not be represented by a single view

- An infinite number of plausible futures exist

- A manageable number of scenarios are being developed to a explore the broad range of futures.



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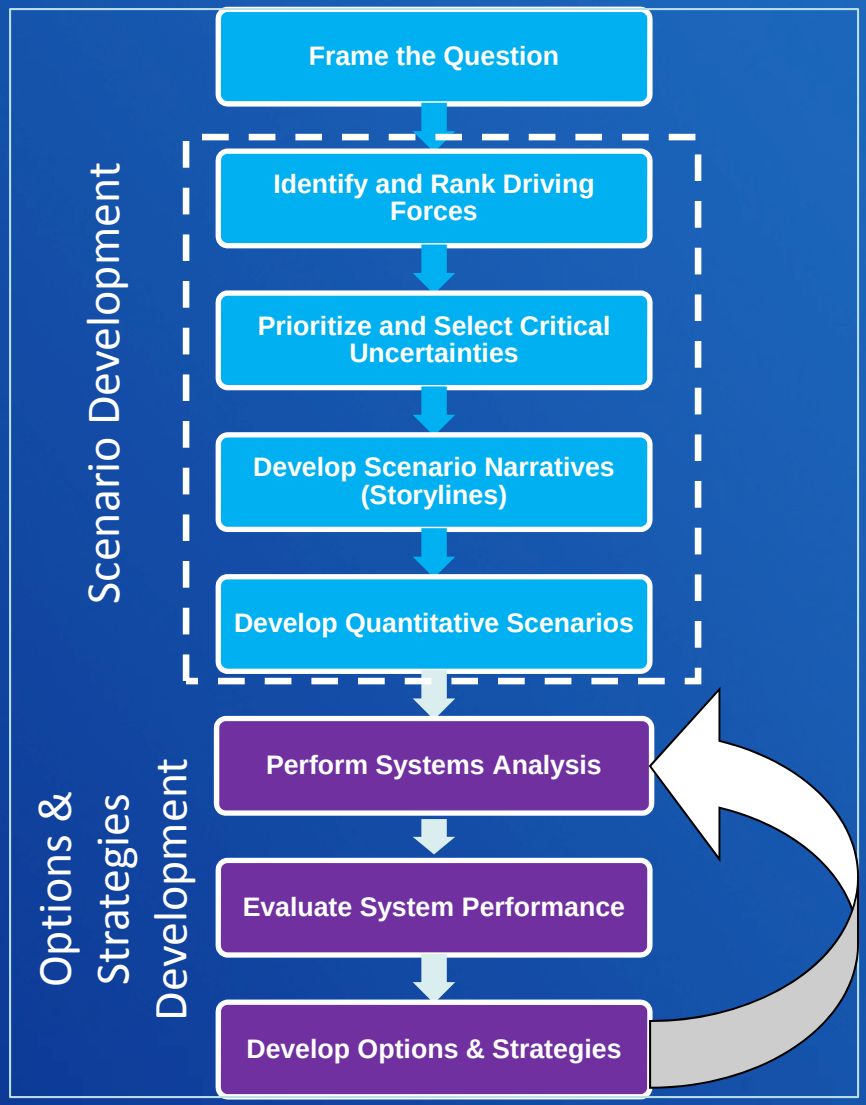
Key Elements of Scenario Approach

- Frame the Question
  - Main question or focal Issue to be addressed in Study
- Identify and rank driving forces
  - Major forces influencing future system reliability
- Prioritize and select critical uncertainties
  - Key driving forces that are highly important and highly uncertain
- Group key uncertainties and develop storylines
  - Narrative descriptions that weave the critical uncertainties into plausible future trajectories
- Develop scenarios
  - Specific, quantitative outcomes of the storylines



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Results from Sub-Team Calls on Driving Forces

No.	Refined Driving Forces
1	Changes in streamflow variability and trends
2	Changes in climate variability and trends (e.g. temperature, precipitation, etc.)
3	Changes in watershed conditions (e.g. diseases, species transitions, etc.)
4	Changes in population and distribution
5	Changes in agricultural land use (e.g. irrigated agricultural areas, crop mixes, etc.)
6	Changes in urban land use (e.g. conversion, density, urbanization, etc.)
7	Changes in public land use (e.g. forest practices, grazing, wilderness areas, etc.)
8	Changes in agricultural water use efficiency
9	Changes in municipal and industrial water use efficiency
10	Changes in institutional and regulatory conditions (e.g. laws, regulations, etc.)
11	Changes to organization or management structures (e.g. state, federal, bi-national institutions)
12	Changes in water needs for energy generation (e.g. solar, oil shale, thermal, nuclear, etc.)
13	Changes in flow-dependent ecosystem needs for ESA-listed species
14	Changes in other flow-dependent ecosystem needs
15	Changes in social values affecting water use
16	Changes in cost of energy affecting water availability and use
17	Changes in water availability due to tribal water use and settlement of tribal water rights claims
18	Changes in water quality including physical, biological, and chemical processes

Responses on Survey on Driving Forces

Respondent Category	No. of Responses Received
Water Management Entities (including Reclamation)	26
NGOs	9
Fishery Management Entities	3
Tribes	3
Contractor team	3
Recreation Management Entities	2
Energy Management Entities	1
Land Management Entity	1

