

RECLAMATION

Managing Water in the West

SEFM Case Study Altus Dam, OK

Workshop on Probabilistic Flood Hazard Assessment
January 29 – 31, 2013



U.S. Department of the Interior
Bureau of Reclamation

Acknowledgements

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- **Report authors: Nicole Novembre, Victoria Sankovich, Jason Caldwell, and Jeffrey Niehaus**
- **Modeling guidance and assistance provided by: Mel Schaefer and Bruce Barker of MGS Consultants**
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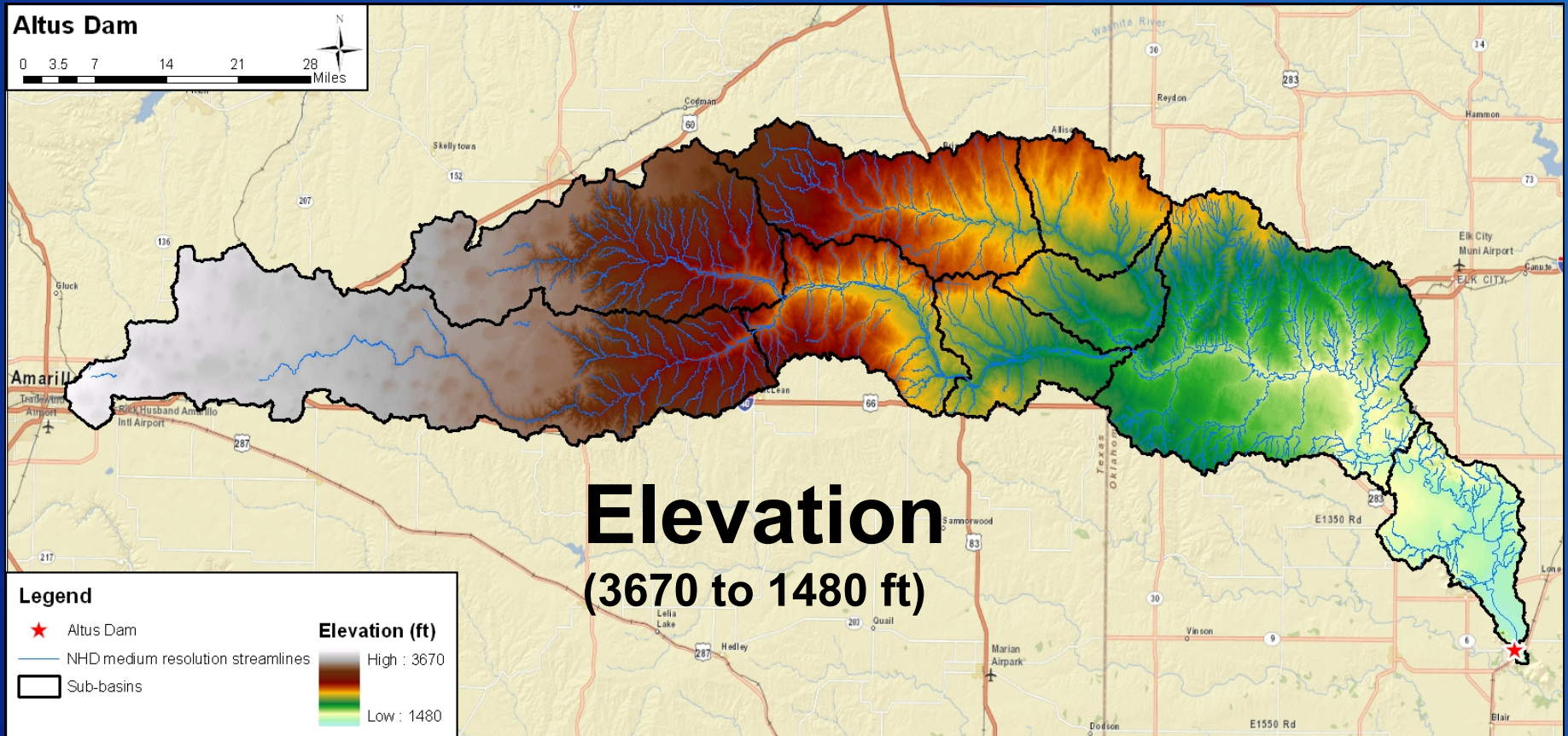
Topics:

1. Project background
2. Calibration
3. Production runs
4. Results
5. Comparison to EMA

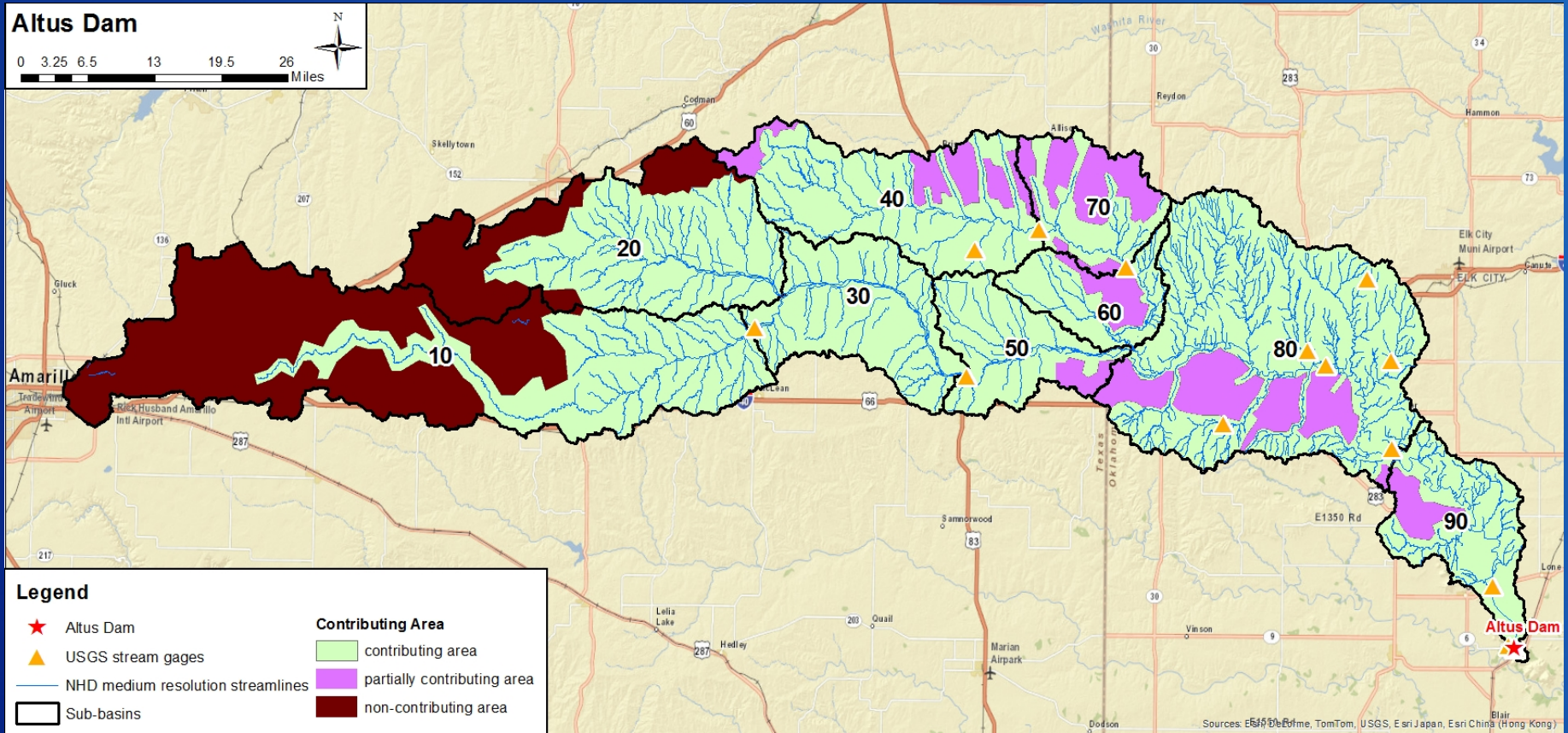


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Drainage Basin Elevation



Non-contributing Area



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Topics:

