Using HEC-WAT to conduct a PFHA on a medium watershed

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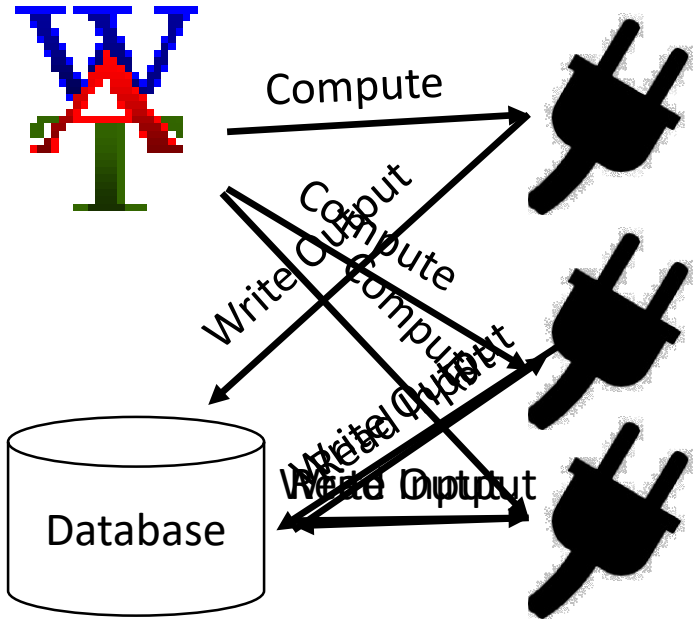
Brief overview of HEC-WAT

- HEC-WAT Manages Watershed-wide System Based computes through plug-ins
- Plug-ins interact with each other through a centralized database



Repeat!

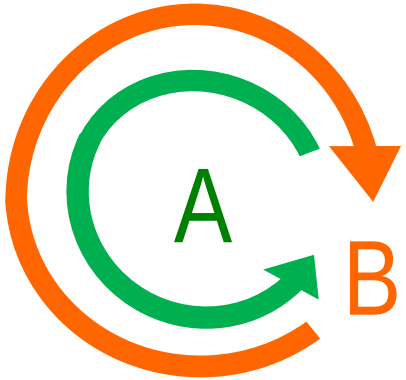
How do we capture a distribution of uncertainty in Output Metrics?

Nested Monte Carlo: *HEC-WAT/FRA*

A. Sample instances of natural variabilities as flood *events*, with enough events to capture the distribution of damage

B. Sample instances of knowledge uncertainties in model parameters to get their impact on the damage distribution

1 outer loop B = a realization



inner loop A varies natural variabilities, computes EAD

outer loop B varies knowledge uncertainty, computes EAD distribution

Sampling Variability and Uncertainty

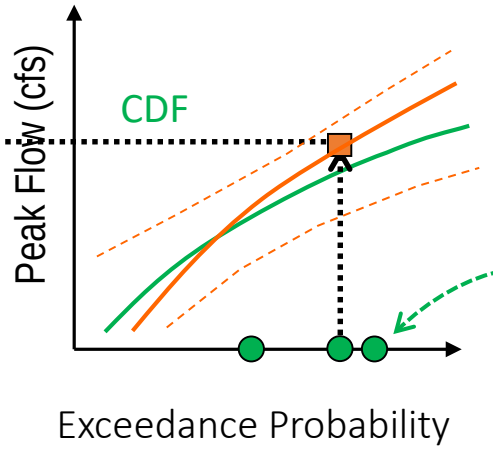
Nested Monte Carlo Simulation

sample new frequency curve (uncertainty)

and then sample events (variability)

Reservoir Analysis
Channel Hydraulics
Levee Behavior
Spreading Model

hydrographs



Random choice of probability ~ $U_i[0,1]$ to "generate" event

One Event: sample member i

sample uncertain model parameters

sample variabilities

stage

Inundation Mapping
Structure Inventory
Damage to Structures

output

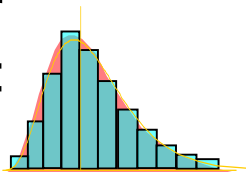
Output(i)

…still end with a sample of outputs

One Realization

For each realization, get an output estimate

After repeating for many realizations:

