Colorado River Basin Water Supply and Demand Study

Public Meeting
Overview of Interim Report No. 1
June 14, 2011
Colorado River Basin Water Supply and Demand Study

- Welcome and Introductions
- Study Overview and Status
- Overview of Interim Report No. 1
- Schedule
- Questions
Colorado River Basin Water Supply and Demand Study

- **Study Objective**
  - Assess future water supply and demand imbalances and develop/evaluate opportunities for resolving imbalances
- **Study being conducted by Reclamation and the Basin States, in collaboration with stakeholders throughout the Basin**
- **Study began in January 2010 and will be completed by July 2012**
- **Email:** ColoradoRiverBasinStudy@usbr.gov
- **Website:** [http://www.usbr.gov/lc/region/programs/crbstudy.html](http://www.usbr.gov/lc/region/programs/crbstudy.html)
- **A planning study – will not result in any decisions**
Colorado River Basin Water Supply and Demand Study

Historic Colorado River Water Supply & Use

10-year running average
Study Outreach

- **Recreation**
  - NPS, Concessionaires, others

- **Hydropower**
  - Western, CREDA, others

- **Ecosystem**
  - NGO collaborative, others

- **Native American Tribes and Communities**
  - Lower Basin, Upper Basin

- **Endangered Species**
  - FWS, others

- **Water Deliveries**
  - Water Districts (agriculture, M&I use)

- **Other**
  - General public, other interested stakeholder groups
Options for Participation in the Study (not mutually exclusive)

- Project website, webinars, emails
- Review and comment on products
- Periodic updates (formal and/or informal)
- Establish points-of-contact with working groups ("Sub-Teams")
- Participation in Sub-Teams
- Other
Study Phases and Tasks

Phase 1: Water Supply Assessment
1.1 – Select Methods to Estimate Current Supply
1.2 – Select Methods to Project Future Supply
1.3 – Conduct Assessment of Current Supply
1.4 – Conduct Assessment of Future Supply

Phase 2: Water Demand Assessment
2.1 – Select Methods to Estimate Current Demand
2.2 – Select Methods to Project Future Demand
2.3 – Conduct Assessment of Current Demand
2.4 – Conduct Assessment of Future Demand

Phase 3: System Reliability Analysis
3.1 – Identify Reliability Metrics
3.2 – Estimate Baseline System Reliability
3.3 – Project Future System Reliability
3.3.5-3.3.8 – Project Future Reliability with Opportunities

Phase 4: Development & Evaluation of Opportunities
4.1 – Develop Opportunities
4.2 – Evaluate and Refine Opportunities
4.3 – Finalize Opportunities

Green denotes essentially complete
Interim Reports

• Facilitate the integration of continuous technical developments and the ongoing input of stakeholders

• Provide a comprehensive “snapshot” of the Study’s progress to date

• Are complete reports as of that date
Interim Report No. 1


- Consists of:
  - Executive Summary
  - Status Report
  - Technical Report A – Scenario Development
  - Technical Report B – Water Supply Assessment
  - Technical Report C – Water Demand Assessment
  - Technical Report D – System Reliability Metrics
Comments

• Should be submitted by July 8, 2011
• May be submitted in the following ways:
  – E-mail to: ColoradoRiverBasinStudy@usbr.gov
  – U.S. mail to:
    U.S. Bureau of Reclamation
    Attention Ms. Pam Adams, LC-2721
    PO Box 61470
    Boulder City NV  89006-1470
  – Fax to: 702-293-8418

• Comments will be incorporated into subsequent interim reports as appropriate
Colorado River Basin Water Supply and Demand Study

Summary of Technical Report A

Scenario Development

Presenter: Terry Fulp
Addressing an Uncertain Future

- 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 and informative number of scenarios are being developed to explore the broad range of futures.

(adapted from Timpe and Scheepers, 2003)
Key Elements of Scenario Approach

- Frame the question
  - Focal question or key issue to be addressed in the Study
- Identify and rank driving forces
  - Major factors 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
Water Supply Scenarios:

**Observed Resampled:**
- Future hydrologic trends and variability will be similar to the past 100 years.

**Paleo Resampled:**
- Future hydrologic trends and variability are represented by the distant past (approximately 1250 years).

**Paleo Conditioned:**
- Future hydrologic trends and variability are represented by a blend of the wet/dry states of the paleo-climate record but magnitudes are more similar to the observed period.

**Downscaled Global Climate Model (GCM) Projected:**
- Future climate will continue to warm with regional precipitation trends represented through an ensemble of future GCM projections.

Water Demand Scenarios:

**Current Trends:**
- Growth, development patterns, and institutions continue along recent trends.

**Economic Slowdown:**
- Low growth with emphasis on economic efficiency.

**Expansive Growth:**
- Economic resurgence (population and energy) and current preferences toward human and environmental values.

**Enhanced Environment and Healthy Economy:**
- Expanded environmental awareness and stewardship with growing economy.

* Additional “branches” possible depending upon assumed trajectory of specific socio-economic factors.

