Mid-term Operations Probabilistic Model of the Colorado River Basin

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U.S. Department of the Interior
Bureau of Reclamation

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PRECISION
WATER RESOURCES ENGINEERING

Mid-term Operations Probabilistic Model of the Colorado River Basin

- Colorado River Basin Overview

- Reclamation Modeling of Mid-term Operations

- Purpose and Goals of the Colorado River Basin MTOM

- The MTOM System in RiverWare
  - Overview of Inputs and Outputs

- Next Steps

PRECISION
WATER RESOURCES ENGINEERING

PWRE

RECLAMATION

Overview of the Colorado River Basin

- 16.5 million acre-feet (maf) allocated annually

  - 7.5 maf each to Upper and Lower Basins

  - 1.5 maf to Republic of Mexico

- 13 to 14.5 maf of consumptive use on average annually

- Operations and water deliveries governed by the "Law of the River"

- 60 maf of storage

- 14.9 maf average annual inflow in Upper Basin over the past 100 years

- 1.3 maf average annual inflow in Lower Basin
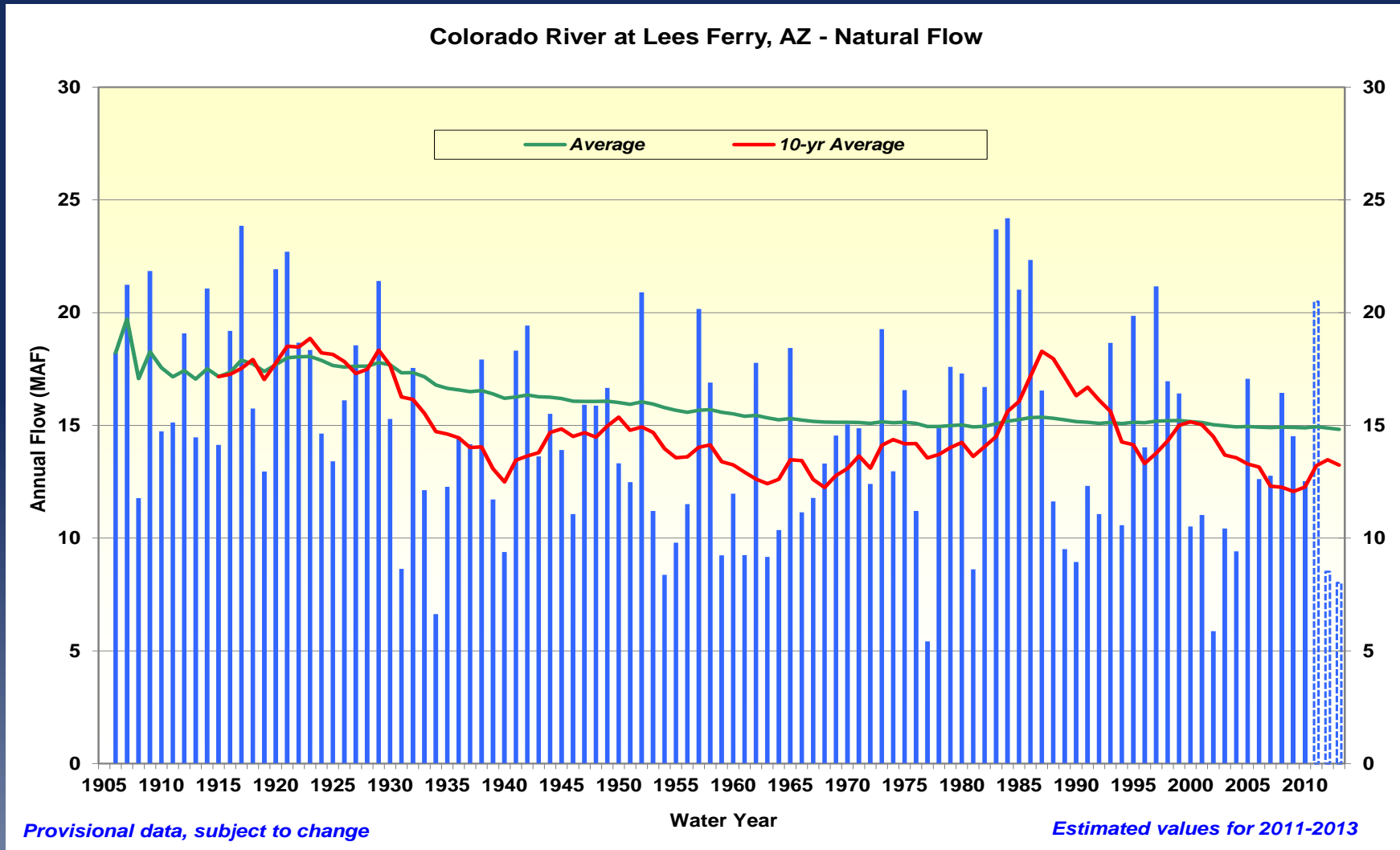
- Inflows are highly variable year-to-year
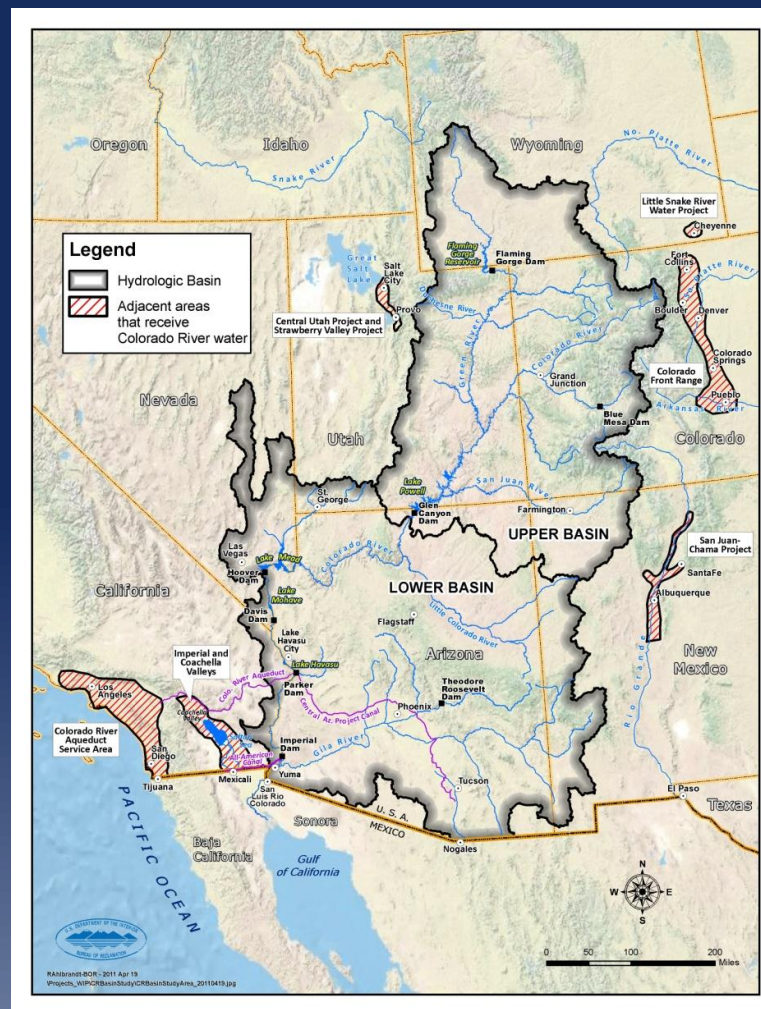
Map of Colorado River Upper and Lower Basins