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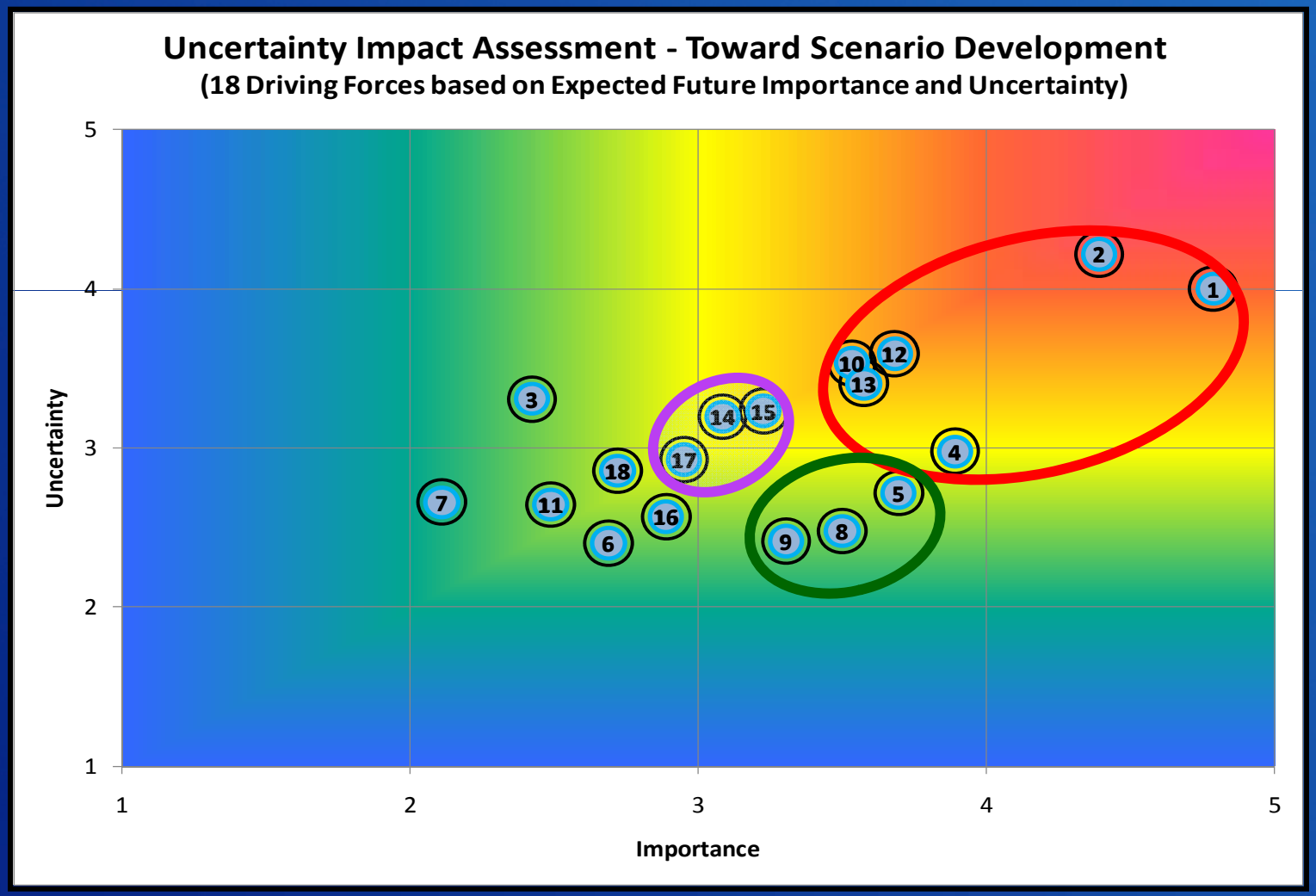
Driving Forces Groupings



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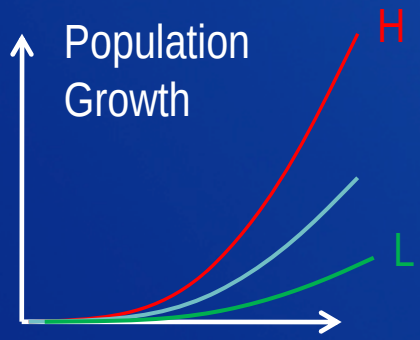
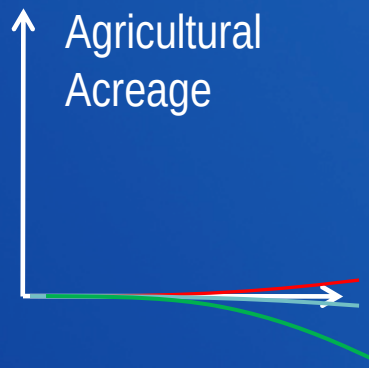
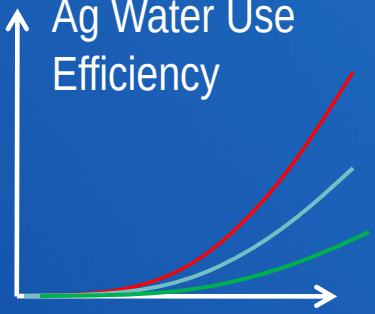
Categorization and Selected Driving Forces for Storyline Development

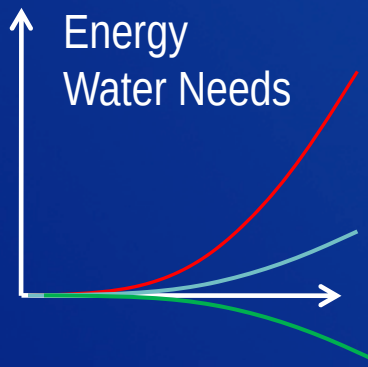
General Driving Force Category	Key CRBS Driving Forces Identified in Survey
Natural Systems (Hydroclimate)	• Changes in streamflow variability and trends [1] • Changes in climate variability and trends (e.g. temperature, precipitation, etc.) [2]
Demographics & Land Use	• Changes in population and distribution [4] • Changes in agricultural land use (e.g. irrigated agricultural areas, crop mixes, etc.) [5]
Technology & Economics	• Changes in agricultural water use efficiency [8] • Changes in municipal and industrial water use efficiency [9] • Changes in water needs for energy generation (e.g. solar, oil shale, thermal, nuclear, etc.) [12]
Social & Governance	• Changes in institutional and regulatory conditions (e.g. laws, regulations, etc.) [10] • Changes in flow-dependent ecosystem needs for ESA-listed species [13] • Changes in other flow-dependent ecosystem needs [14] • Changes in social values affecting water use [15] • Changes in water availability due to tribal water use and settlement of tribal water rights claims [17]

Example Plausible Trajectories of Driving Forces









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Scenario-Based Approach toward Addressing Uncertainties

Water Supply Scenarios

Hydroclimatic Variability & Change (Past, Present, and Future)

1. Observed Historic Record
2. Paleo-Conditioning
3. Paleo Record
4. Downscaled Climate Projections

Water Demand Scenarios

Storyline Approach to Plausible Future Demands

1. Baseline Demands
2. Alternative Futures by Storylines
   - More Intensive Demands (higher population growth, less water use efficiency, lower technology use)
   - Less Intensive Demands *(stable population growth, more water use efficiency, rapid technology adoption)*