* Preliminary – Subject to change
Integration of Supply and Demand Scenarios

Water Supply Scenarios
(multiple realizations for each scenario)

Water Demand Scenarios

Recent Trends

Recent Trends

Paleo Resampled
Paleo Conditioned
Observed Resampled
Downscaled GCM Projected

Climate indexing for demands

Reclamations
Colorado River Basin Water Supply and Demand Study

Summary of Technical Report B

Water Supply Assessment

Presenter: Carly Jerla
Objective of the Water Supply Assessment

• The objective of the Water Supply Assessment is to assess the probable magnitude and variability of historical and future natural flow\(^1\) in the Basin

• The assessment includes the potential effects of future climate variability and climate change

\(^1\)Natural flow represents the flow that would have occurred at a location had depletions and reservoir regulation not been present upstream of that location
## Critical Uncertainties Affecting Water Supply Scenarios

<table>
<thead>
<tr>
<th>Critical Uncertainty Identified in Survey</th>
<th>General Driving Force Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in streamflow variability and trends</td>
<td>Natural Systems</td>
</tr>
<tr>
<td>Changes in climate variability and trends</td>
<td>Natural Systems</td>
</tr>
</tbody>
</table>
Water Supply Scenarios *

- **Observed Resampled**: future hydrologic trends and variability are similar to the past approximately 100 years.

- **Paleo Resampled**: future hydrologic trends and variability are represented by reconstructions of streamflow for a much longer period in the past (nearly 1,250 years) that show expanded variability.

- **Paleo Conditioned**: future hydrologic trends and variability are represented by a blend of the wet-dry states of the longer paleo-reconstructed period (nearly 1,250 years), but magnitudes are more similar to the observed period (about 100 years).

- **Downscaled GCM Projected**: future climate will continue to warm with regional precipitation and temperature trends represented through an ensemble of future downscaled GCM projections.

* Preliminary – Subject to change.
Projections of Natural Flow at Lees Ferry
Annual and Monthly Statistics

2011-2060 Period Mean Annual Flows

- The peak natural flow under the Downscaled GCM Projected scenario occurs in May, one month earlier than the other scenarios.
- This monthly peak is approximately 500 kaf less than under the other scenarios.
Projections of Natural Flow at Lees Ferry
Deficit and Surplus Statistics

Computed over the 2011-2060 Period

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Observed Resampled</th>
<th>Paleo Resampled</th>
<th>Paleo Conditioned</th>
<th>Downscaled GCM Projected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of Deficit(^1) lasting 5 years or longer</td>
<td>22%</td>
<td>30%</td>
<td>25%</td>
<td>40%</td>
</tr>
<tr>
<td>Frequency of Surplus(^1) lasting 5 years or longer</td>
<td>28%</td>
<td>15%</td>
<td>18%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

\(^1\)A deficit/surplus period occurs whenever the 2-year running mean is below/above the observed mean of 15.0 maf
Projected Changes in Temperature
Annual mean change under the Downscaled GCM Projected scenario

Change in degrees Celsius compared to 1971-2000 mean

- **2025 (2011-2040)**
- **2055 (2041-2070)**
- **2080 (2066-2095)**

Warming is projected to increase across the Basin.
Projected Changes in Precipitation
Annual mean change under the Downscaled GCM Projected scenario

Percent change compared to 1971-2000 mean

General trend towards drying is projected although precipitation increases higher elevations are projected
Projected Changes in Snowpack

Mean change in April SWE under the Downscaled GCM Projected scenario

Snowpack is projected to decrease as more precipitation falls as rain and warmer temperatures cause an earlier melt.
Next Steps

• Additional analysis and investigation of the Downscaled GCM Projected scenario is ongoing in two areas in particular

  1) Application of a secondary bias-correction to the natural flows generated by the hydrologic model

  2) Analysis of sequences that exhibit extremely high natural flows
Colorado River Basin Water Supply and Demand Study

Summary of Technical Report C

Water Demand Assessment

Presenter: Jim Prairie
Objective of the Water Demand Assessment

• The objective of the Water Demand Assessment is to assess the quantity and location of current and future water demands in the Study Area¹ to meet the needs of Basin resources

• Basin resources include: municipal and industrial (M&I) use, hydropower generation, recreation, and fish and wildlife habitat

¹The Study Area is defined as the hydrologic boundaries of the Basin plus the adjacent areas of the Basin States that receive Colorado River water
## Critical Uncertainties Affecting Water Demand Scenarios