Natural Flow
Colorado River at Lees Ferry Gaging Station, Arizona
Water Year 1906 to 2013

Colorado River at Lees Ferry, AZ - Natural Flow

Provisional data, subject to change

Estimated values for 2011-2013

Modeling of Mid-term Operations

- **24-Month Study Model**
  - 12 major reservoirs

    (9 Upper Basin, 3 Lower Basin)
  - 2-year projection updated monthly
  - Single projection based on "most probable" inflow forecast
- **24-Month Study Output**
  - Annual Operating Plan model
  - Under the 2007 Interim Guidelines, used to determine operating tiers of Lake Powell and Lake Mead
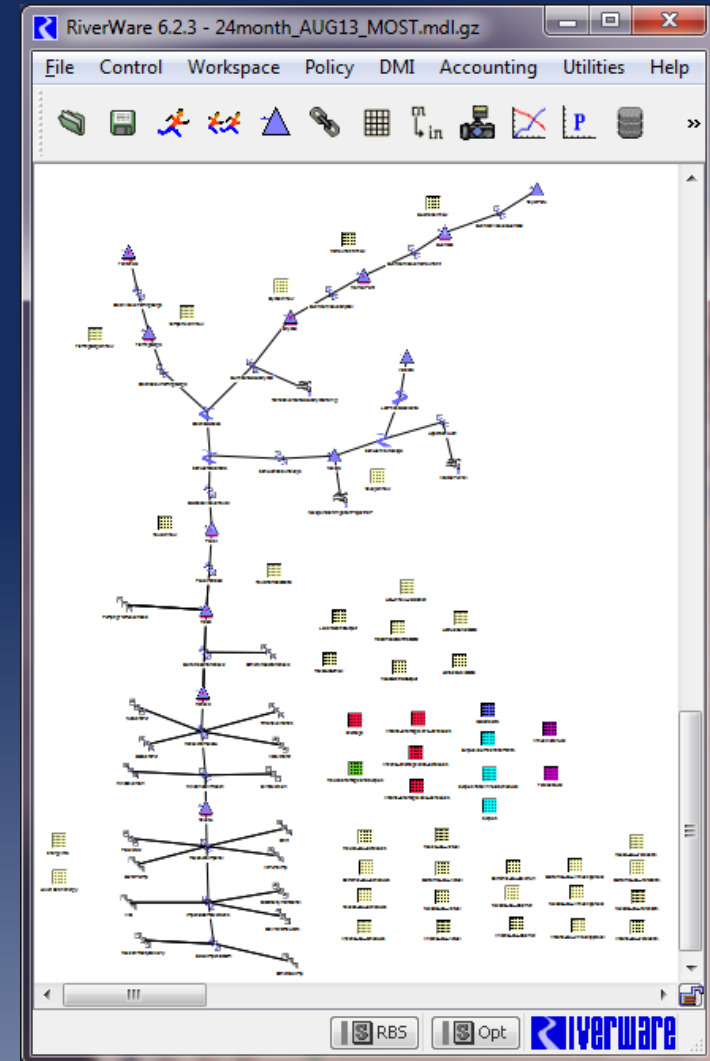
Motivation for the MTOM System

- To better quantify range of possibilities for the mid-term future of the Colorado River Basin

- An additional tool to propagate a distribution of inflows through the basin to simulate a distribution of mid-term reservoir conditions

- Used to estimate potential risks and provide a platform for mid-term planning
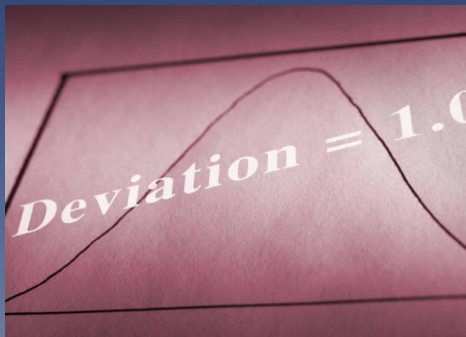
The Goal of MTOM

- Produce a user-friendly package that allows for Reclamation and its stakeholders in the Colorado River Basin for risk assessment and planning for potential water releases, including peak flows, as well as probabilities of shortage or surplus
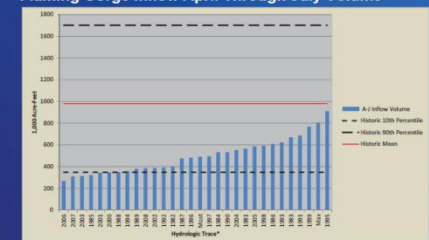
Recent Updates to MTOM

- Run-time increased from 2 years to 5 years
  - Including 5-year inflow forecasts from the Colorado Basin River Forecast Center (CBRFC) Ensemble Streamflow Prediction (ESP) model

- Added flexibility to simulate any number of traces and run length in MRM

- Incorporation of Lower Basin Demand Variability under Lake Mead normal operations