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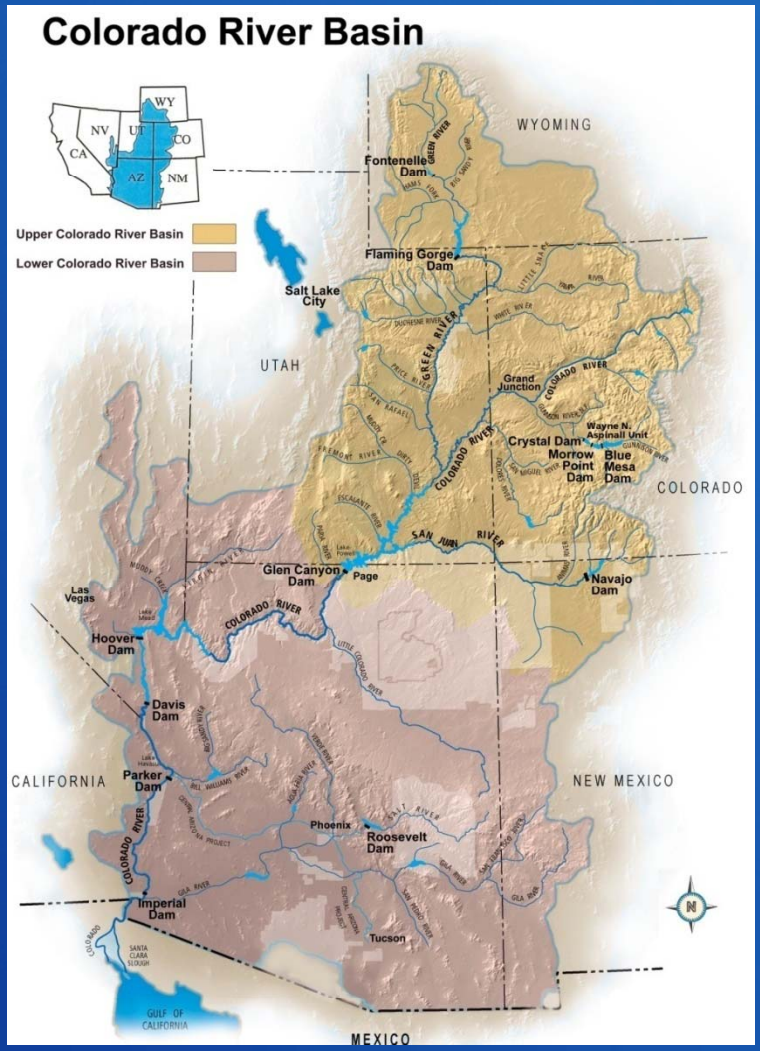
Colorado River Basin Water Supply and Demand Study

Sub-Teams' Status



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Water Supply Assessment

- Objectives
  - Assess the strengths, weaknesses, constraints, and uncertainties of the datasets and methods used to determine historical and projected trends in Colorado River Basin water supply.
  - Develop transparent and scientifically credible methods to enhance understanding of key hydroclimatic processes in the Colorado River Basin.

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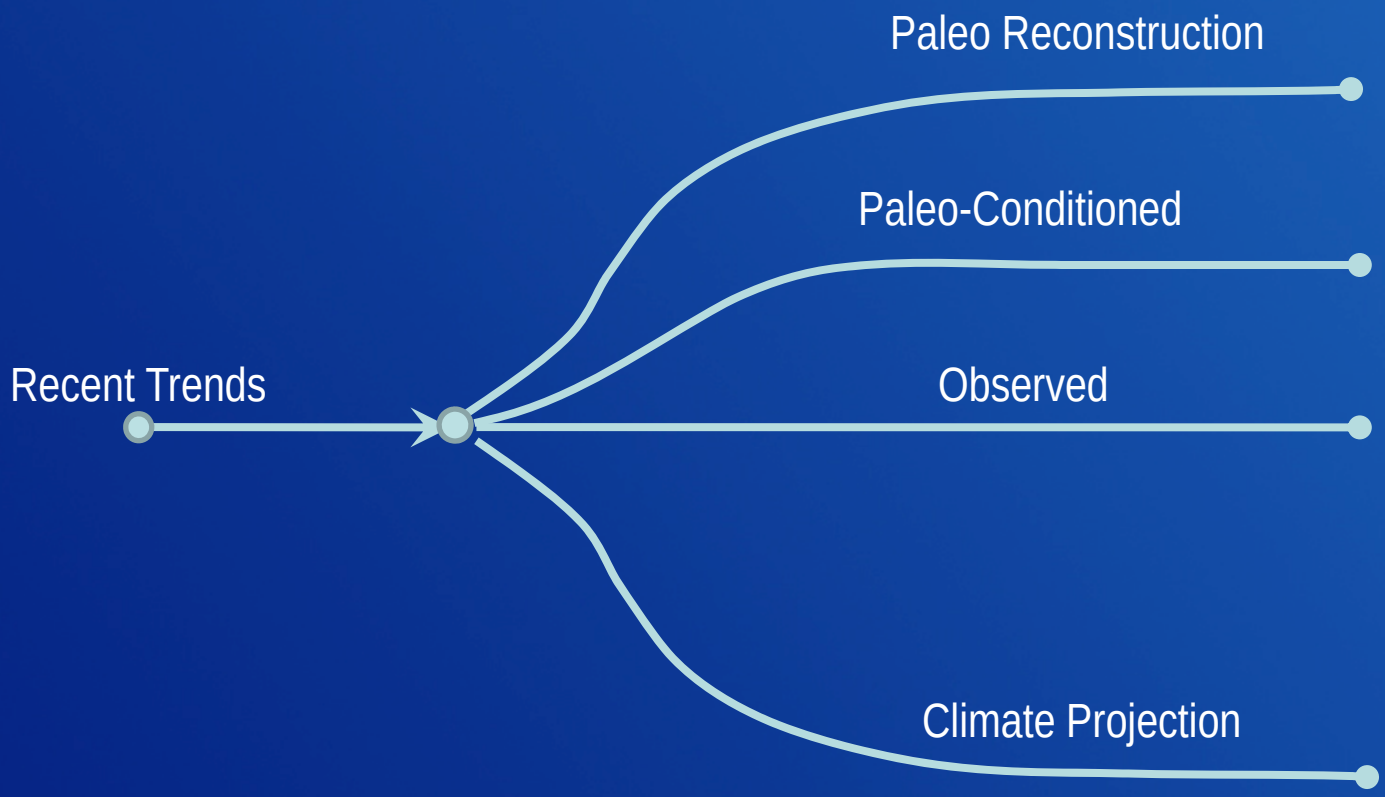
Draft Water Supply Scenarios: Alternative Views of Variability and Change



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Draft Water Supply Scenario Themes

- **Observed**
  - Theme: Historic instrumental period for streamflow represents suitable trends and variability for characterizing the future
- **Paleo Reconstruction**
  - Theme: Paleoclimate period offers a more expansive understanding of streamflow variability that may be more representative of future variability
- **Paleo-Conditioned**
  - Theme: Inter-annual variability of paleo reconstructions is believed to be more representative of future variability, but streamflow magnitudes are believed to best represented by the instrumental period
- **Climate Projection**
  - Theme: Future climate and streamflow variability is represented through global climate models and simulated hydrologic conditions driven by the results of these models