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2. Calibration

GOAL – estimate fixed parameters to be used in production runs.

Calibration parameters:

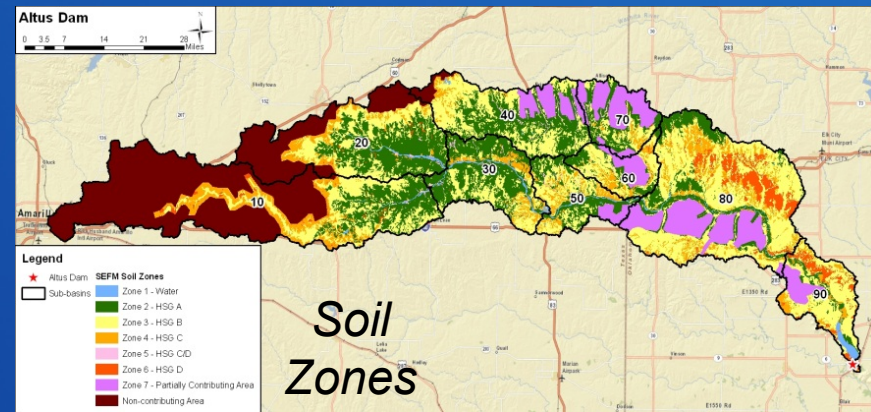
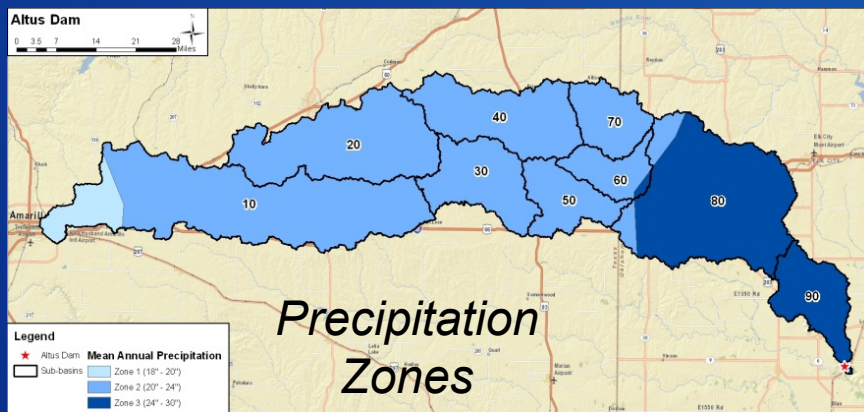
1. Soil infiltration parameters
2. Surface runoff parameters
3. Interflow parameters
4. Basin routing travel times

PROCESS – Select model parameters that produce results that most closely match observed flows.

Inputs for Calibration Runs

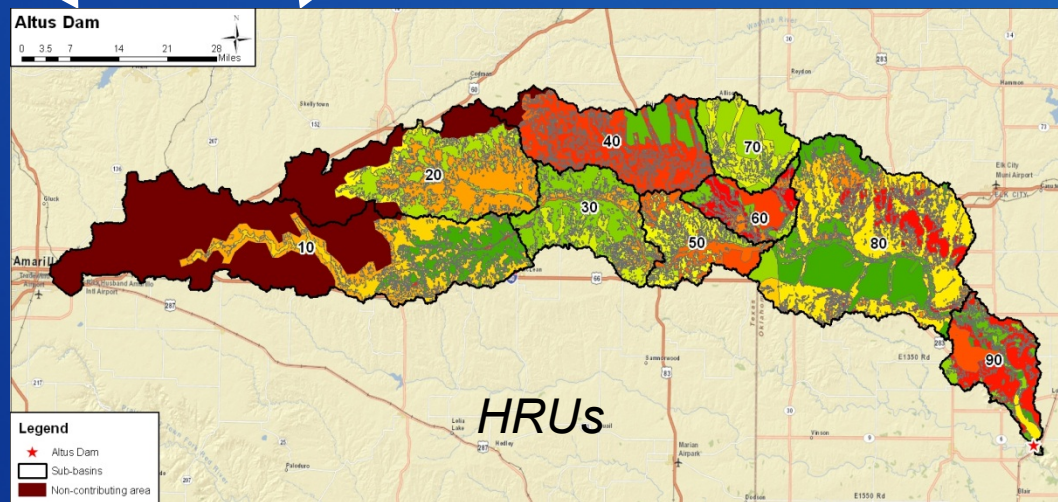
- a) Hydrologic Runoff Units (HRUs)
- b) HEC-1 Template
- c) Meteorological Inputs
- d) Hydrological Inputs

a) Hydrologic Runoff Units (HRUs)



Overlay:

- Precipitation zones (3)
- Soil zones (7)
- Elevation zones (1)
- Sub-basins (9)