- Incorporation of Shortage and Surplus to Mexico under IBWC Minute 319
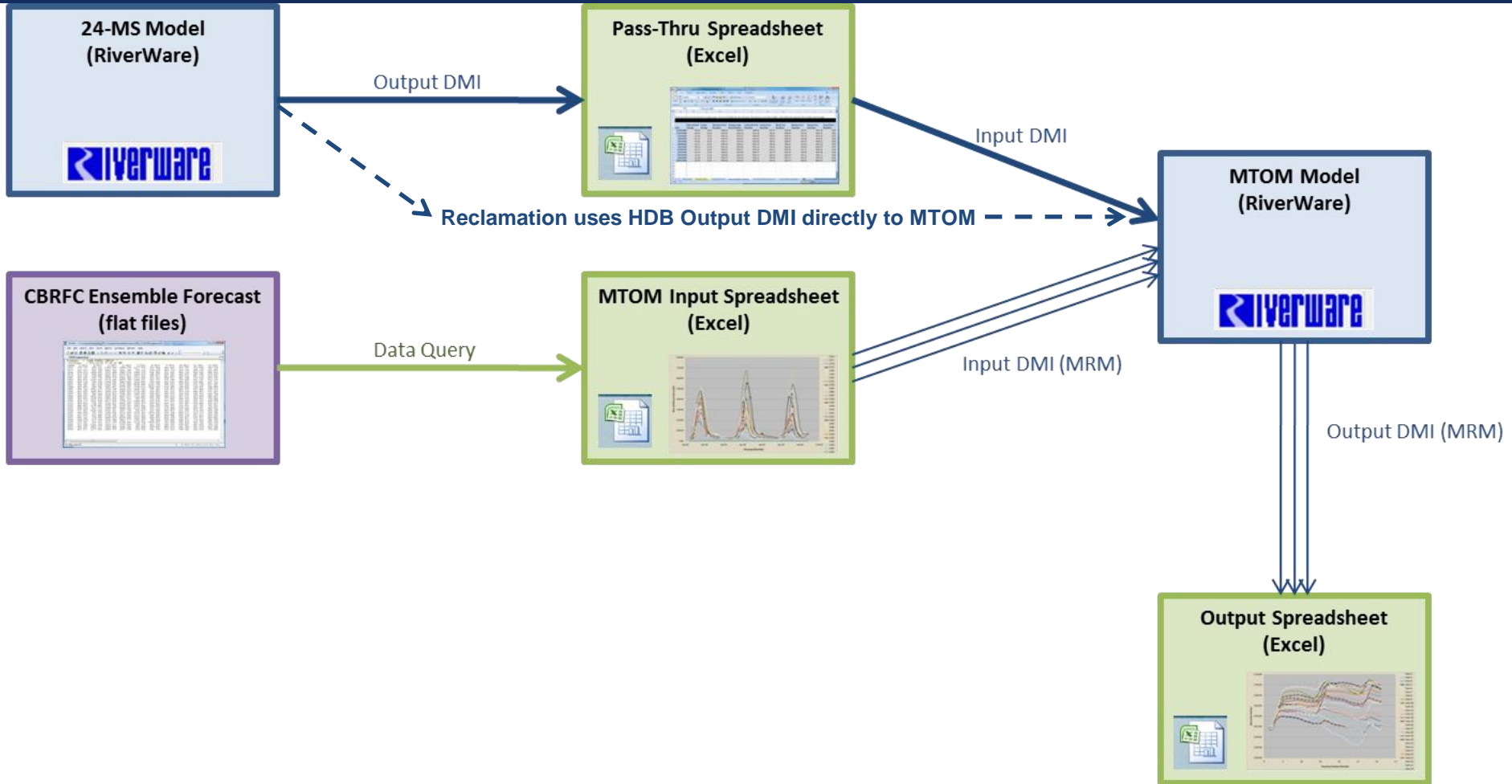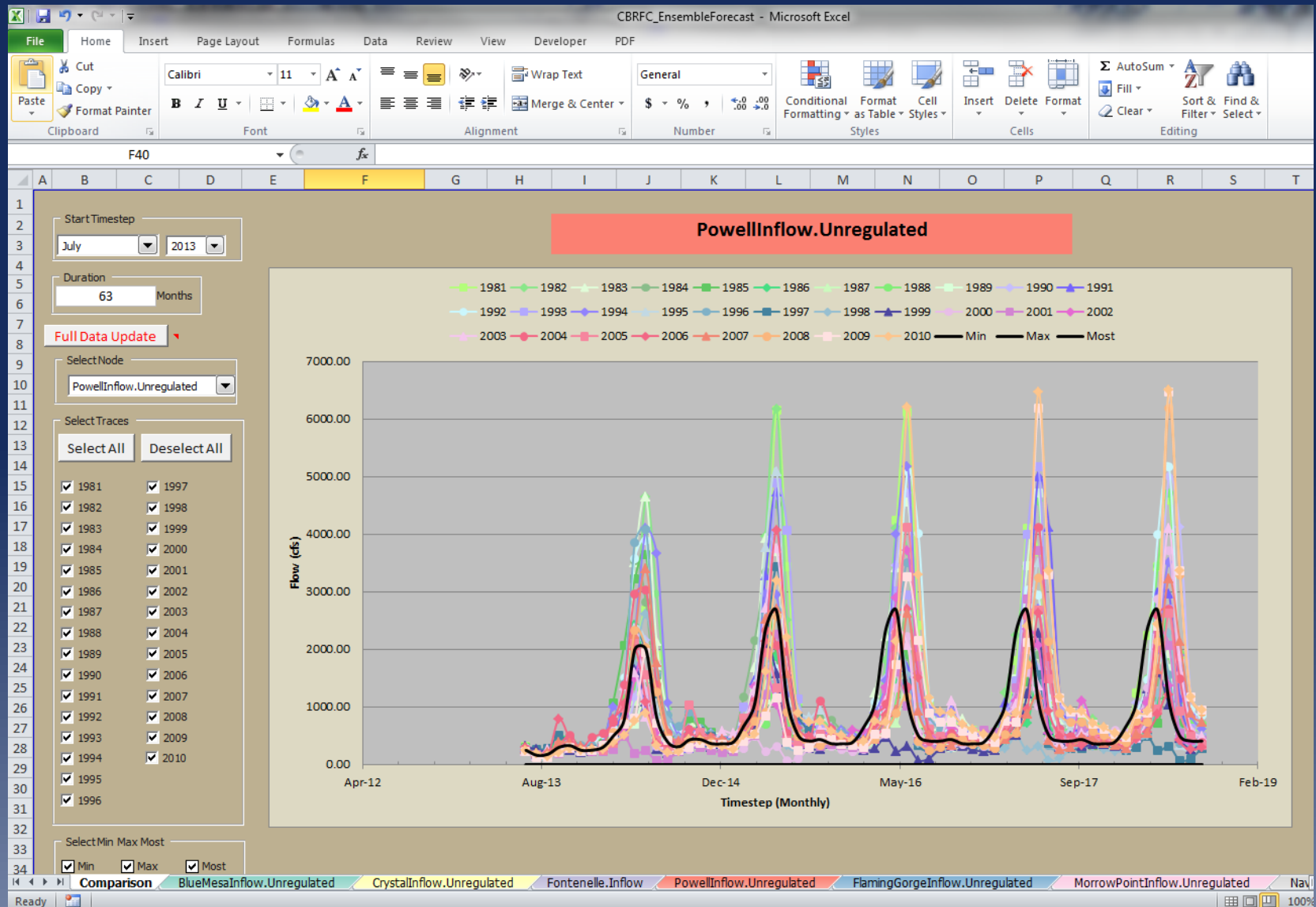
Why RiverWare Works for MTOM