Water Supply Indicators

- **Water Supply Indicators**
  - Streamflow (29 locations)
  - Temperature
  - Precipitation
  - Snowpack
  - Soil moisture
  - Runoff efficiency
  - Evapotranspiration efficiency
  - Climate pattern indices (ENSO, PDO, AMO, etc.)
- **Assessment Methods**
  - Spatial (point, grid, basin, watershed)
  - Time (monthly, annual, decadal, multi-decadal
  - Statistics (mean, variance, percentiles, trend
  - Results display (tables, graphs, maps)
  - Data sources (observed, paleo, VIC results, climate projections)
  - Relevance (contribution to WSI and Study goals)

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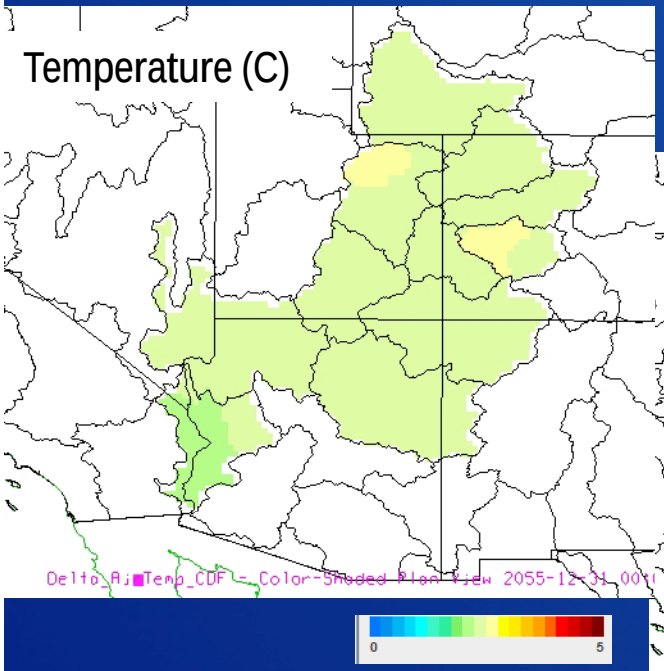
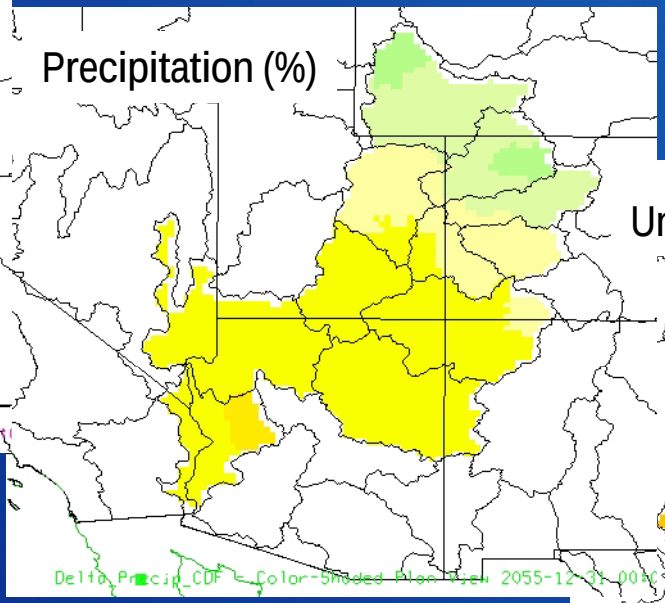
Projected Climate Changes by 2055

Annual median change from over 100 projections

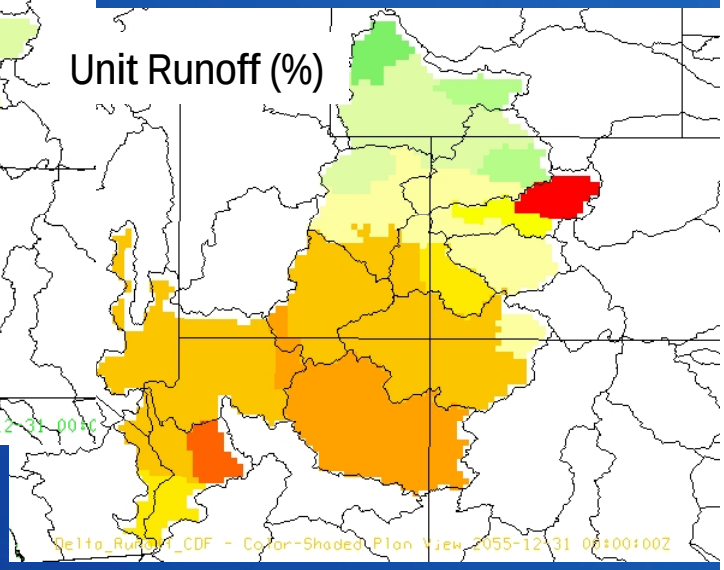


Entire basin expected to continue to warm

Precipitation changes not distributed uniformly in time or space



Runoff reductions for most of the basin



PRELIMINARY DRAFT – IN REVIEW

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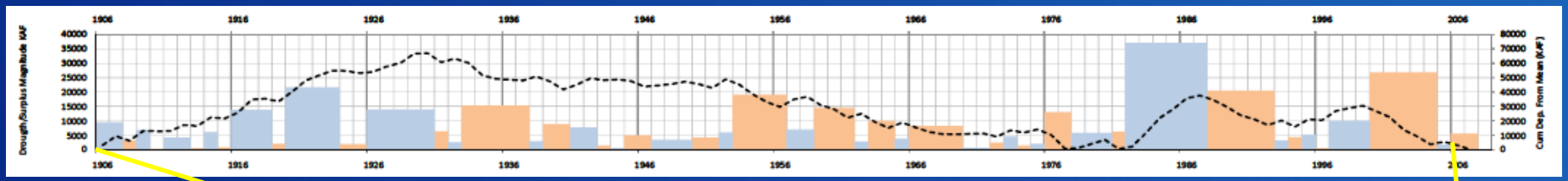
Analysis of Drought Magnitude and Duration for Observed (top) and Paleo Record (bottom)

Ability to examine accumulated streamflow surpluses (blue) / deficits (orange) and magnitude and duration of drought for the observed record 1906-2007



Ability to examine accumulated streamflow surpluses / deficits and magnitude and duration of drought for the paleo record 762-2005

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Water Demand Assessment

- Objective:
  - assess the quantity and location of existing and future water demands, including the potential effects of climate variability and climate change

- Approach:
  - Develop future consumptive and non-consumptive demands
  - Estimate potential variability in demand due to future uncertainty (e.g. economic, technical, global climate change)
  - Examine system sensitivity
  - Create a transparent record

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Draft Socio-Economic Storyline Themes

- "A": Current Trends
  - Theme: Continuation of current trends and policies (i.e., status quo)
- "B"
  - Theme: Balanced economic growth with efficiency improvements
- "C"
  - Theme: Economic resurgence and conventional social preferences toward human development of resources
- "D"
  - Theme: Expanded environmental awareness and stewardship