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<tr>
<th>Critical Uncertainty Identified in Survey</th>
<th>General Driving Force Category</th>
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<tbody>
<tr>
<td>Changes in population and distribution</td>
<td>Demographics &amp; Land Use</td>
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<tr>
<td>Changes in agricultural land use</td>
<td></td>
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<tr>
<td>Changes in agricultural water use efficiency</td>
<td>Technology &amp; Economics</td>
</tr>
<tr>
<td>Changes in municipal and industrial water use efficiency</td>
<td></td>
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<tr>
<td>Changes in water needs for energy generation</td>
<td></td>
</tr>
<tr>
<td>Changes in institutional and regulatory conditions</td>
<td>Social &amp; Governance</td>
</tr>
<tr>
<td>Changes in flow-dependent ecosystem needs for Endangered Species Act-listed species</td>
<td></td>
</tr>
<tr>
<td>Changes in other flow-dependent ecosystem needs</td>
<td></td>
</tr>
<tr>
<td>Changes in social values affecting water use</td>
<td></td>
</tr>
<tr>
<td>Changes in water availability due to tribal water use and settlement of tribal water rights claims</td>
<td></td>
</tr>
</tbody>
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**Water Demand Scenarios**

- **Current Trends**: growth, development patterns, and institutions continue along recent trends

- **Economic Slowdown**: low growth with emphasis on economic efficiency

- **Expansive Growth**: economic resurgence (population and energy) and current preferences toward human and environmental values

- **Enhanced Environment and Healthy Economy**: expanded environmental awareness and stewardship with growing economy

* Preliminary – Subject to change
** Additional “branches” possible depending upon assumed trajectory of specific socio-economic factors
Approach to Quantifying Demand Scenarios

- Storyline
  - Irrigation efficiency
  - M&I efficiency
  - Tribal Use and Settlements
  - Minerals Projections
  - Ecosystem needs
  - Irrigated acreage
  - Pop
  - Energy projections
  - Regulatory Environ.
  - Social Values
  - ESA listed species needs

- Quantify parameter characteristics

- Demand and Loss Categories

- Study area demand

- Determine Colorado River demand

- Study Area Demand
- Colorado River Demand
- Non-CR Supply
Current Trends Scenario

• Theme
  – Growth, development patterns, and institutions continue along recent trends

• Parameter Characteristics
  – Best estimate of population growth
  – Nominal increases in irrigated agricultural lands
  – Continued current trends in agricultural water use efficiency
  – M&I water use efficiency increases according to current policy and technology
  – Water needs for energy expand
  – No anticipated changes in regulations
  – No change in currently realized ESA-listed species needs
  – No change in current planning and/or projections associated with ecosystem needs or practices
  – Social values affecting water use are similar to recent past
  – Tribal water use continues as projected in settlements
Historical Colorado River Water Consumptive Use by Use Category
Next Steps

• Quantifying the scenarios will be primary focus of the coming months

• Scenario quantification will begin with the Current Trends scenario, followed by the quantification of the other scenarios (Economic Slowdown, Expansive Growth, and Enhanced Environment and Healthy Economy)
Colorado River Basin Water Supply and Demand Study

Summary of Technical Report D

System Reliability Metrics

Presenter: Carly Jerla
Objective of the System Reliability Metrics

- The objective of the System Reliability Metrics task is to develop a set of comprehensive metrics\(^1\) to be used to measure the potential impacts to Basin resources from future supply and demand imbalances.

- Metrics will also be used to measure the effectiveness of options and strategies to address supply and demand imbalances.

\(^1\)Metrics are measures that indicate the ability of the Colorado River system to meet the needs of the Basin resources under multiple future conditions.
System Reliability Metrics

Resource Categories
- Water Deliveries
- Electrical Power Resources
- Water Quality
- Flood Control
- Recreational Resources
- Ecological Resources

Metrics can be measured quantitatively or qualitatively depending on the data and tools available.
Next Steps

• Next steps include fully defining metrics that have been identified but have not yet been defined
  – In particular these include metrics related to the Ecological Resources category
• Adjustments to metrics will be made as some defined metrics may not prove to be informative or further analysis identifies the need for other metrics
Colorado River Basin Water Supply and Demand Study

Updated Study Timeline & Questions
<table>
<thead>
<tr>
<th>Milestones &amp; Updated Study Timeline</th>
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<tbody>
<tr>
<td><strong>February – April 2011</strong></td>
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<tr>
<td>Quantify Demand Scenarios</td>
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<td><strong>July – September 2011</strong></td>
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<tr>
<td>Perform “Baseline” System Reliability Analysis</td>
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<tr>
<td><strong>September – December 2011</strong></td>
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<tr>
<td>Develop Options &amp; Strategies</td>
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<tr>
<td><strong>October 2011</strong></td>
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<tr>
<td>Publish Interim Report No. 2</td>
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<tr>
<td><strong>November 2011 – February 2012</strong></td>
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<tr>
<td>Perform System Reliability Analysis with Options &amp; Strategies</td>
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<tr>
<td><strong>March 2012</strong></td>
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<tr>
<td>Publish Interim Report No. 3</td>
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<tr>
<td><strong>April – May 2012</strong></td>
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<tr>
<td>Finalize &amp; Evaluate Options &amp; Strategies</td>
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<tr>
<td><strong>June 2012</strong></td>
</tr>
<tr>
<td>Publish Draft Final Study Report for Comment</td>
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<tr>
<td><strong>July 2012</strong></td>
</tr>
<tr>
<td>Publish Final Study Report</td>
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Colorado River Basin Water Supply and Demand Study

QUESTIONS?

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