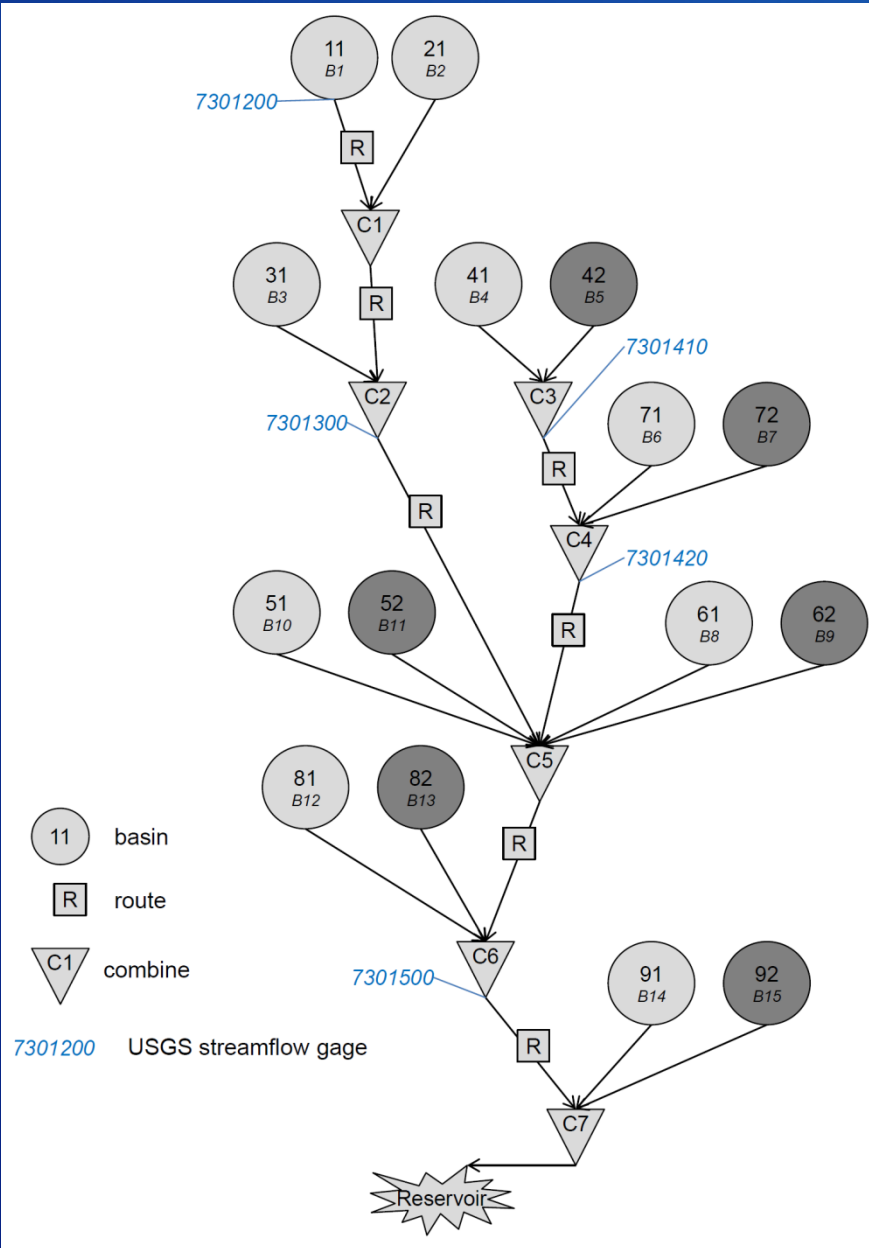
→ 64 HRUs

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b) HEC-1 Template

SEFM calculates runoff from each sub-basin.

HEC-1 defines connectivity and routing between the basins.



c) Meteorological Inputs

- Storm templates for each calibration storm
- Antecedent precipitation
- Evapotranspiration

d) Hydrologic Inputs

Streamflow observations for each calibration event

Provide range of parameters for calibration:

- **Soil infiltration parameters**
- **Surface runoff unit hydrograph parameters**
- **Interflow unit hydrograph parameters**

Soil Infiltration Parameters

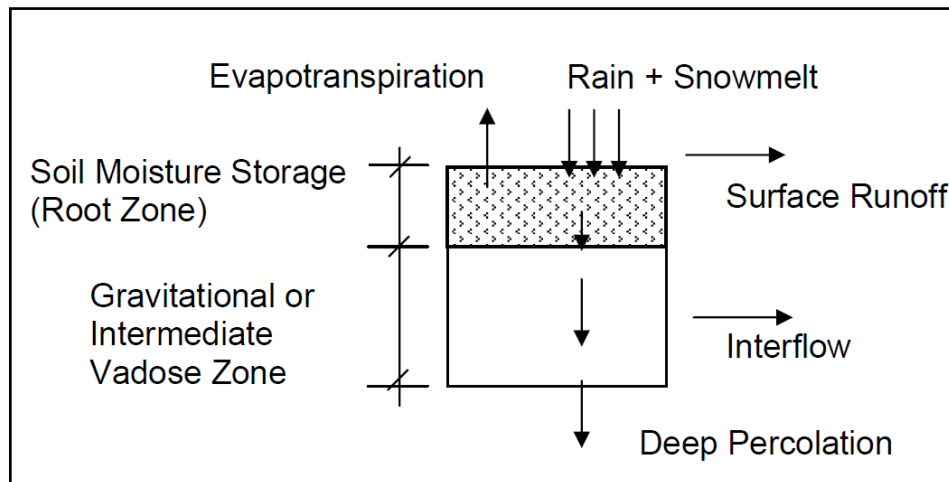


Figure 2-13.1 – Schematic of Soil Moisture and Runoff Processes Used in the Stochastic Model

$$F = (GIA) SMD^{IEXP} + FC \quad (2-13.1)$$

$$GIA = (F_{max} - FC) / SMD_{max}^{IEXP} \quad (2-13.2)$$

- where:
- F – is the surface infiltration rate (inches/hour),
 - GIA – is a soil zone specific constant that yields the maximum surface infiltration rate when the soil moisture content is equal to the wilting point,
 - SMD – is the soil moisture deficit (inches),
 - SMD_{max} – is the maximum soil moisture deficit, which equals the soil moisture storage capacity (inches)
 - $IEXP$ – is the infiltration exponent, default value is 1.4,
 - FC – is the minimum surface infiltration rate for the soil zone (inches/hour),
 - F_{max} – is the maximum surface infiltration rate for the soil zone (inches/hour).