- MRM Functionality

  - Allows for variable hydrology and variable operational policy

  - In MTOM

    - Variable hydrology

    - Static operational policy

- Use Excel direct connect to Input and Output appropriate data
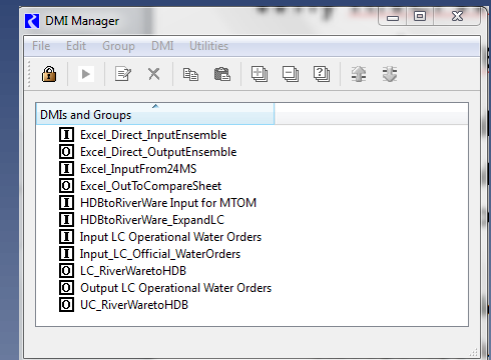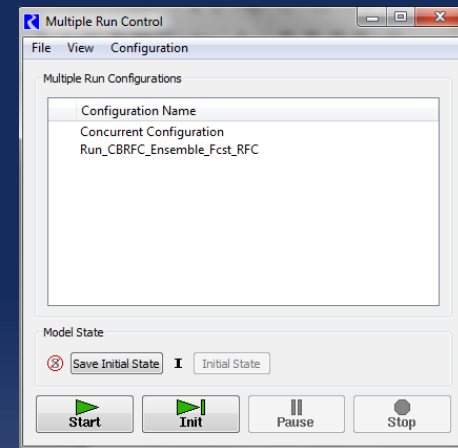
MTOM System

Ensemble Forecasts in Excel (x 12)

CBRFC Inflow Forecast Points

Upper Basin Forecast Sites
- Fontenelle Reservoir
- Flaming Gorge Reservoir
- Yampa River Inflow
- Taylor Park Reservoir
- Blue Mesa Reservoir
- Morrow Point Reservoir
- Crystal Reservoir
- North Fork of the Gunnison Inflow
- Vallecito Reservoir
- Navajo Reservoir
- Animas River Inflow
- Lake Powell

Colorado River–Upper Basin
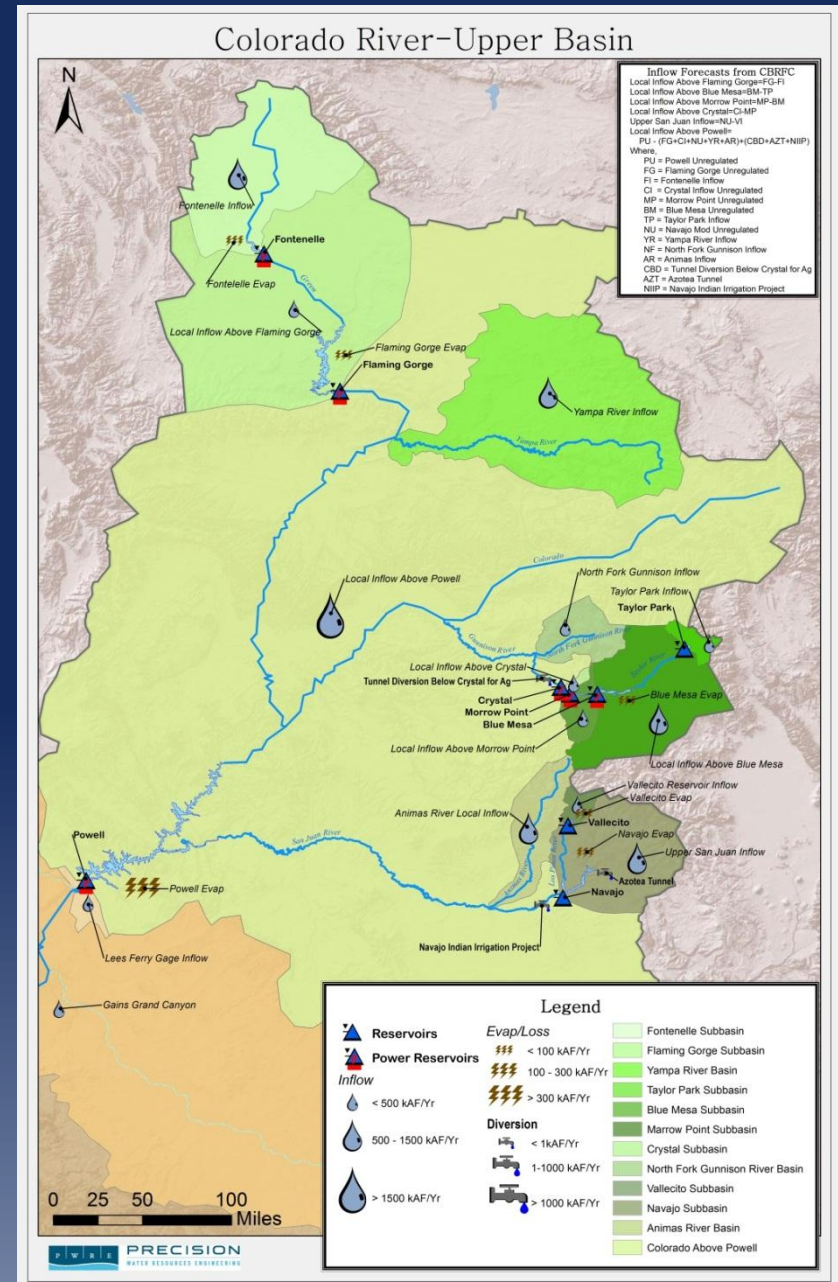
Within Each MRM Run