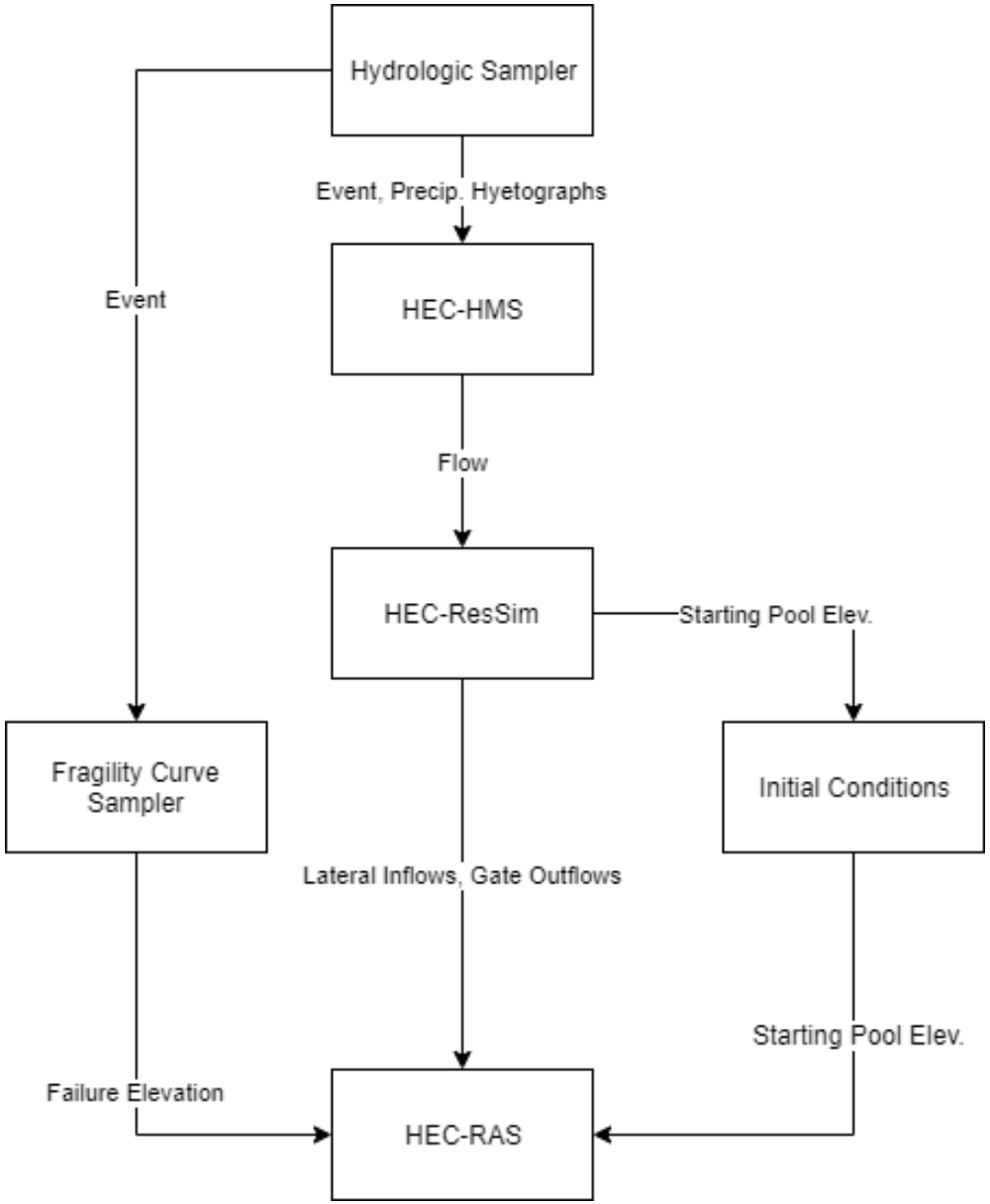


Distribution of Output

EV = 1/nSum(Output(i))

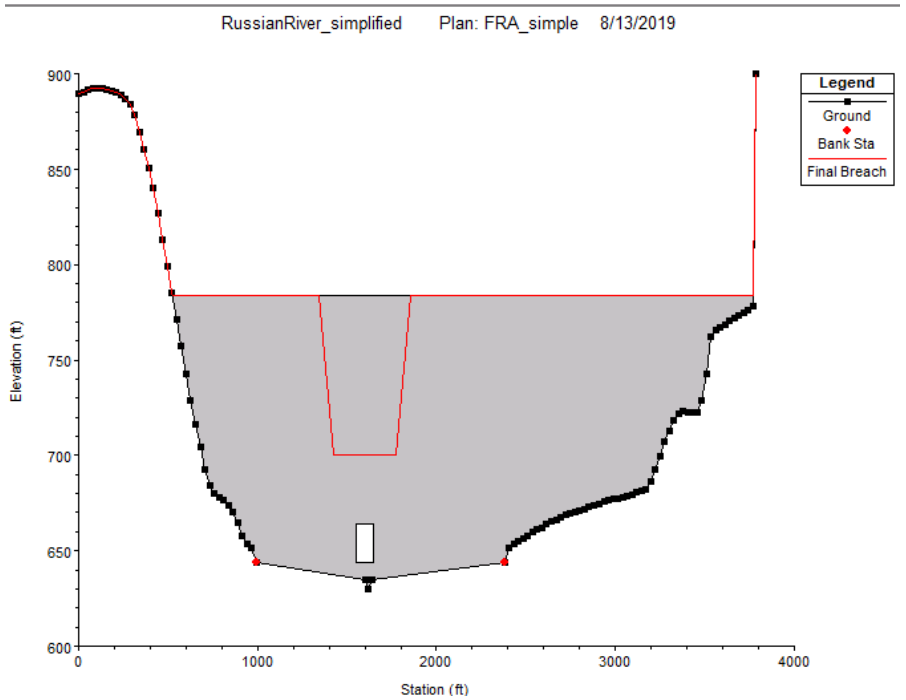
What is an “Event”?