Surface runoff unit hydrograph

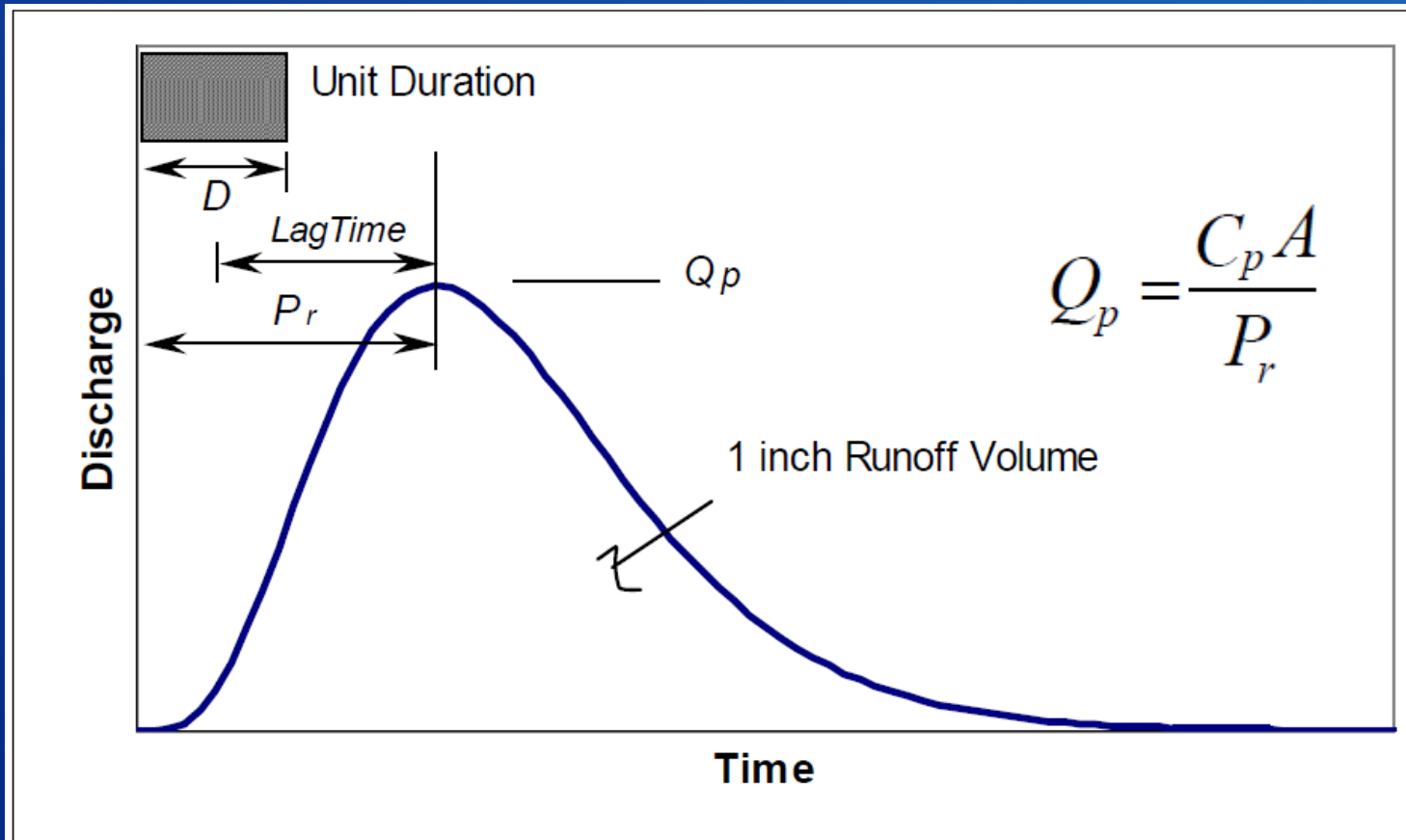


Figure 2-14.1 – Characteristics of Unit Hydrographs

(Schaefer and Barker, 2004)

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Interflow Parameters

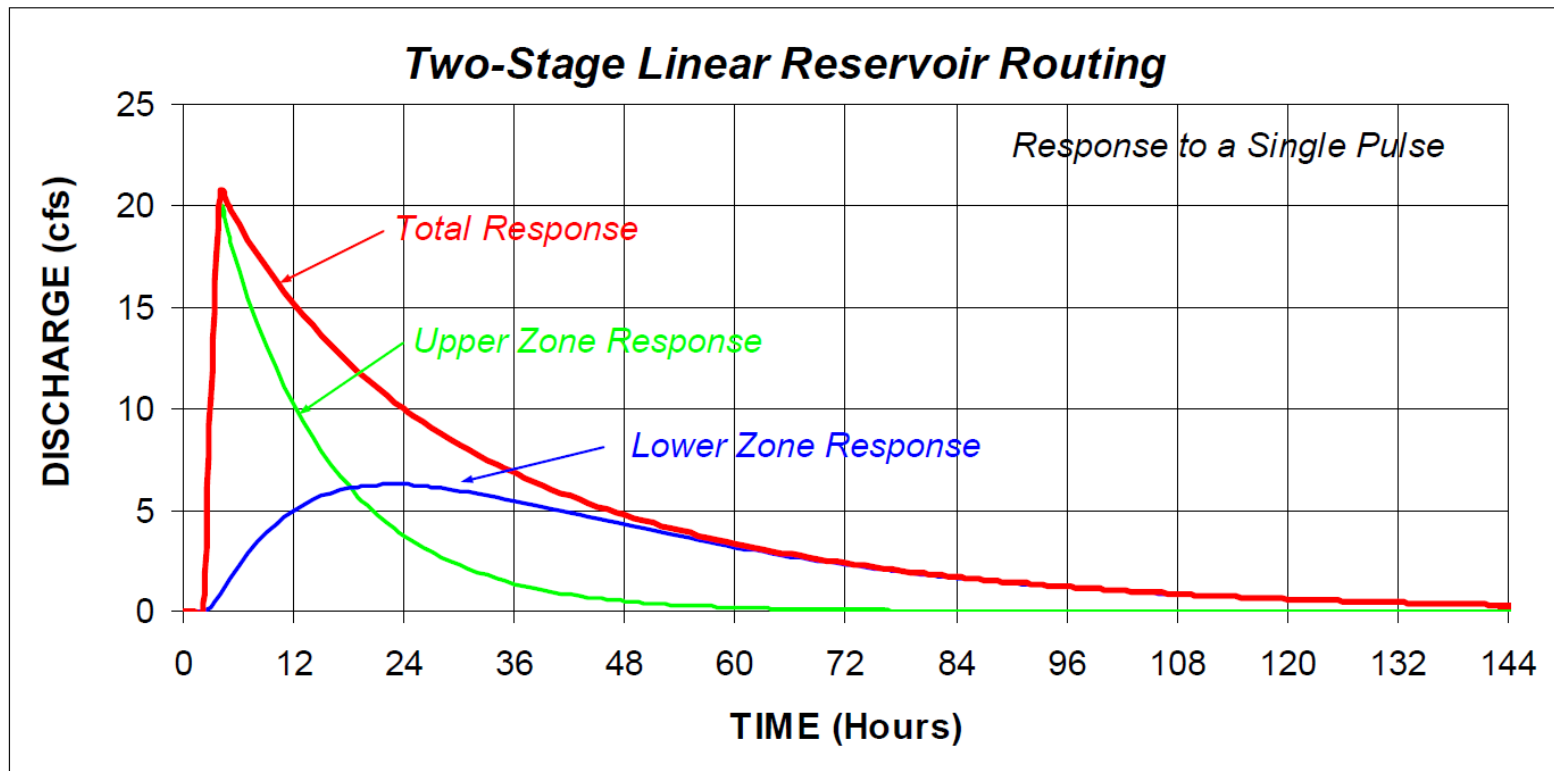


Figure 2-15.1 – Example of Two-Stage Linear Reservoir Routing for Interflow Runoff

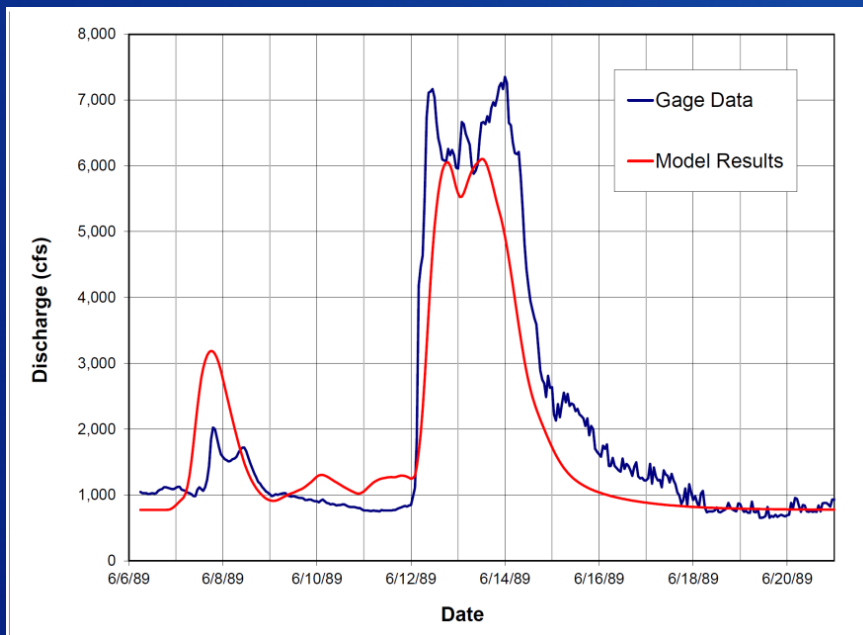
(Schaefer and Barker, 2004)