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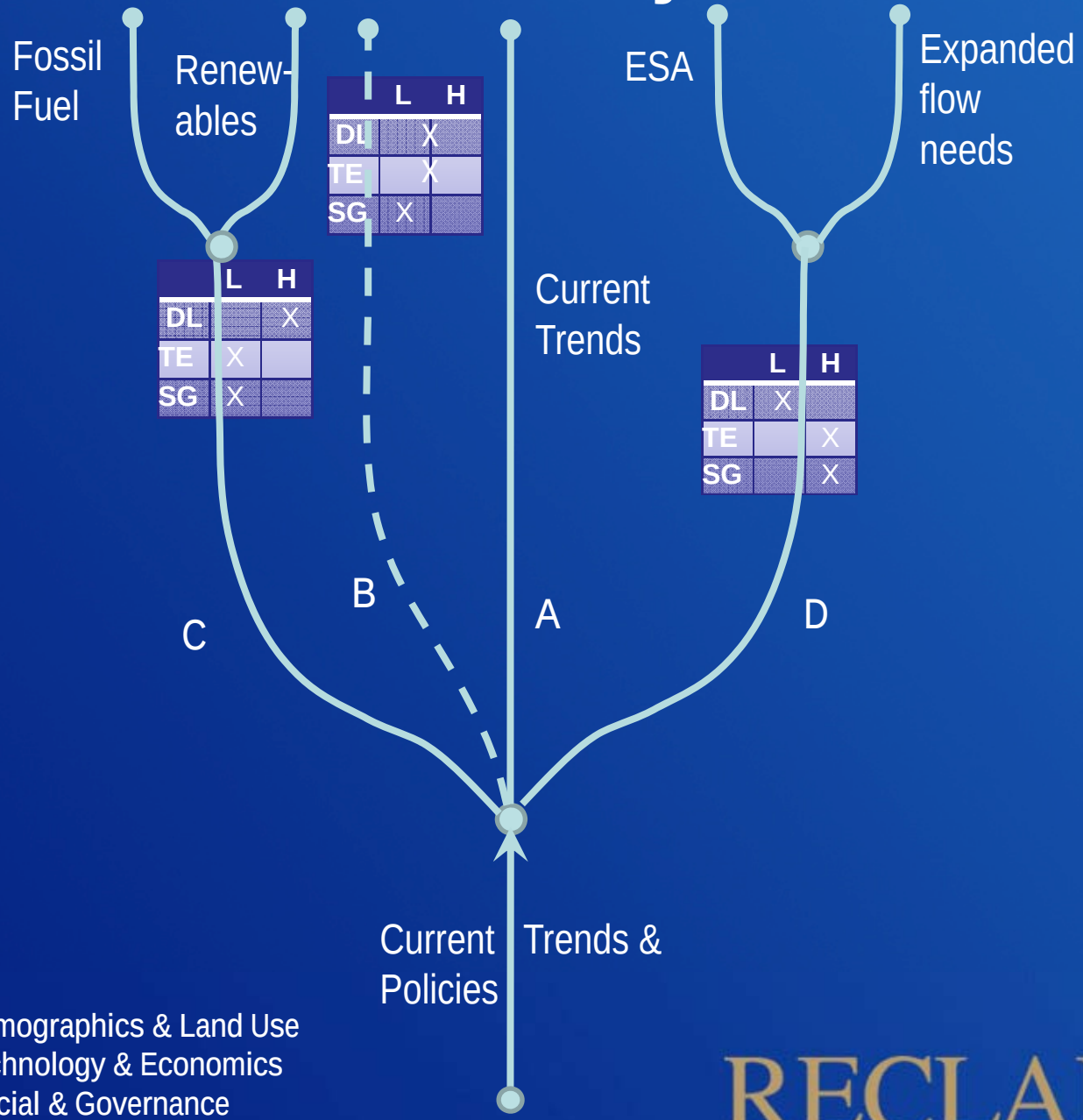
Draft Scenario Trajectories



DL = Demographics & Land Use
TE = Technology & Economics
SG = Social & Governance

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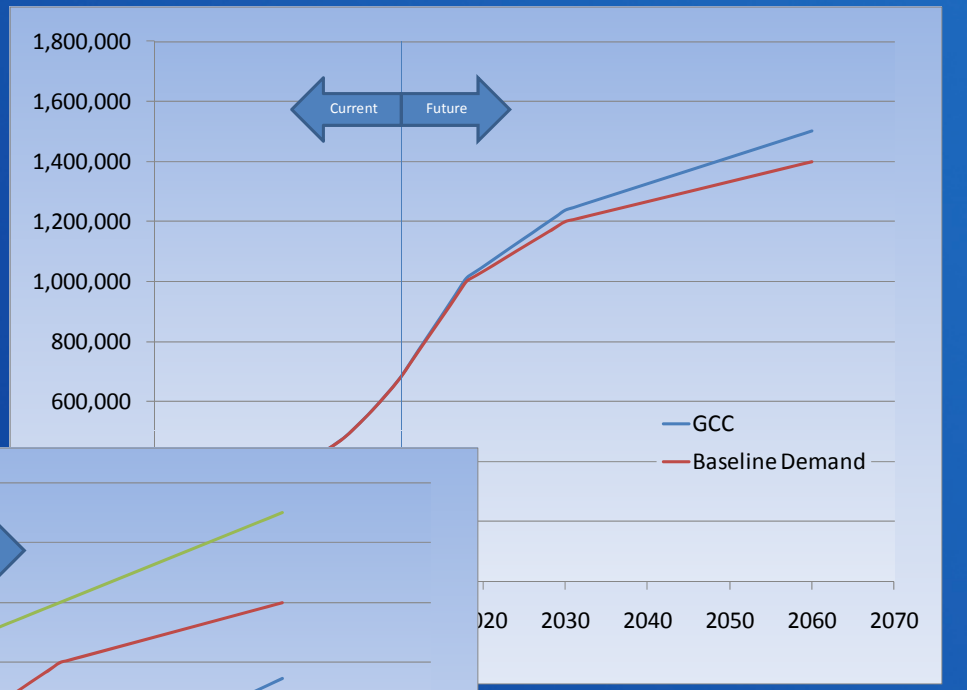
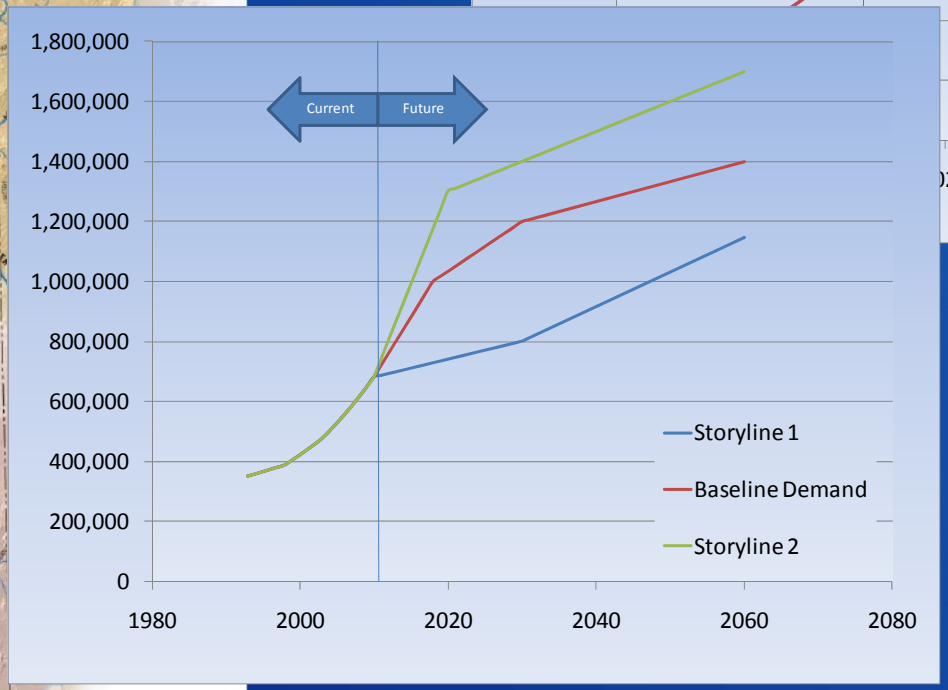
Example Deliverables