- Precipitation Events
- Reservoir Regulation
- Dam Failure
- Hydraulic modeling

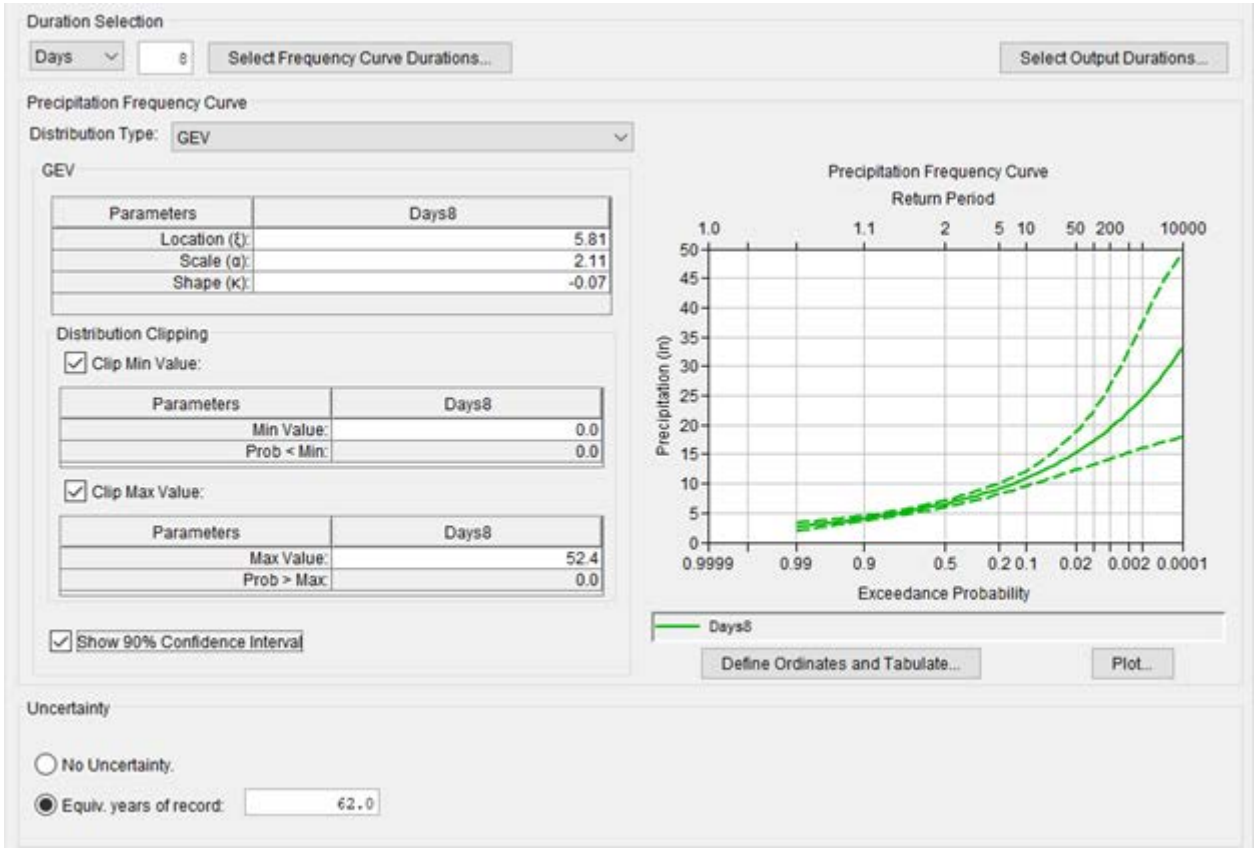


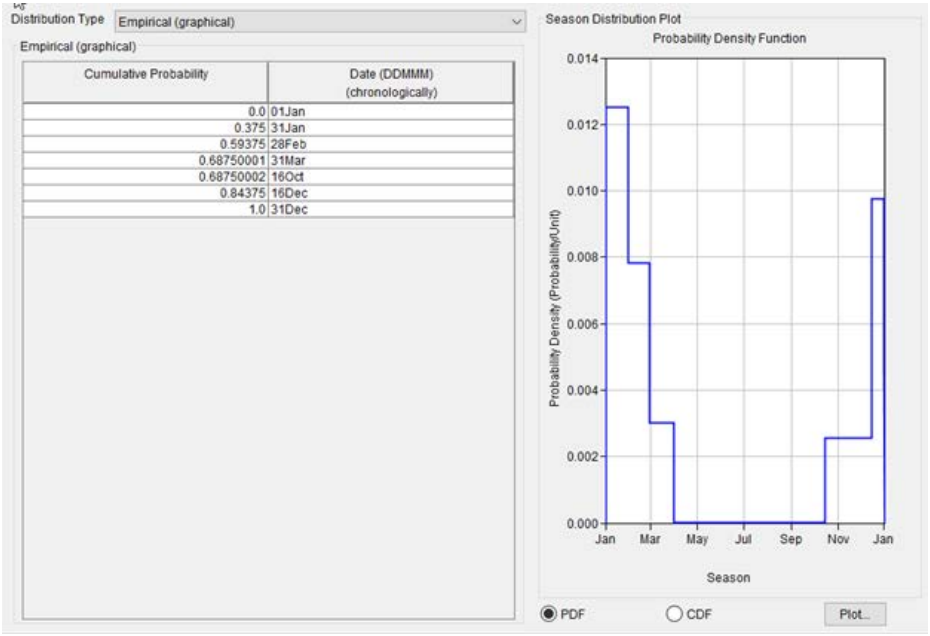
Watershed

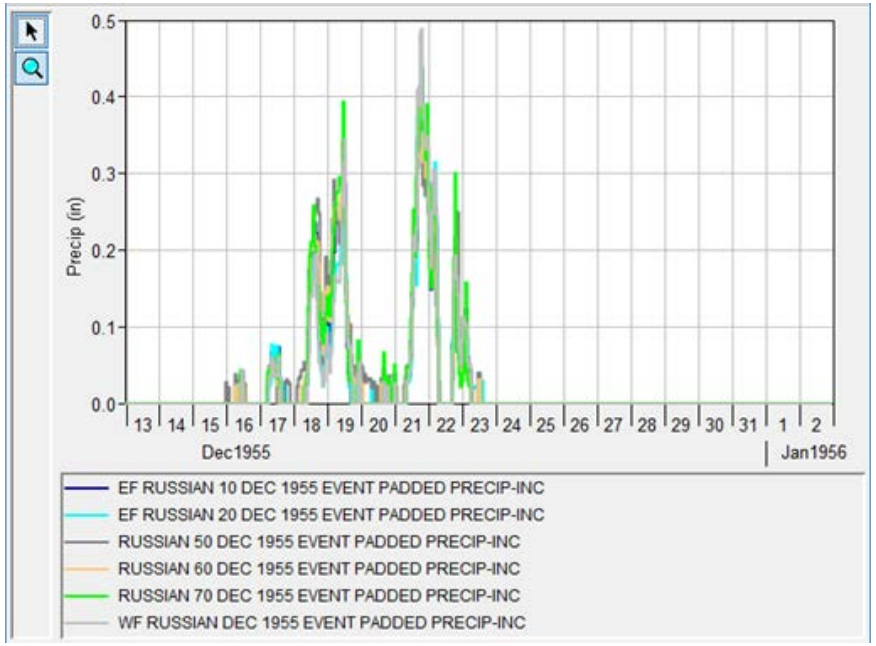
- Russian River, Sonoma County California
- 1,485-square-mile watershed from the Coast Ranges in northern California
- Lake Mendocino, Coyote Valley Dam
- Outputs were stored at three downstream locations (in Red).