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Calibration Process

Generalized Likelihood Uncertainty Estimation (GLUE) method (Beven and Binley, 1992)

Compare model results to observed flows to determine best input parameters for the model:

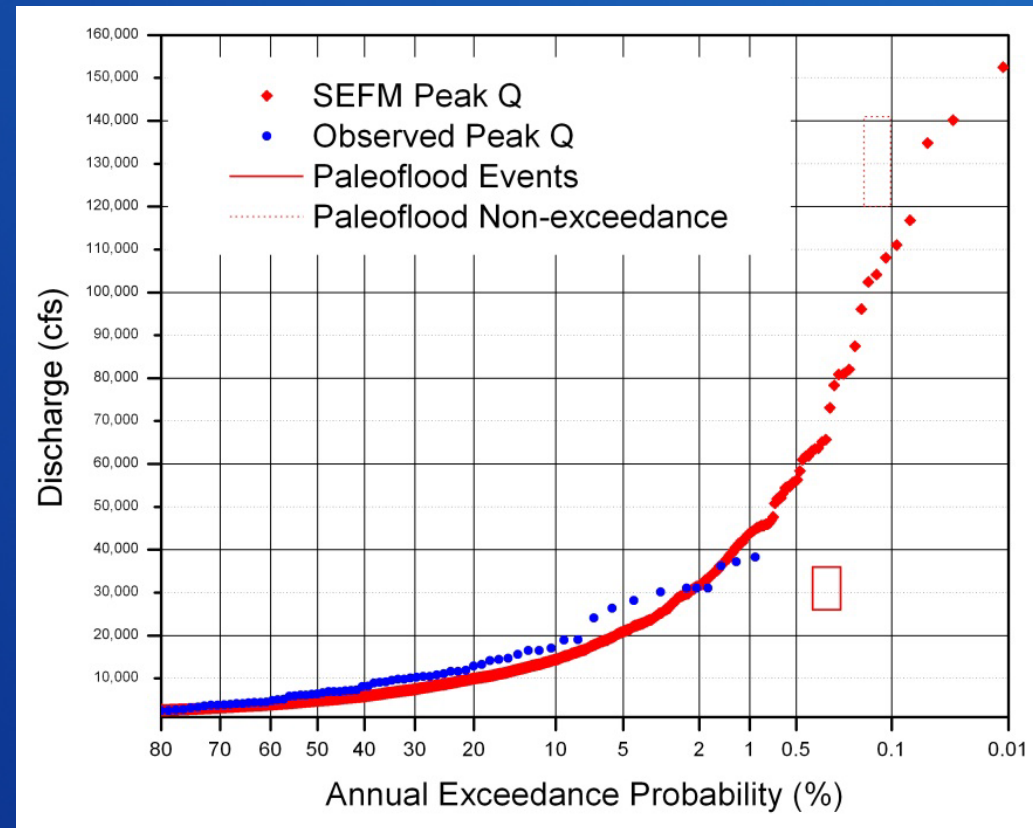


- Calculate goodness-of-fit measures
- Calculate % error for Q_p and V
- Visually compare hydrograph shapes

Calibration Process

Perform a frequency run and compare frequency curves from model to frequency curves from streamflow data.

- peak flows
- 24-hr mean flows
- 72-hr mean flows



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3. Inputs for Production Runs

- a) **Hydrologic Runoff Units (HRUs) – same as calibration**
- b) **HEC-1 Template – same as calibration**
- c) **Meteorological Inputs**
- d) **Hydrological Inputs**

c) Meteorological Inputs

- **Storm duration**
- **Storm volume (precipitation magnitude frequency)**
- **Storm templates (spatial and temporal distribution)**
- **Storm seasonality**
- **Antecedent precipitation**
- **Evapotranspiration**

d) Hydrologic Inputs

- **Antecedent soil moisture**
- **Soil moisture at start of climatic year**
- **Antecedent streamflow**
- **Initial reservoir elevation**

- **Calibrated values:**
 - **Soil infiltration parameters**
 - **Surface runoff unit hydrograph parameters**
 - **Interflow unit hydrograph parameters**

Production Runs

- **Specify the number of runs**
- **Specify the plotting position**
- **Run SEFM:**
 - **SEFM selects a month of storm occurrence**
 - **A storm template is selected and scaled**
 - **Parameters are selected based upon month**
 - **HEC-1 input files generated for each simulation**

Production Runs

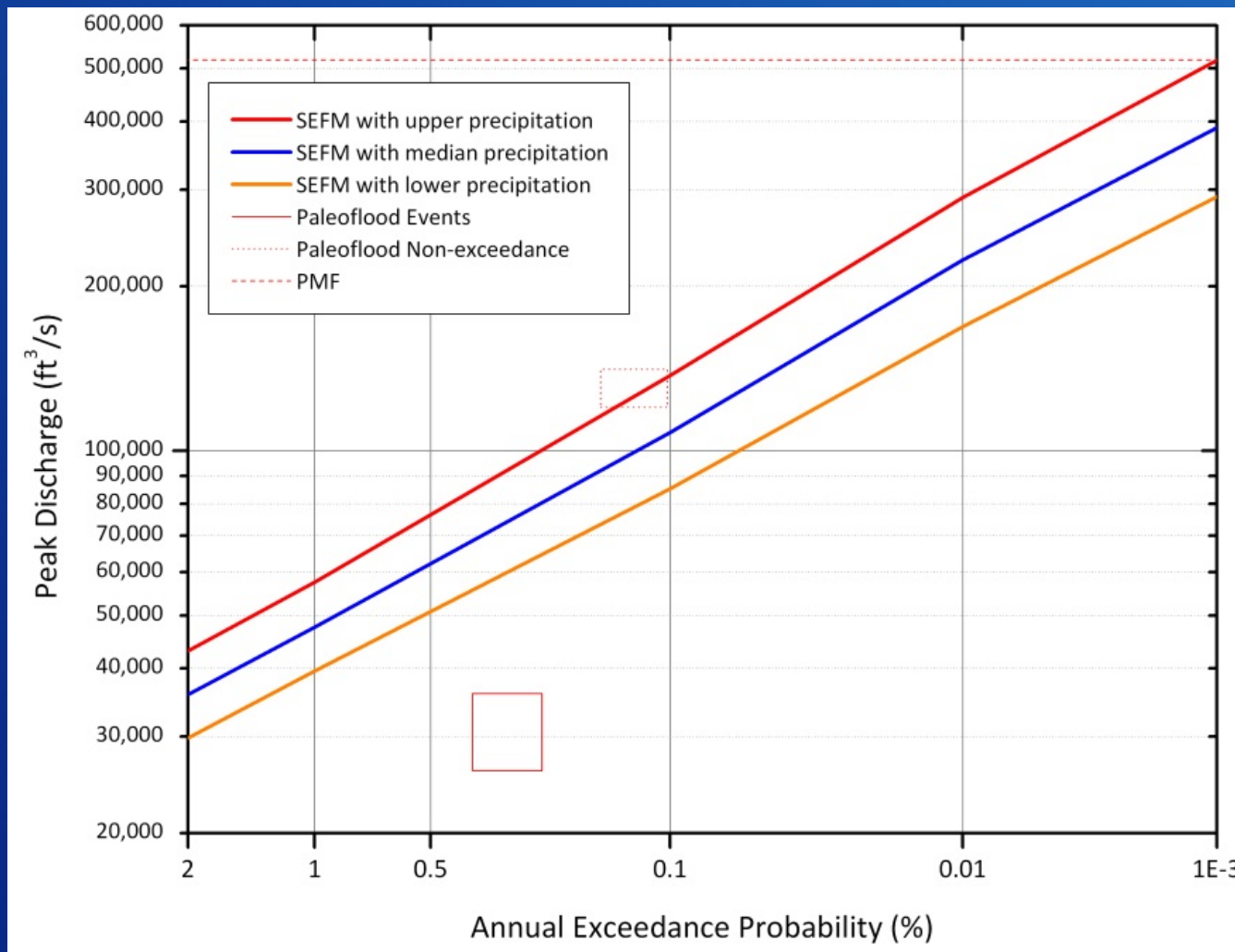
- Run HEC-1 batch file
- Import HEC-1 output files into SEFM
- Events are ranked to develop frequency curves