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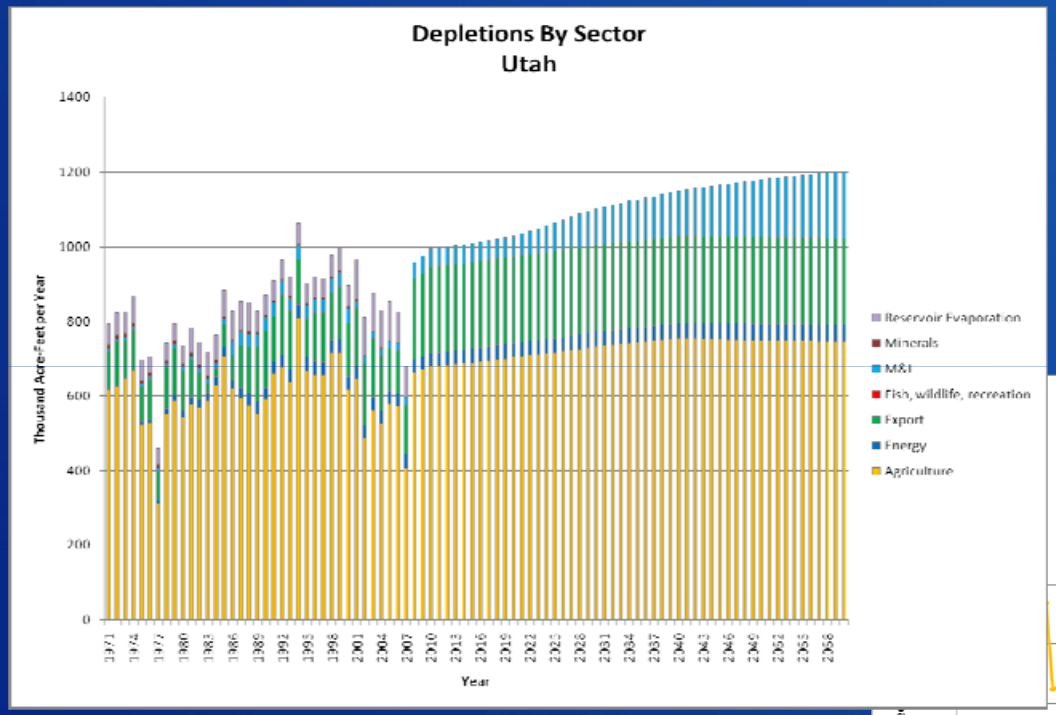
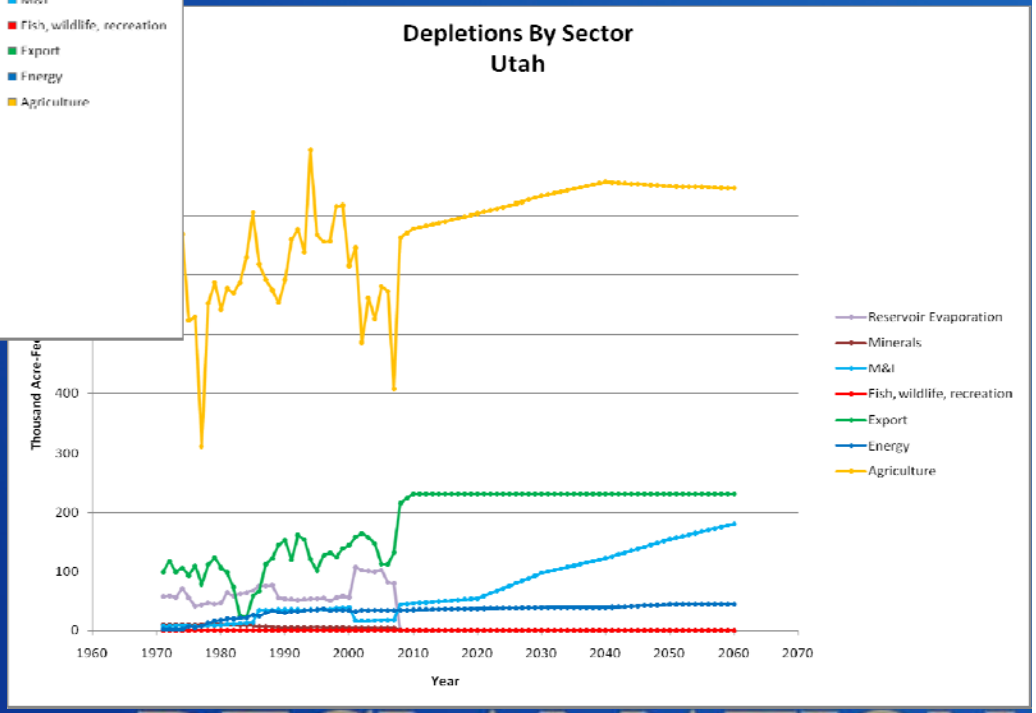
State Summary - Utah





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System Reliability Metrics

- Objective
  - Develop a metric system that will be used to characterize water supply and demand imbalances in the Colorado River Basin and measure the effectiveness of mitigation and adaptation strategies in remedying those imbalances.
- Approach
  - Metrics will be developed considering the methods to be used to project future water supply and demand.
  - Metrics will be developed through coordination with a diverse group of sub-team members.