- Takes Advantage of Four Run Cycles
  - Each run cycle solves a different section of the basin (Upper Basin to the Lower Basin)
  - Allows for reservoirs to solve and allows to NOT have to forecast values within logic
  - Each Run Cycle starts at the beginning time step but allows for the previous Run Cycle data to be saved for use in the next
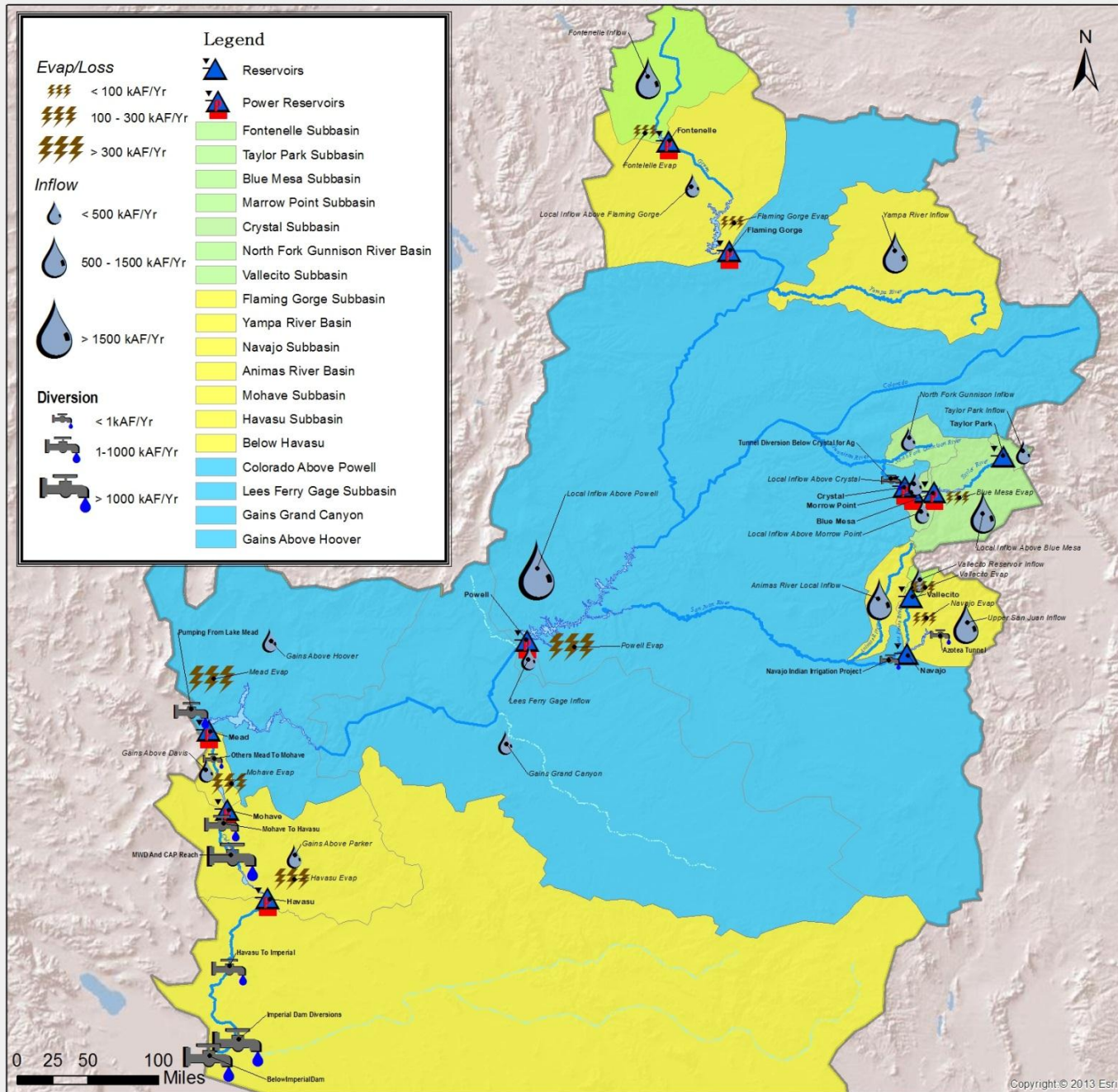
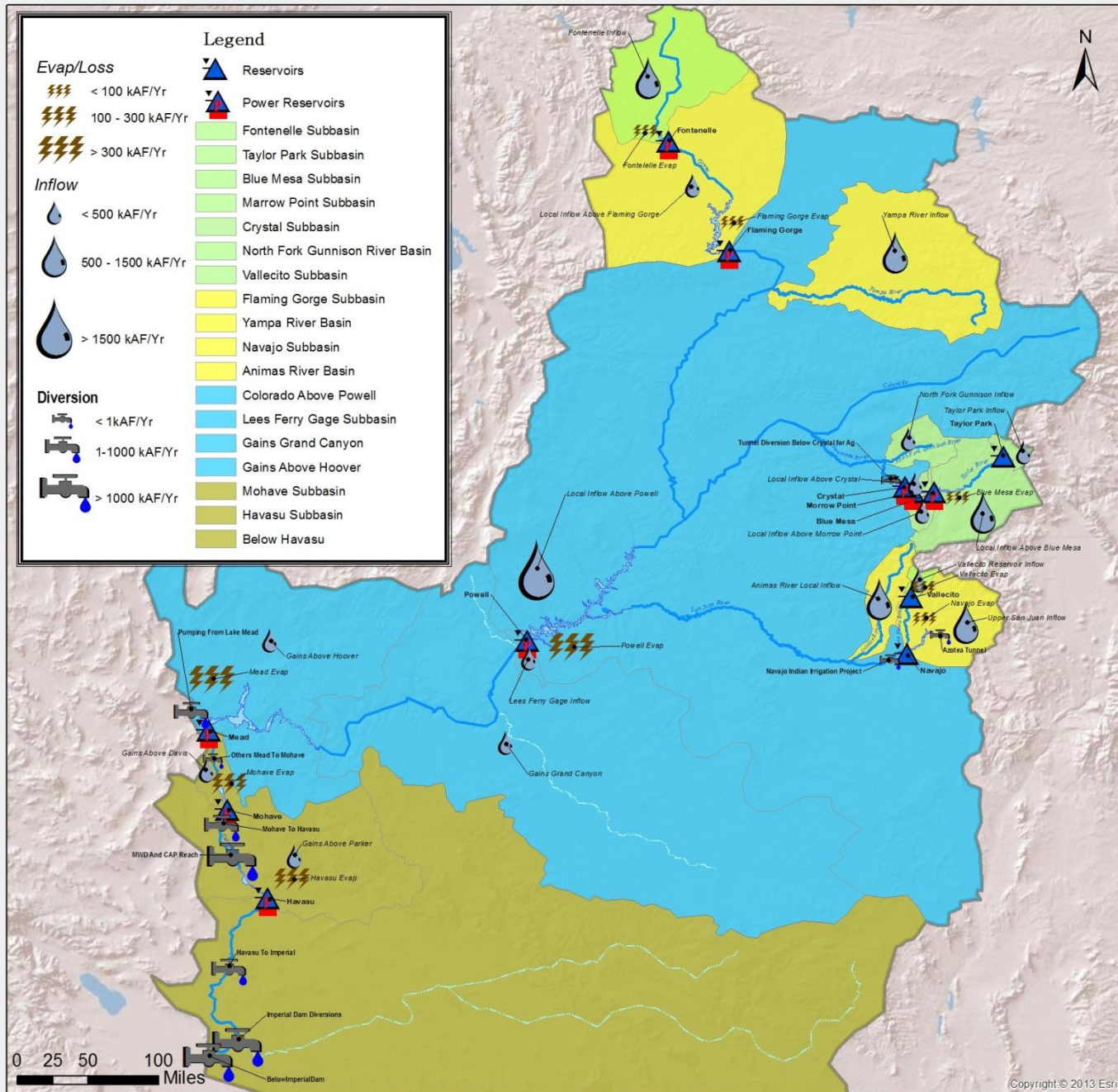Colorado River Basin-Run Cycle 1