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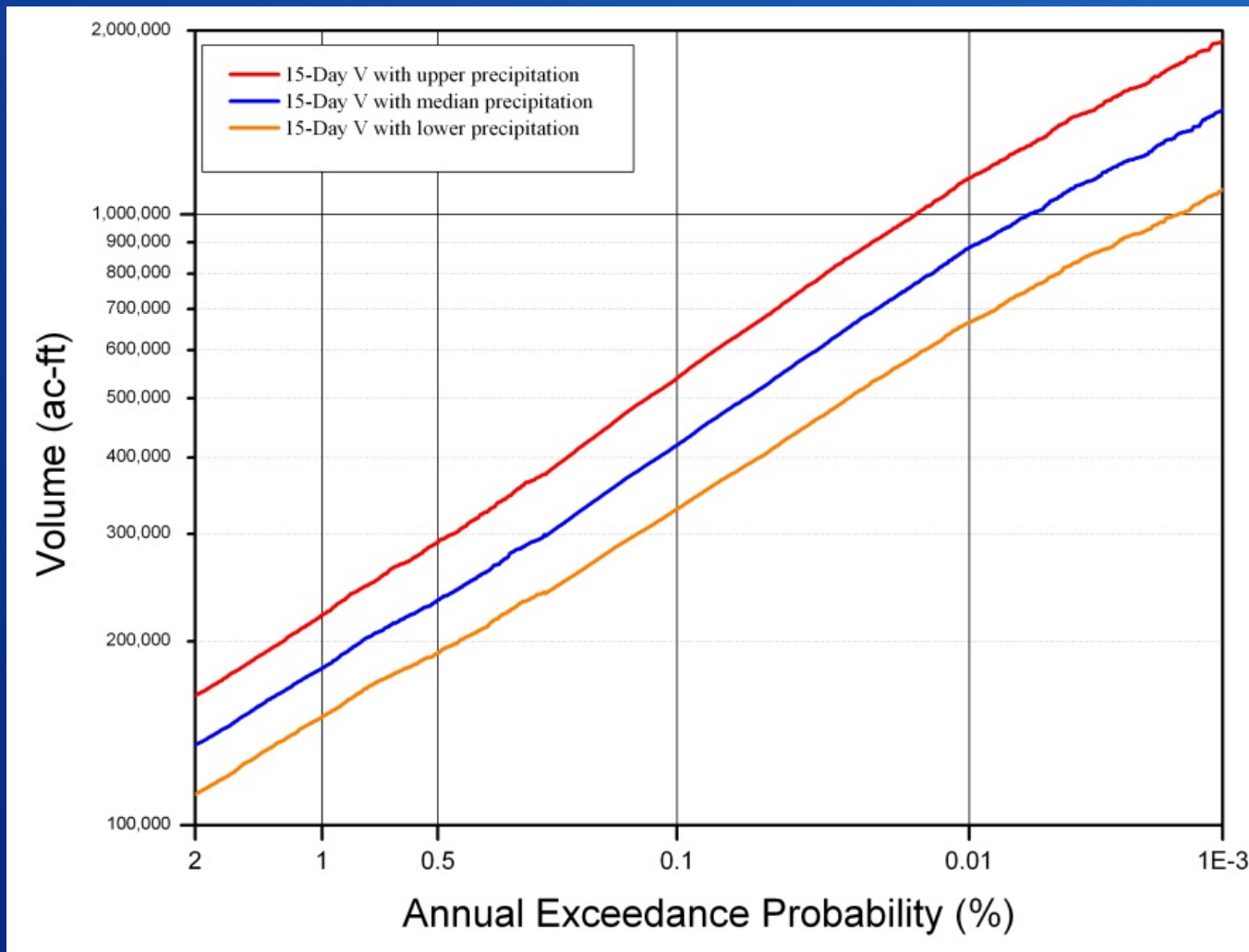
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Peak Discharge frequency curves



Red – 95th percentile precipitation
Blue – 50th percentile precipitation
Orange – 5th percentile precipitation