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System Reliability Metrics Categories

- Water Allocations & Deliveries *
- Electrical Power Resources *
- Water Quality *
- Recreation *
- Ecological Values
- Operational Resources

*** Includes economic and/or socioeconomic evaluations.**

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Metrics – Draft Work Product

- **Matrix with supporting report.**
- **A simplified matrix example is shown:**

Category / Metric	Measurement Approach	Source & Reference
Water Allocation & Deliveries		
Modeled Deliveries by Node & by State	Delivery amounts at 90th, 50th, and 10th percentile. Percent difference from baseline.	Data Source = CRSS Output Metric Reference = Sub-teams and Project Team
Hydroelectric Power Generation		
Modeled Power Generation by Plant	Generation amounts at 90th, 50th, and 10th percentile. Percent difference from baseline.	Data Source = CRSS Output Metric Reference = Defined by WAPA
Operational Risk		
Watershed Landscape Changes	Qualitative Discussion.	Data Source = Literature Metric Reference = Reclamation Operations, USGS

Data Source = Source of data used for metric evaluation.
Metric Reference = Reference used to define the metric purpose and when applicable the metric threshold.

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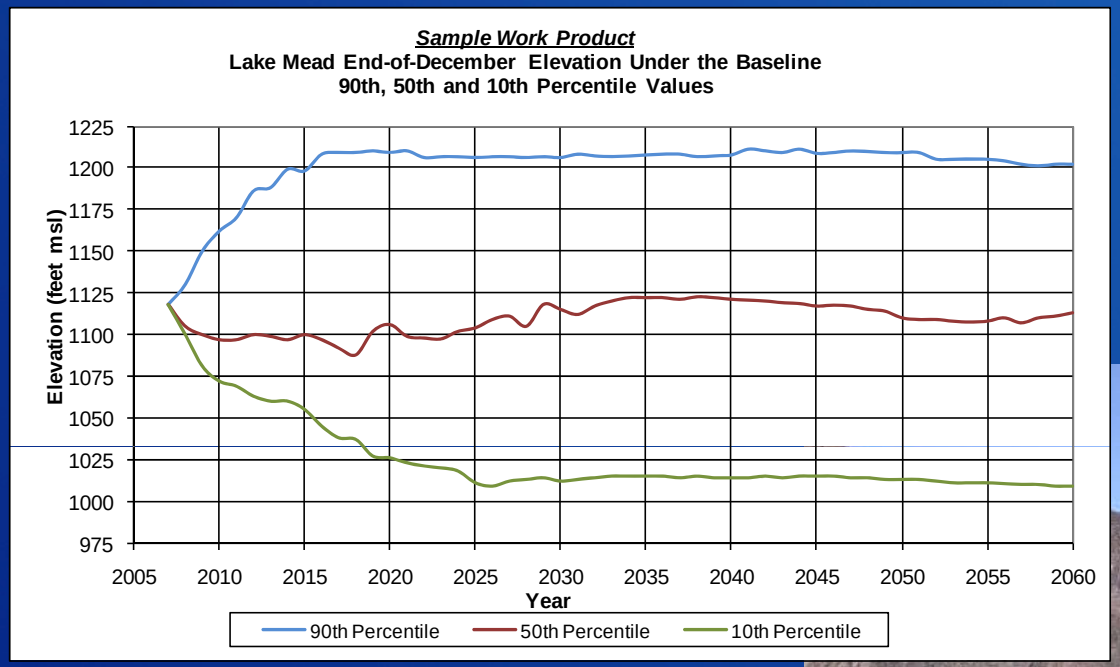
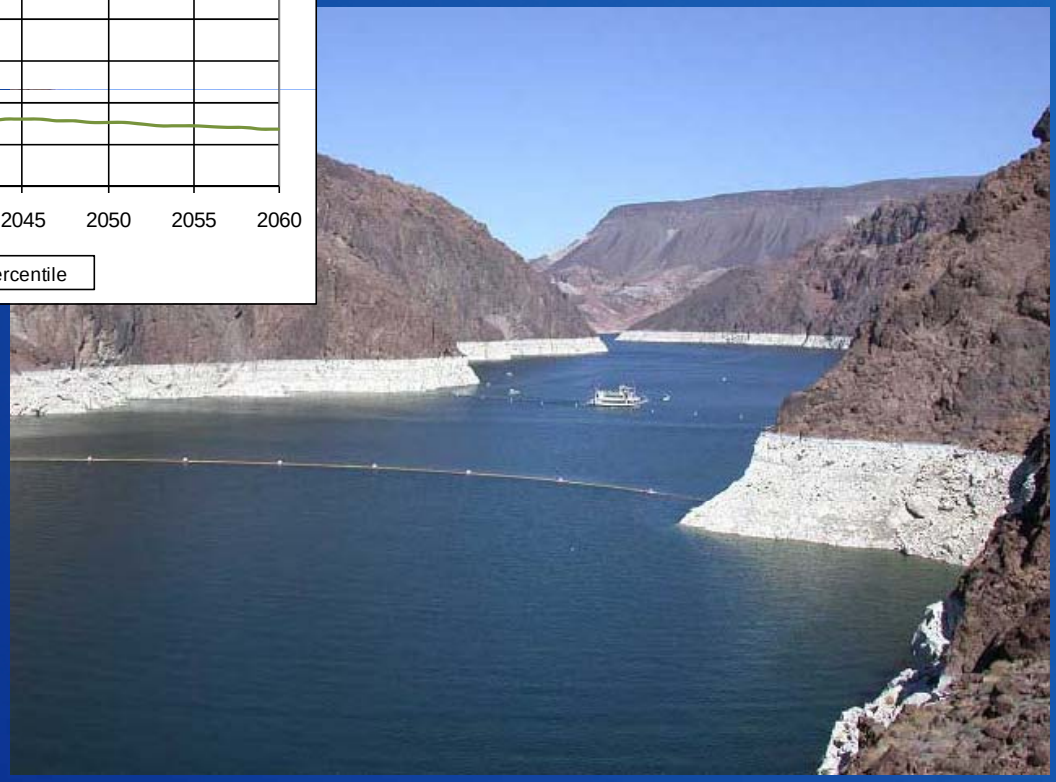
Example Measurement of a Metric