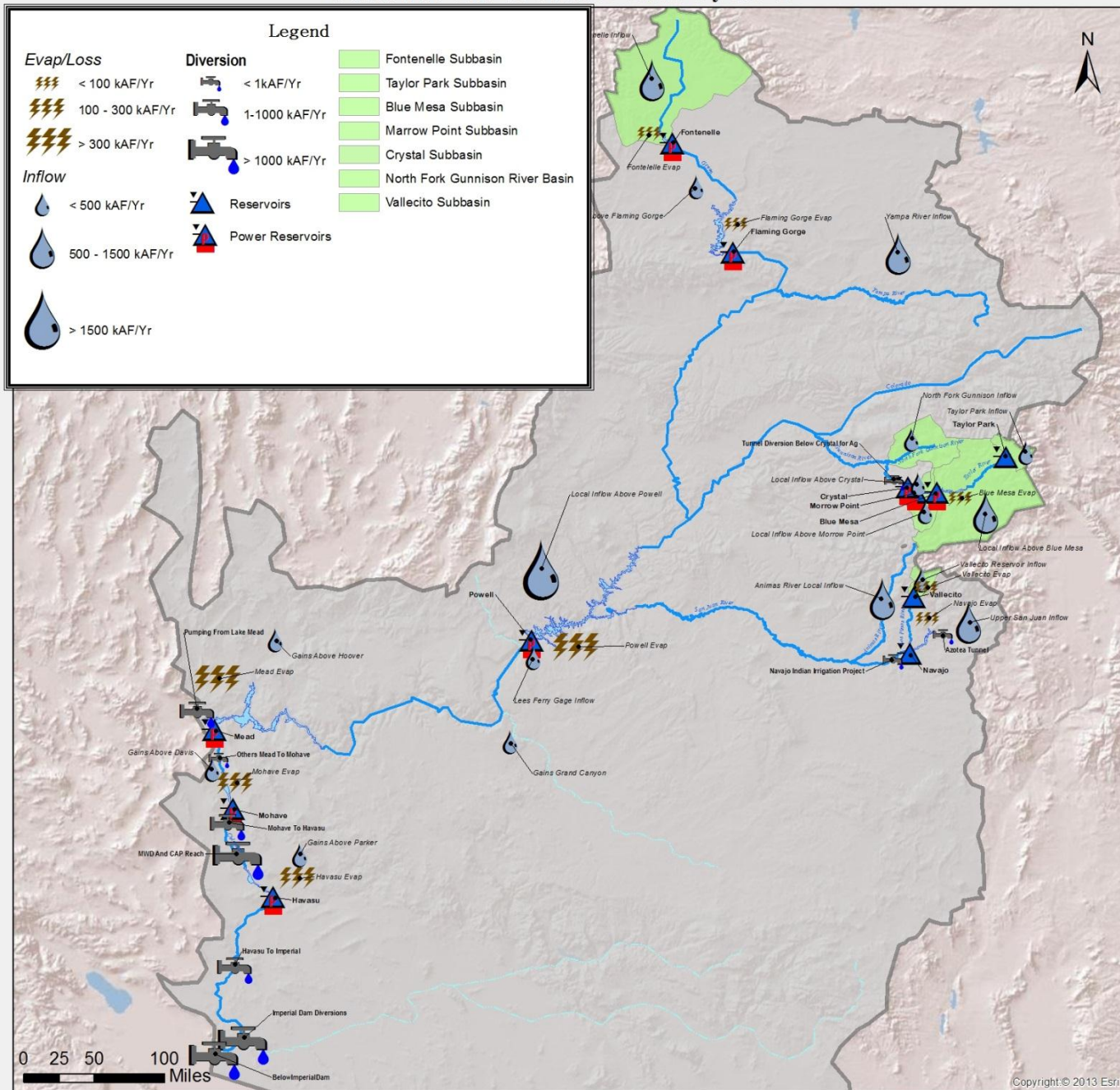
Colorado River Basin-Run Cycle 2
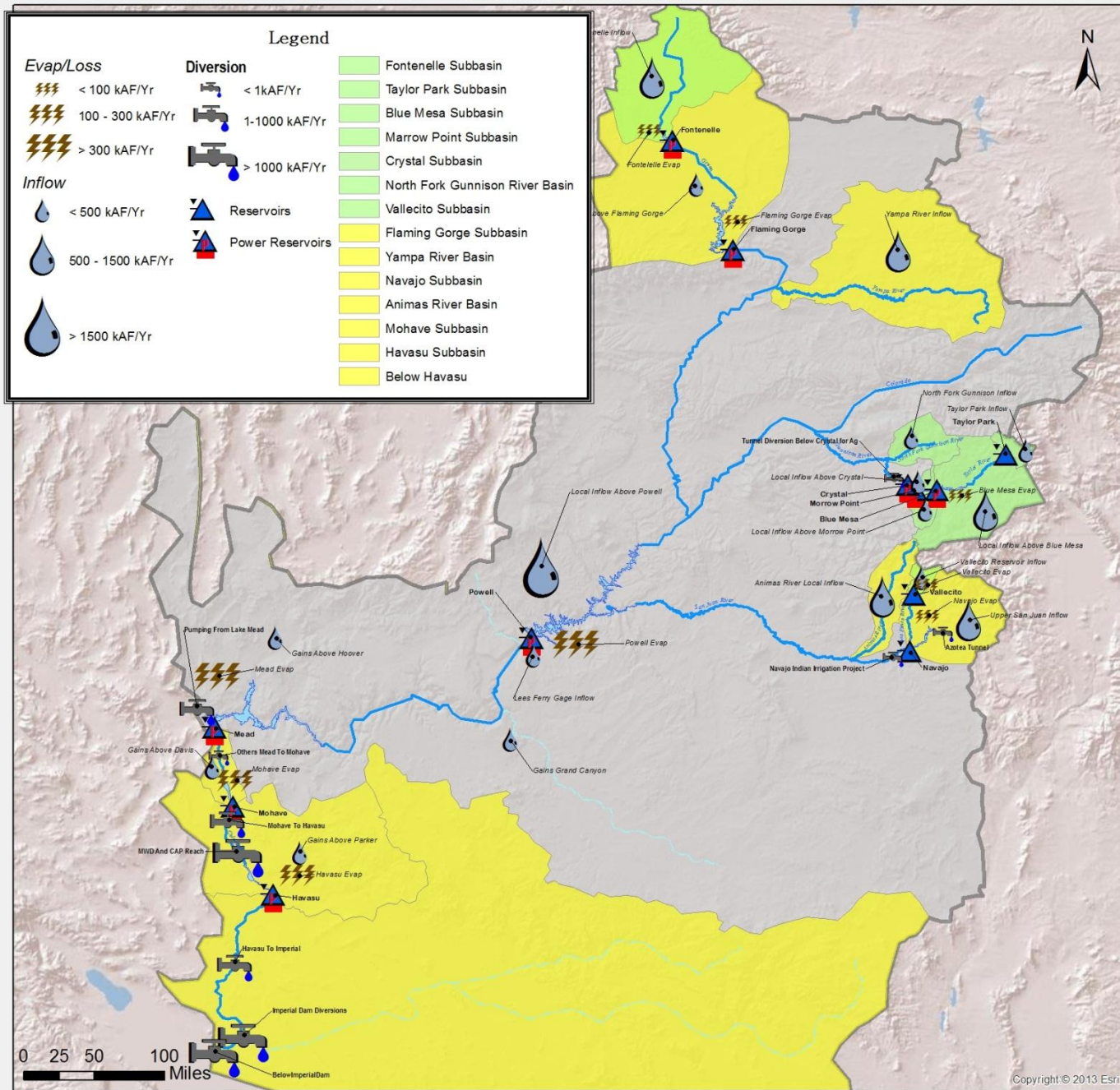
Colorado River Basin-Run Cycle 3
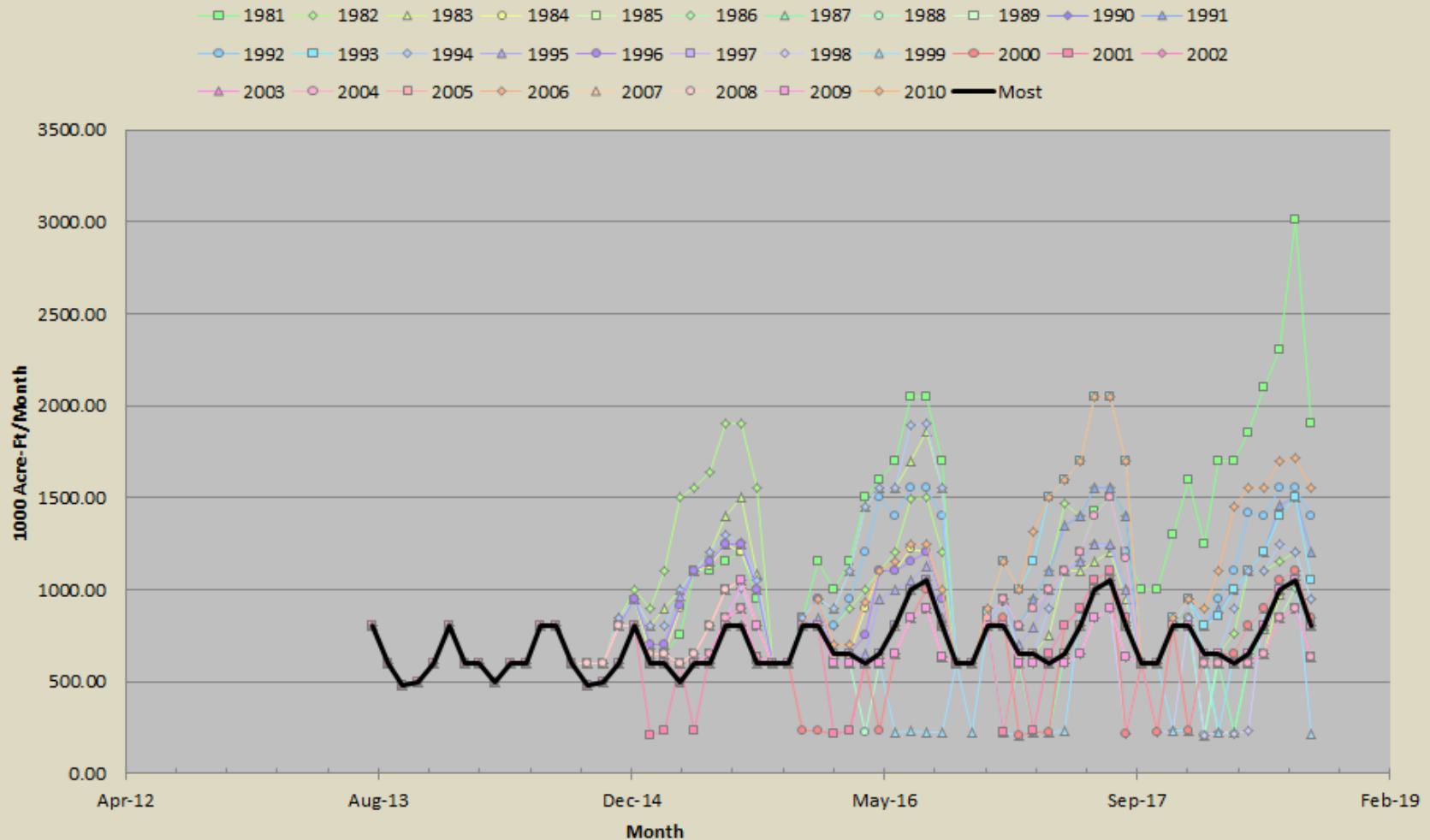
Colorado River Basin-Run Cycle 4