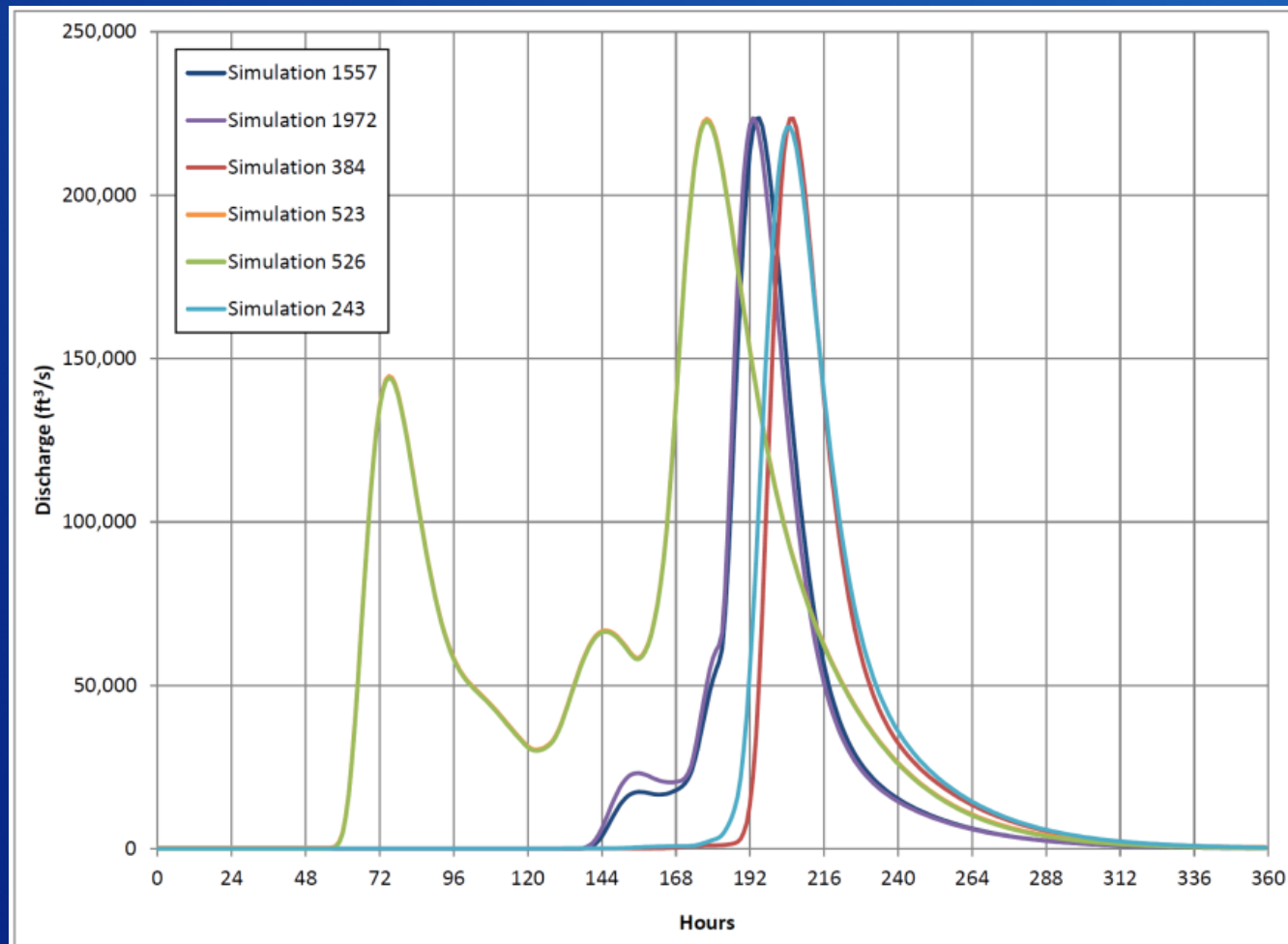
15-day volume frequency curves



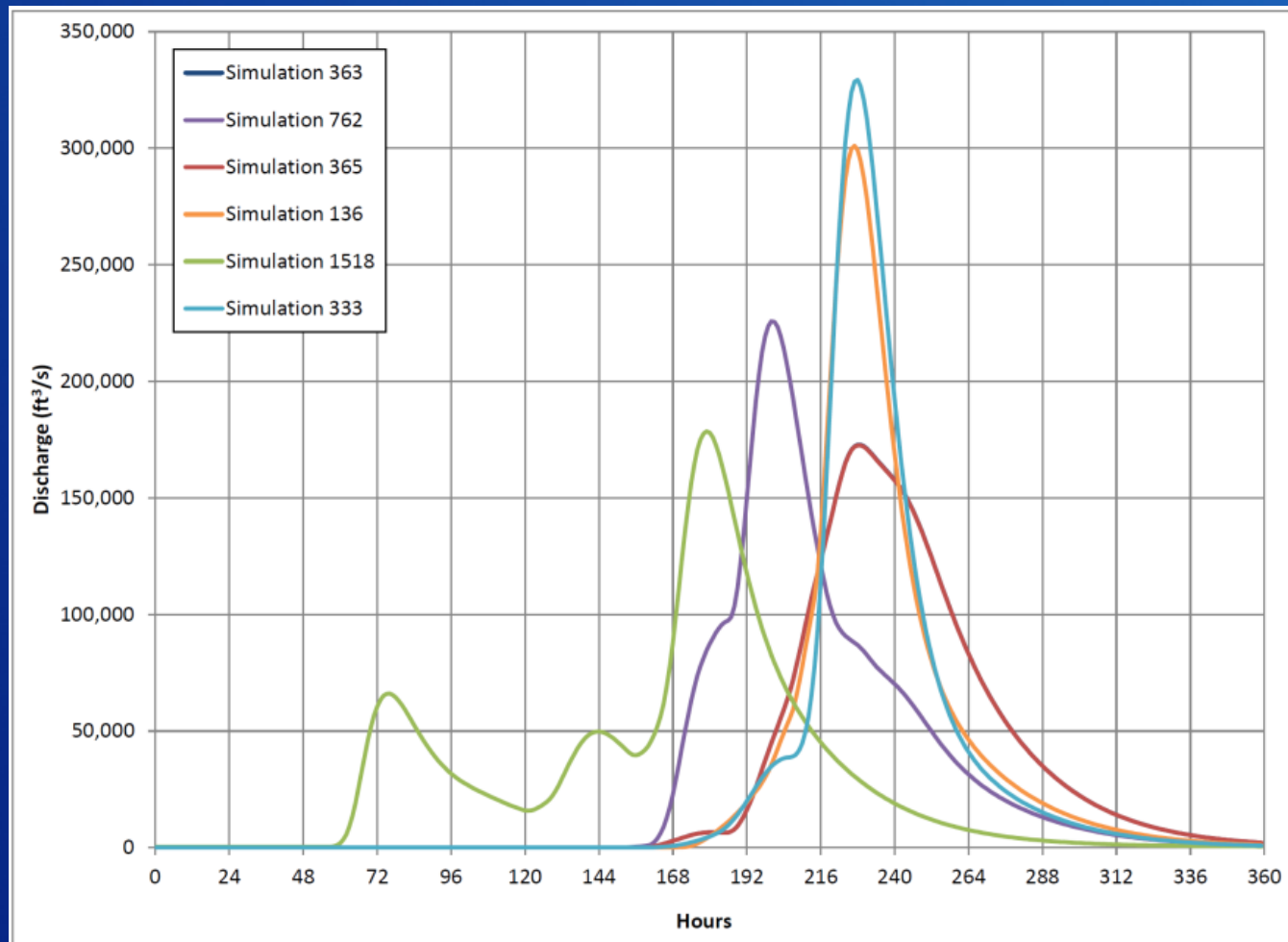
Red – 95th percentile precipitation
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10,000-yr Hydrographs based on Peak Discharge