Precipitation Frequency

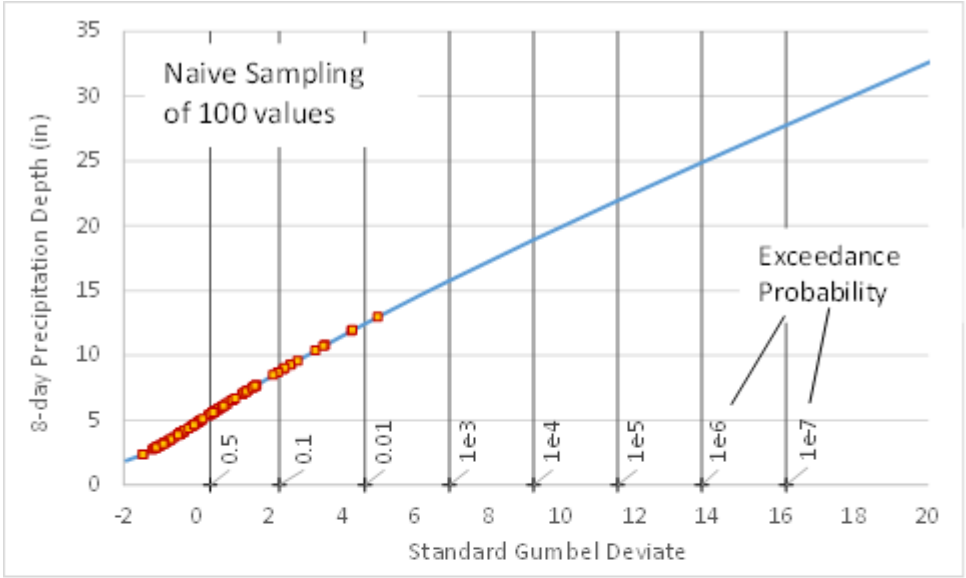


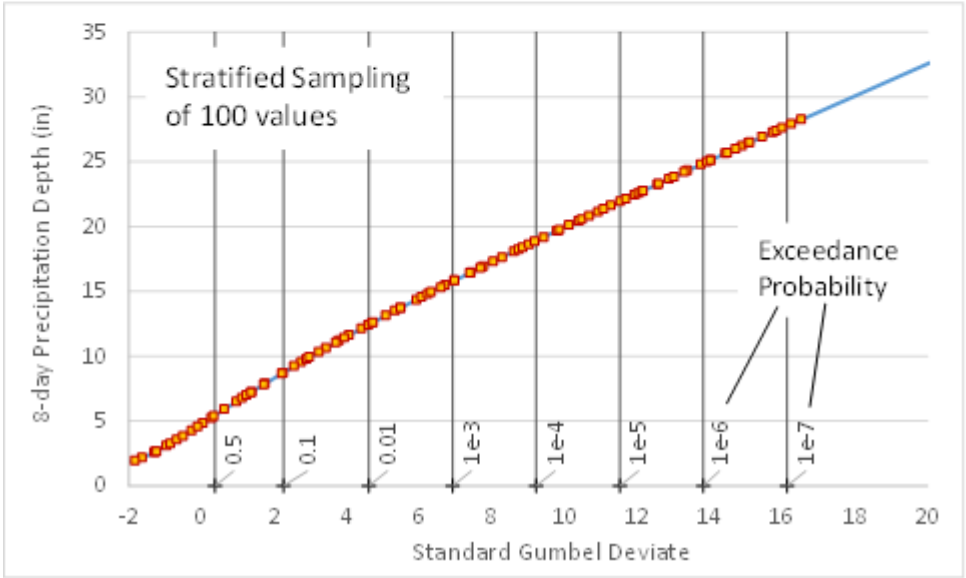




Stratification

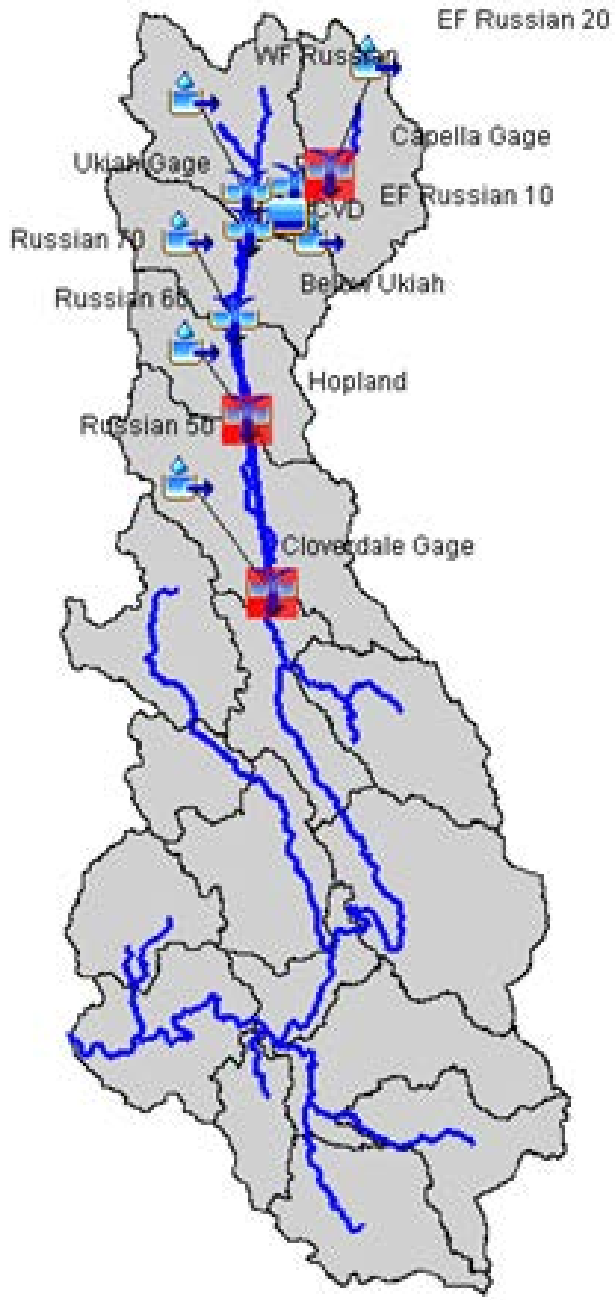
- In order to achieve sufficient modeling samples we stratified the Natural variability loop