Output

- Each run will run a direct connect to excel DMI and send the appropriate data into a spreadsheet where output can be processed

- Allows for an easy interface between the model and excel for viewing and analysis of output from the MRM run
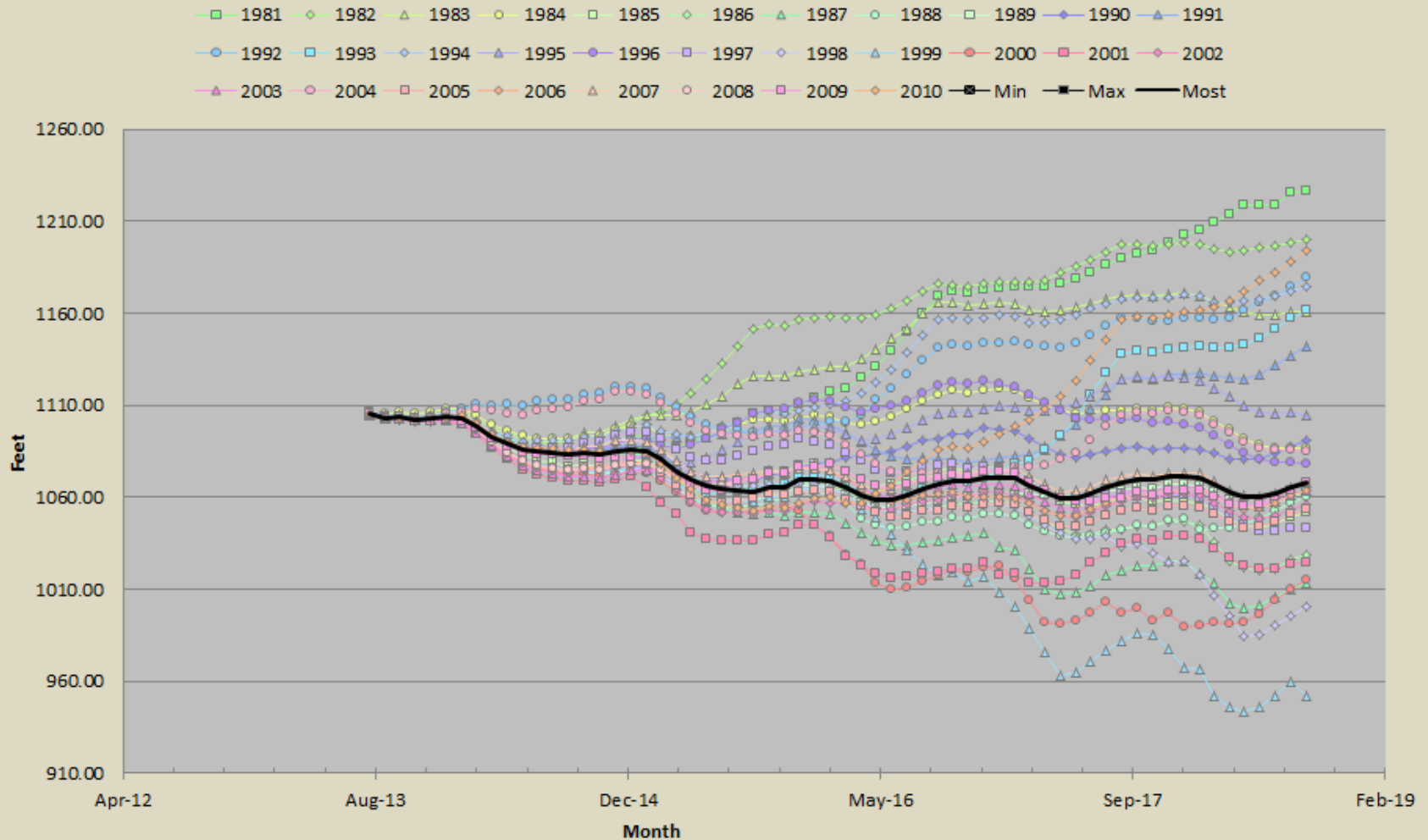
Output of Data

Powell.Outflow

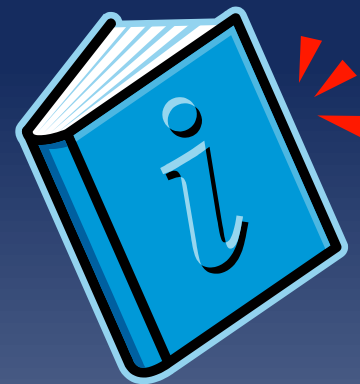# Output of Data

Mead.Pool Elevation

Probabilities of Powell Annual Releases

Next Steps

- Continue to validate the model

- Develop user manual and technical documentation

- Finalize process for distributing stakeholder report

- Develop more scenarios for more robust probabilistic analysis

Questions?