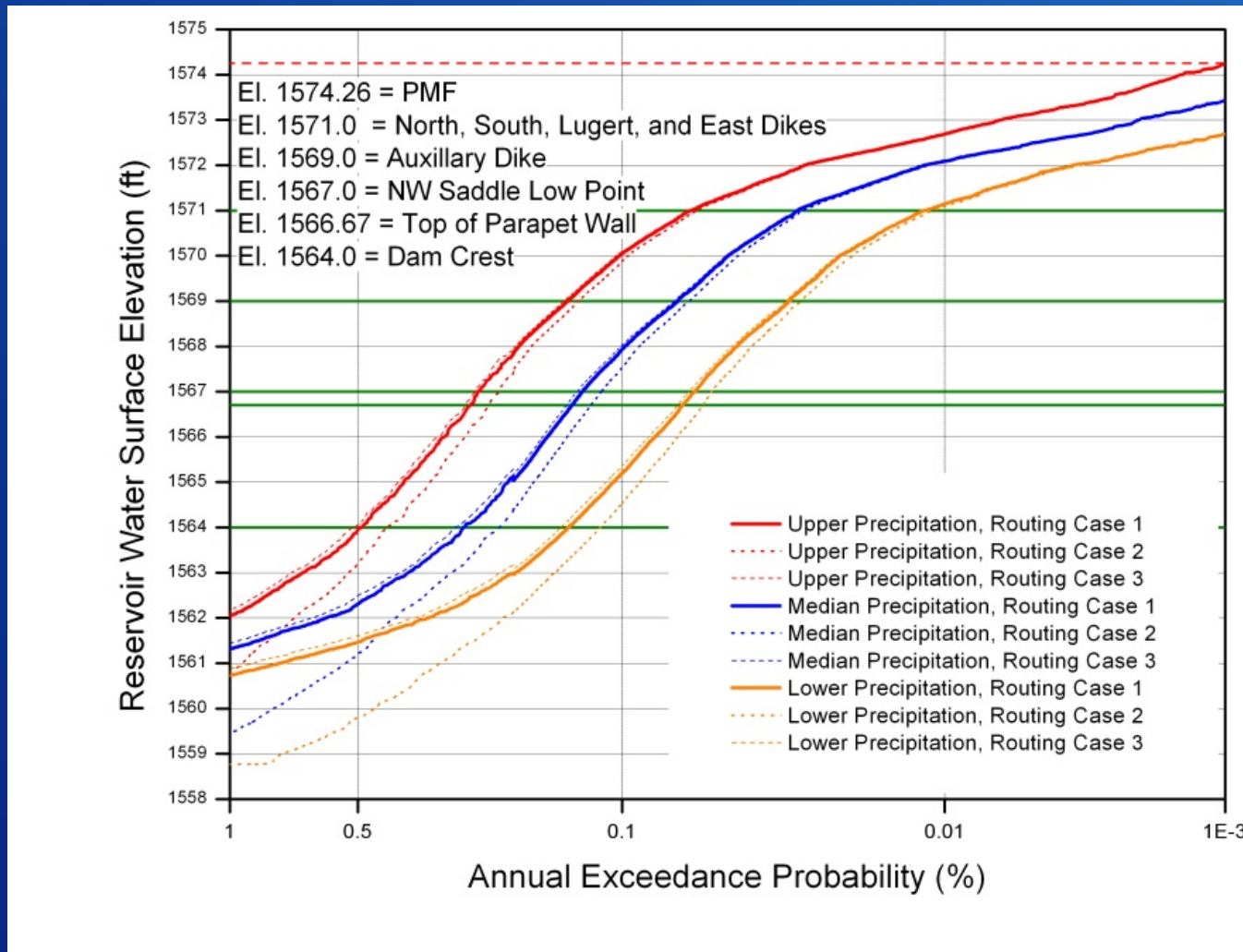


10,000-yr Hydrographs based on Volume



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Reservoir elevation frequency curves



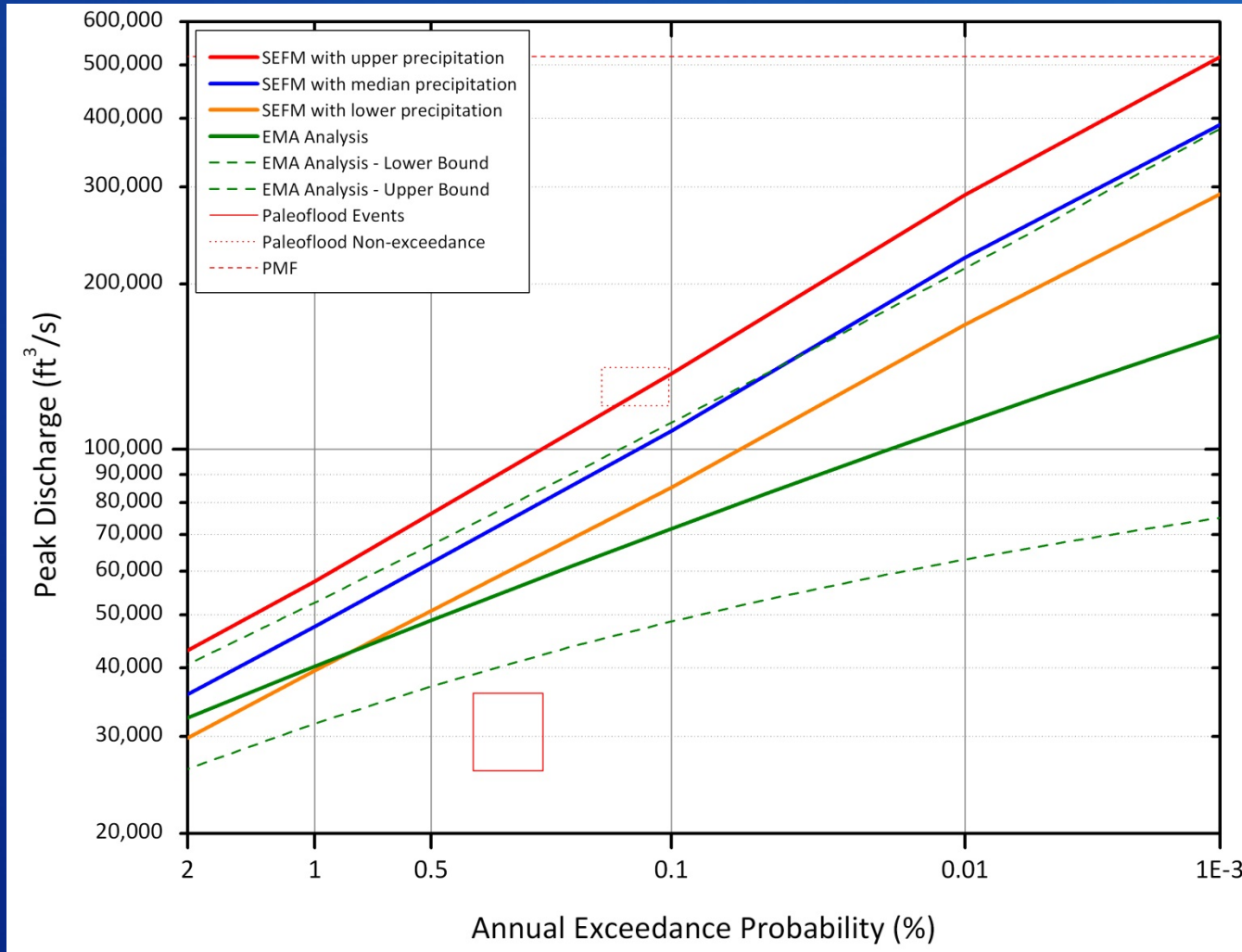
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Comparison to EMA with paleoflood data



Thank You

Questions?

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