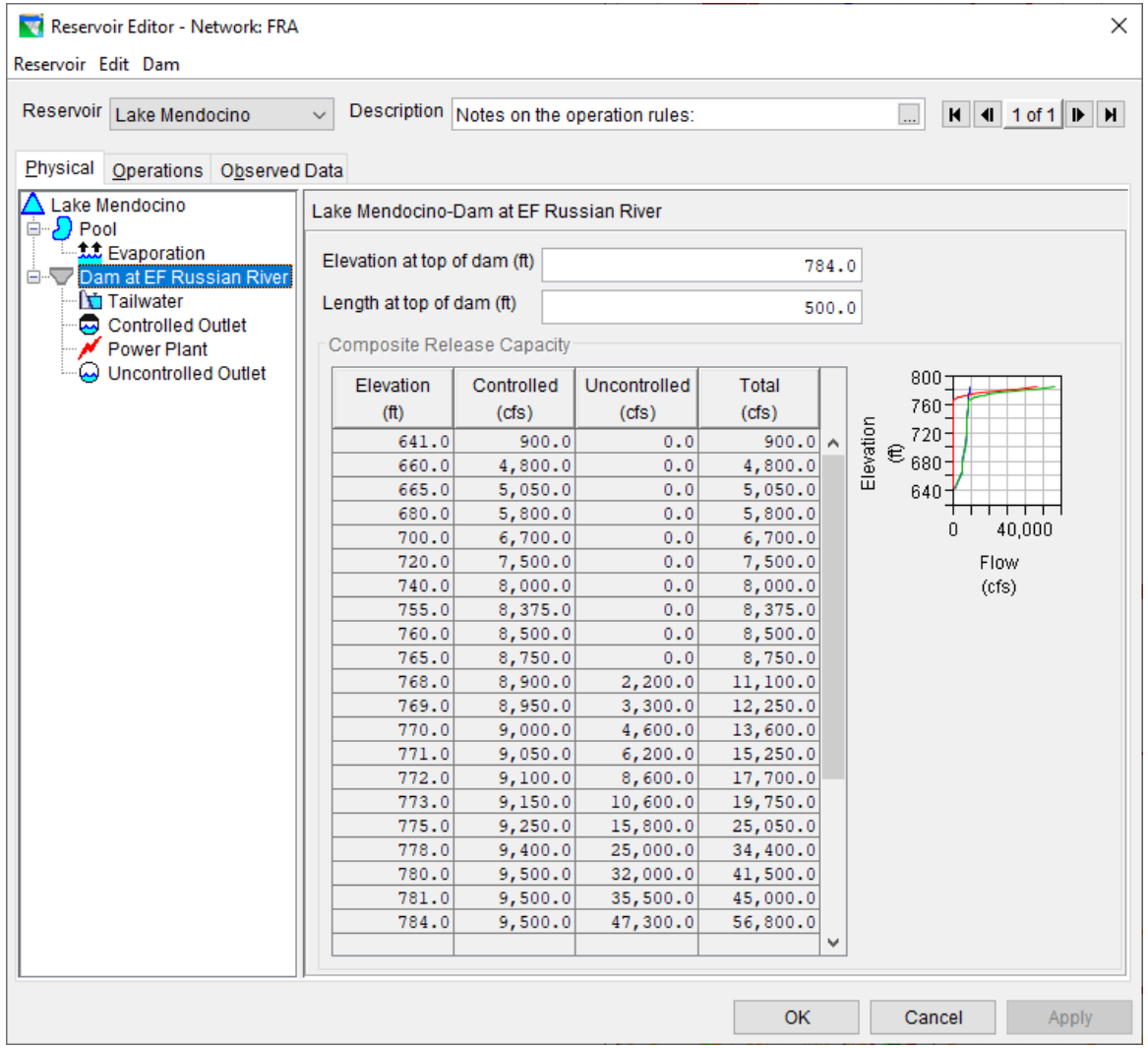


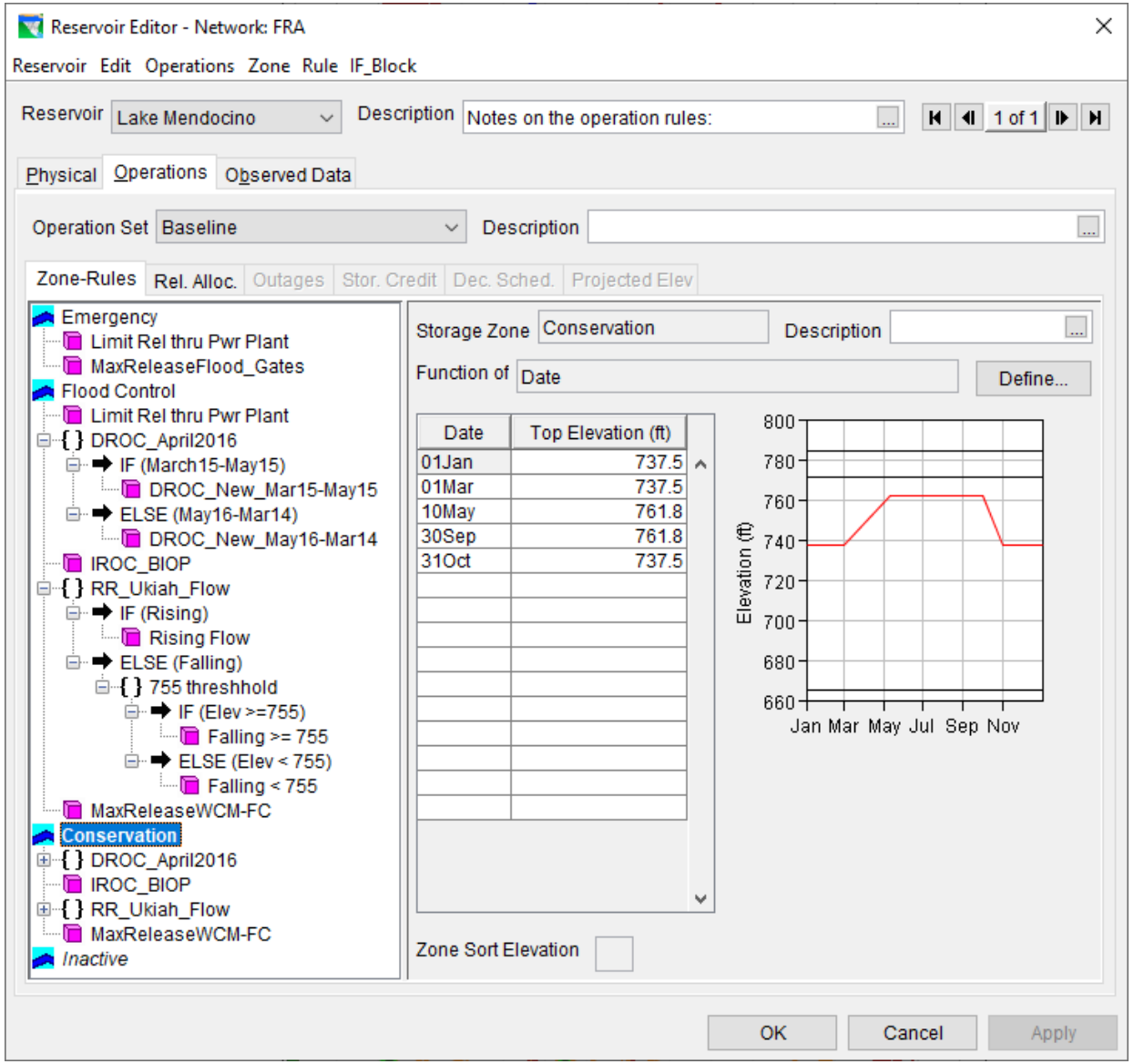
Rainfall Runoff

- Precipitation generated by the Hydrologic Sampler were provided to HEC-HMS
- Each basin receives a unique hyetograph for the shape set selected
- Basin outflows are mapped to HEC-RAS lateral inflows