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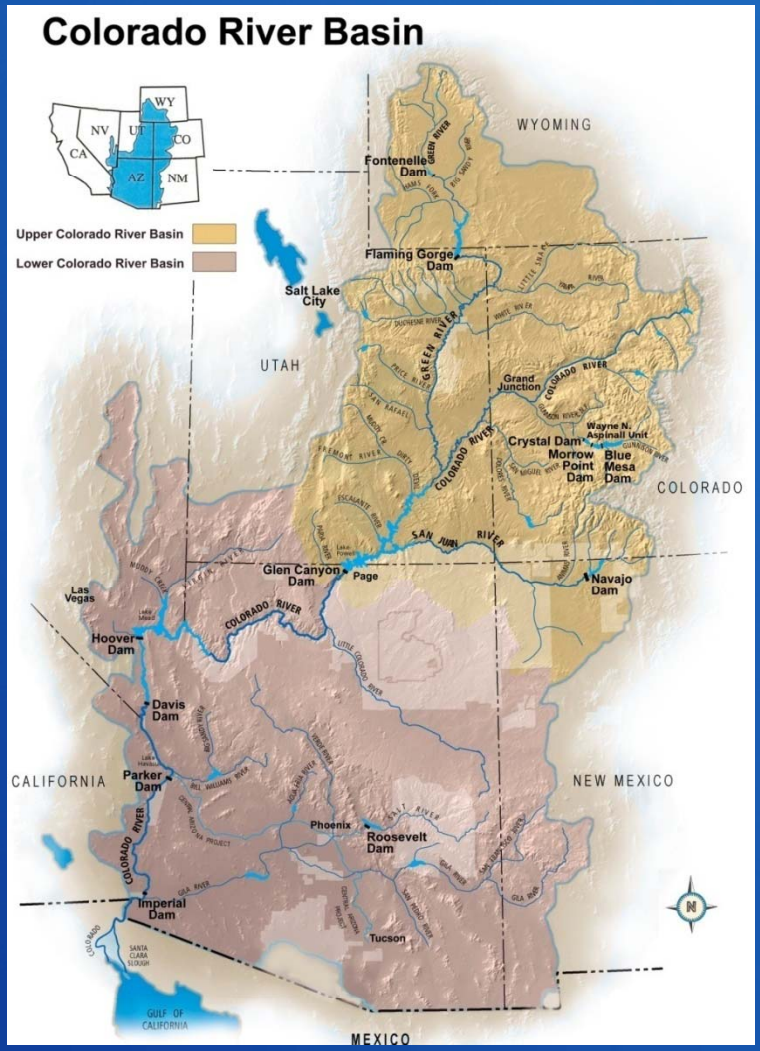
Updated Schedule



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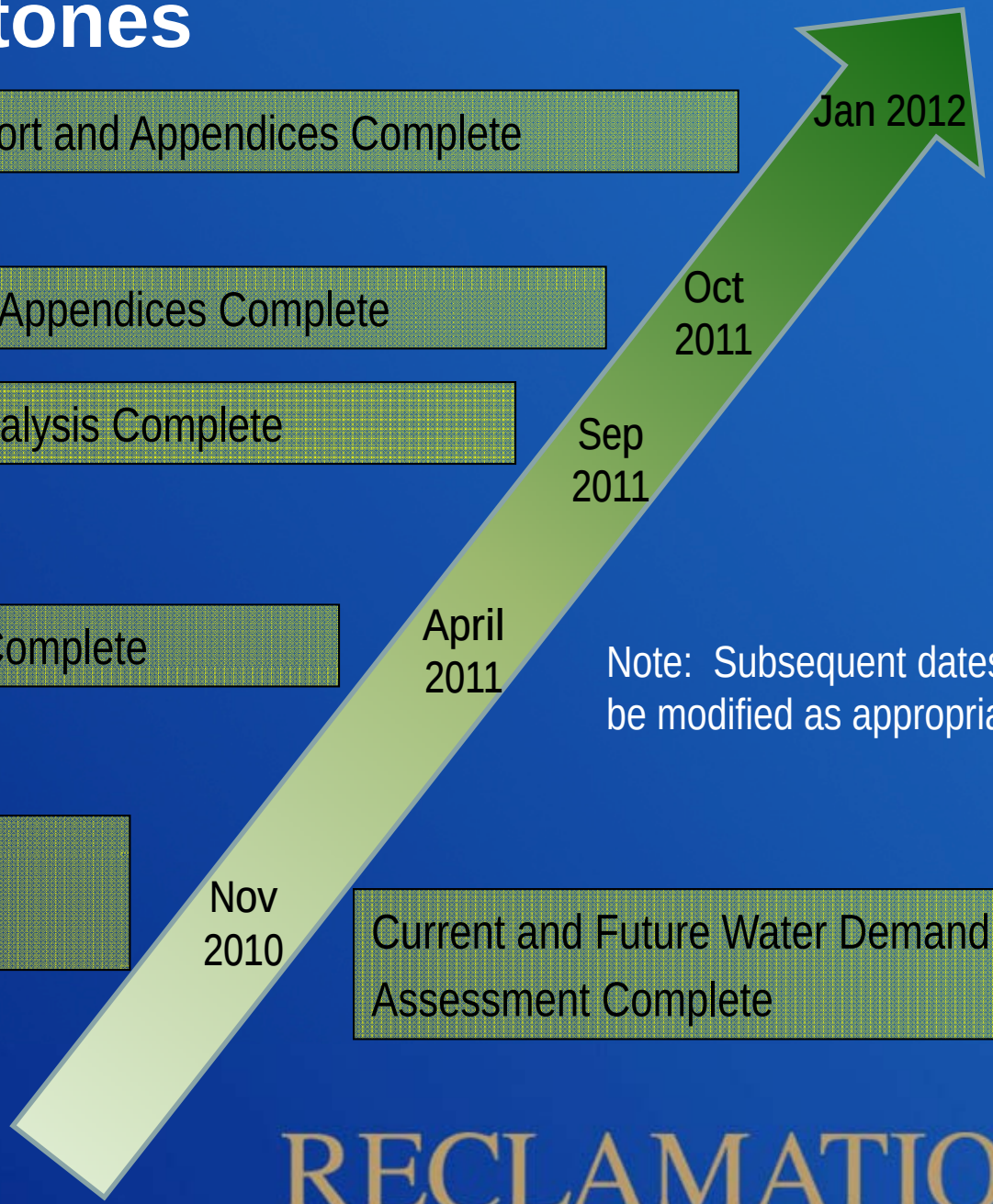
Timeline - Milestones



Note: Subsequent dates will be modified as appropriate

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Colorado River Basin Water Supply and Demand Study

Study Contact Information

- Co-Study Managers:
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- Project Manager: Amber Cunningham, 702-293-8472, azcunningham@usbr.gov
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- Telephone: 702-293-8500; Fax: 702-293-8156

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