Reservoir Operations





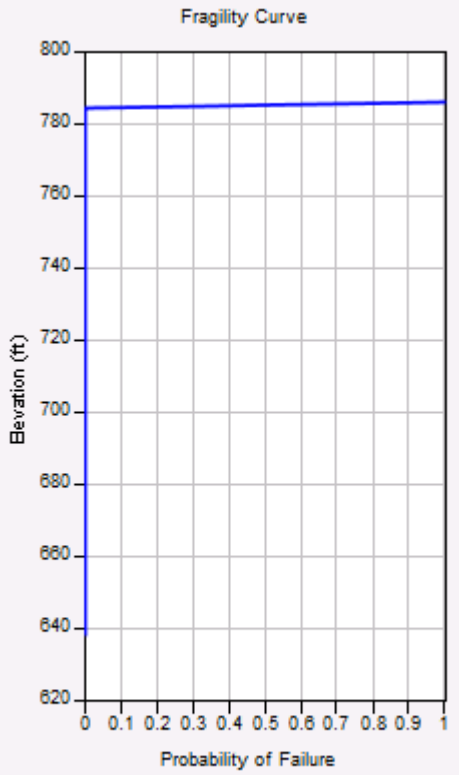
Dam Failure

Randomize every: Event

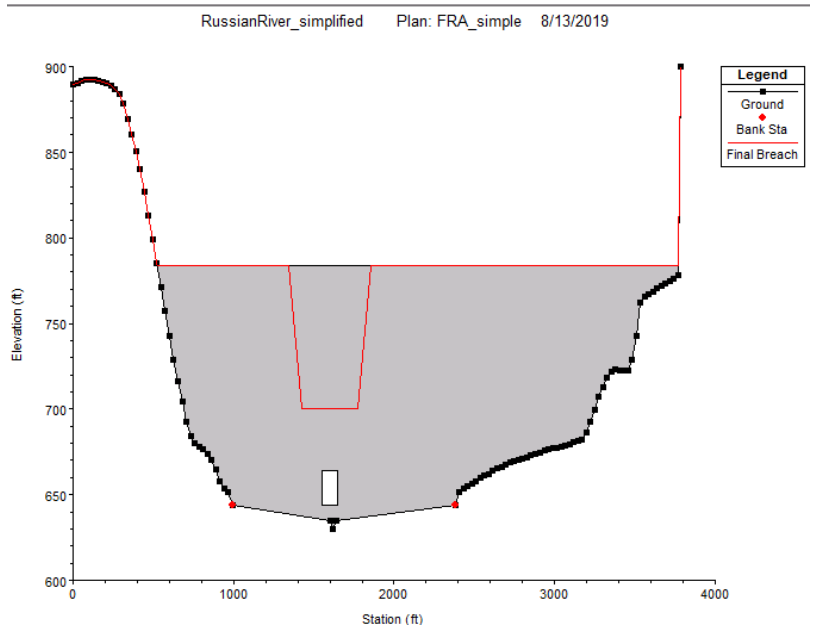
Levee: DAM

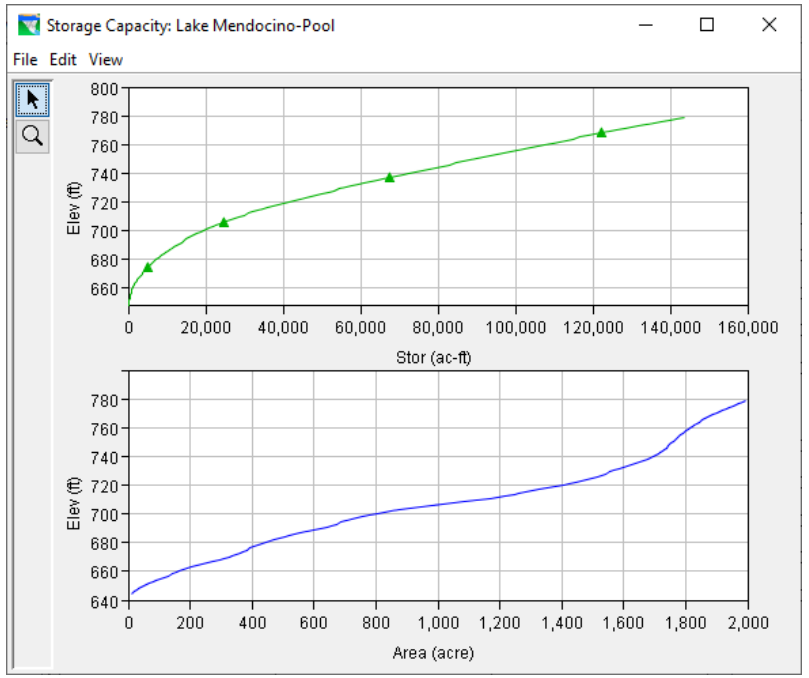
Failure Location: InlineStructure

Elevation (ft)	Prob. of Failure
638.0	0.0
638.1	0.000010
784.0	0.000011
786.0	1.0



OK Cancel Apply

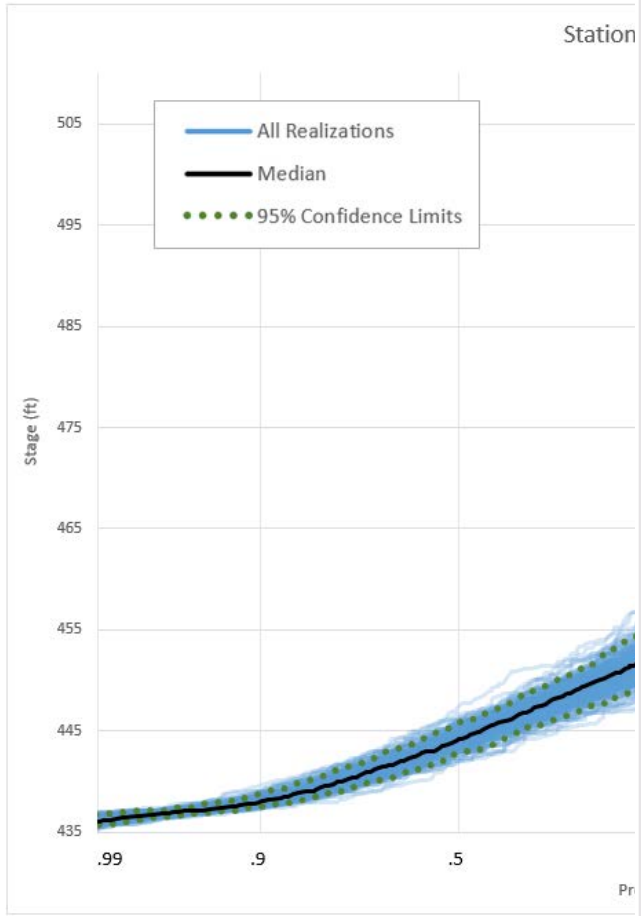


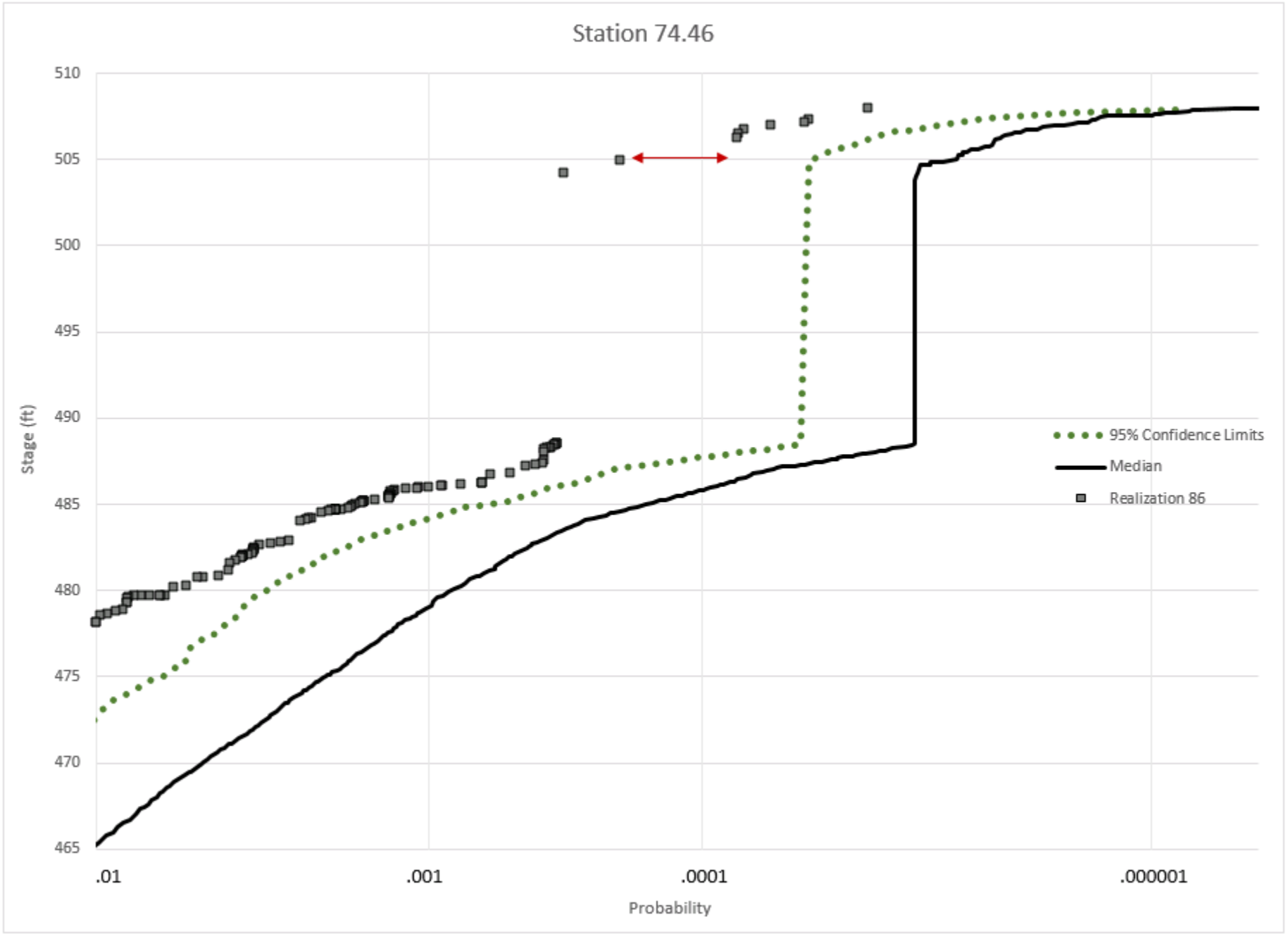


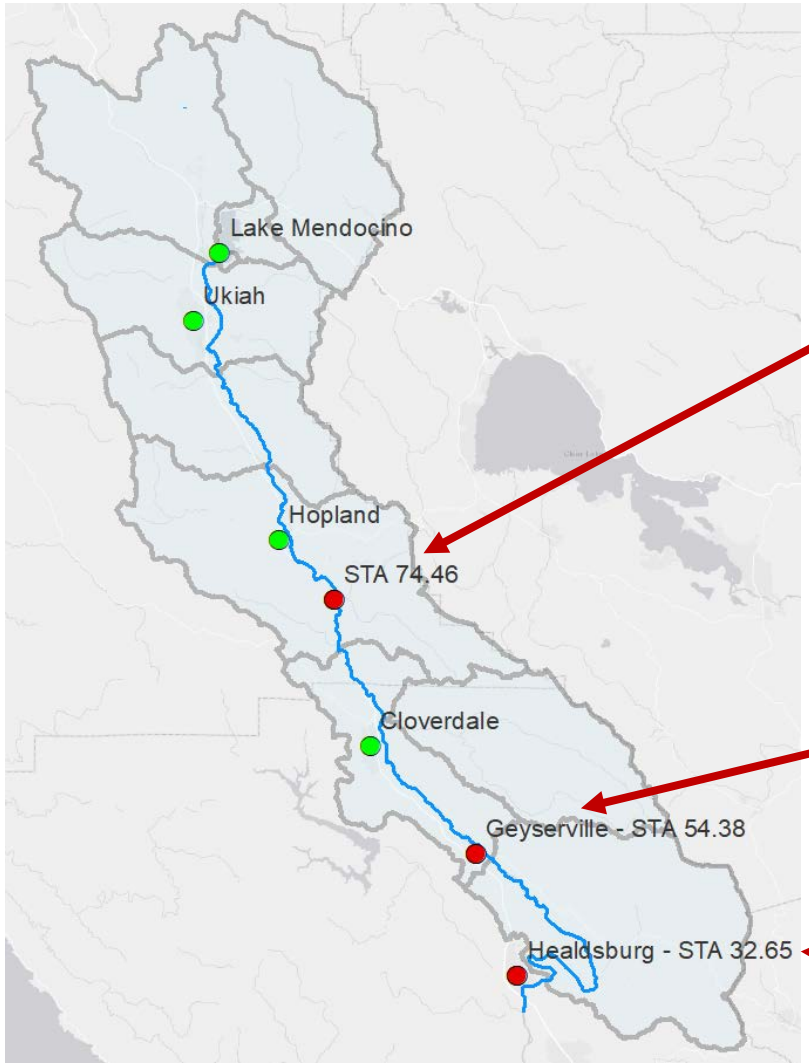
Hydraulic Modeling

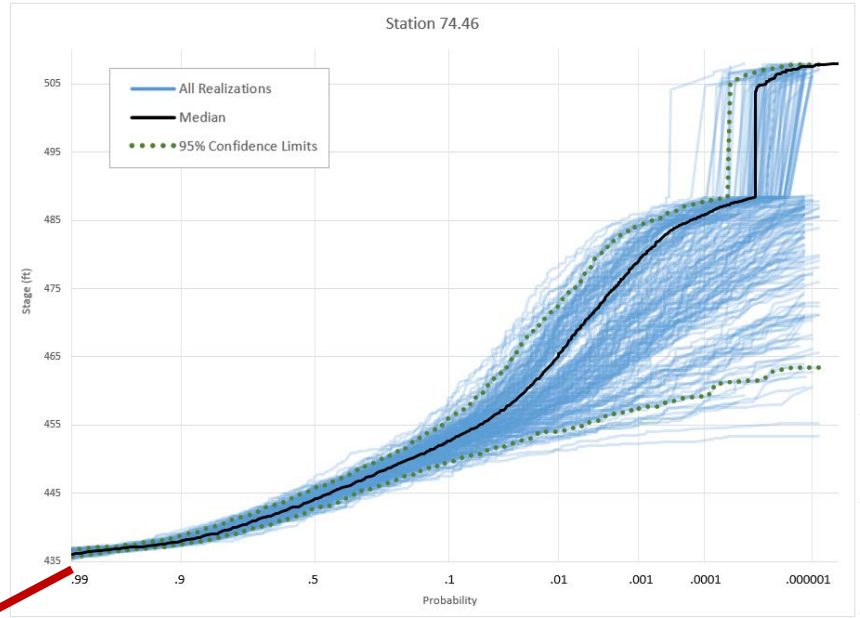
- The Starting Pool Elevation for ResSim was used to set the initial pool for RAS
- Releases from the gate in the inline structure were set to be overridden by ResSim

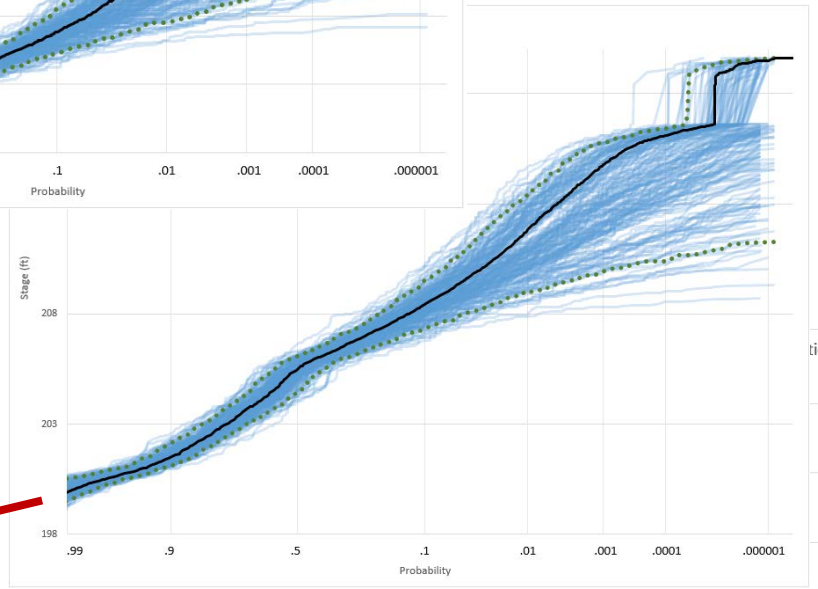
Outputs

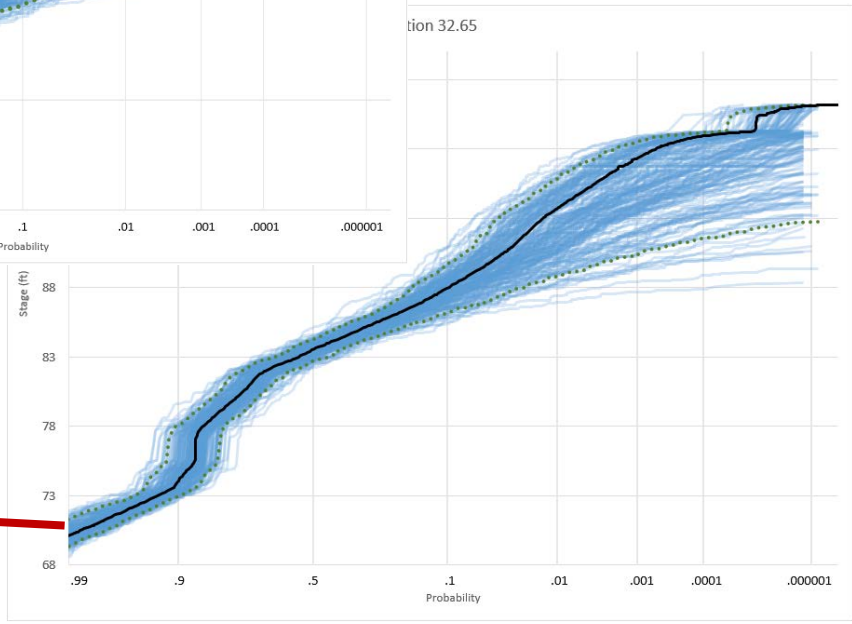

Station
All Realizations
Median
95% Confidence Limits
Stage (ft)
505
495
485
475
465
455
445
435
.99
.9
.5


Station 74.46
Stage (ft)
510
505
500
495
490
485
480
475
470
465
.01
.001
.0001
.000001
Probability
95% Confidence Limits
Median
Realization 86


Lake Mendocino
Ukiah
Hopland
STA 74.46
Cloverdale
Geyserville - STA 54.38
Healdsburg - STA 32.65


Station 74.46
All Realizations
Median
95% Confidence Limits
Stage (ft)
505
495
485
475
465
455
445
435
.99
.9
.5
.1
.01
.001
.0001
.000001
Probability


Stage (ft)
208
203
198
.99
.9
.5
.1
.01
.001
.0001
.000001
Probability


tion 32.65
Stage (ft)
88
83
78
73
68
.99
.9
.5
.1
.01
.001
.0001
.000001
Probability

Conclusions

- HEC-WAT can produce Hazard Frequency curves that show the influence of dam failure.
- Stratified Sampling is necessary to reduce computational burdens
- HEC-WAT distributed computes need better error handling and system operation tooling
- It is difficult to link HEC-RAS and HEC-ResSim to properly account for flood wave volume and pool frequency.
- HEC-ResSim needs to be able to respect dam failure as part of the rule operations.