



# Ensemble Forecasts Applied to Real-World Decision Making: the New York City Water Supply Operations Support Tool (OST)

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10<sup>th</sup> Anniversary HEPEX Workshop

24 June 2014 • College Park, MD



# Presentation Outline

- ❖ Water supply system overview
- ❖ Operations Support Tool (OST)
- ❖ OST use cases
- ❖ Summary



# New York City Water Supply

- ❖ Three systems
  - Croton
  - Catskill
  - Delaware
- ❖ 19 reservoirs & 3 lakes
- ❖ 2,000 square mile watershed
- ❖ 8 upstate counties
- ❖ Serves 9 million people
  - 50% of New York State population
- ❖ Delivers 1.1 billion gal per day
- ❖ Unfiltered supply (Cat/Del)



## Provide an adequate supply of high-quality drinking water







# Multiple Objectives and Challenges

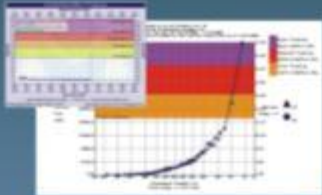
- ❖ Supply reliability
- ❖ Drinking water quality
- ❖ Tailwater fisheries
- ❖ Ecological flows
- ❖ Recreation
- ❖ Spill mitigation
- ❖ Operating costs
- ❖ Hydropower
- ❖ Long-term supply/demand
- ❖ Climate change



## Near Real Time Data Sources



USGS Streamflow Data



National Weather Service Forecast Data



NYCDEP SCADA Data

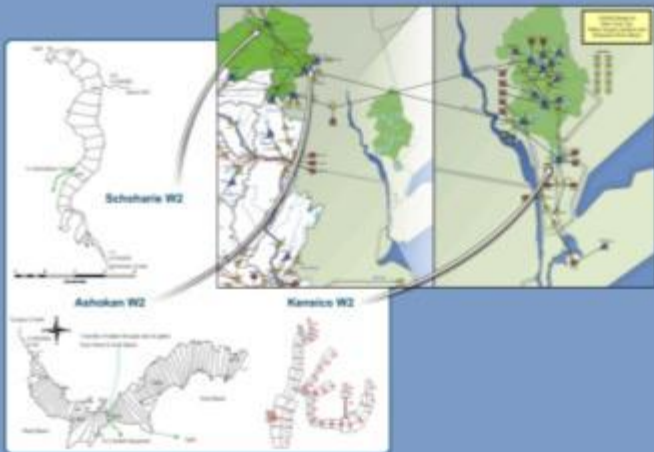


NYCDEP Keypoint Water Quality Data



Near Real Time Network Water Quality Data

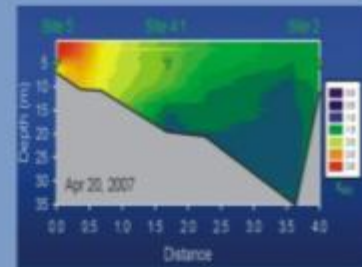
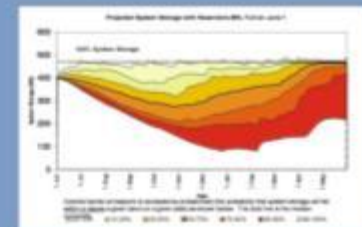
## OASIS W-2 Model



## OST Databases

Raw Data  
↓  
Automated QA/QC  
↓  
Clean Data  
↓  
Automated Model Input  
↓  
Model Output  
↓  
Archived Historical Data

## Post-Processors

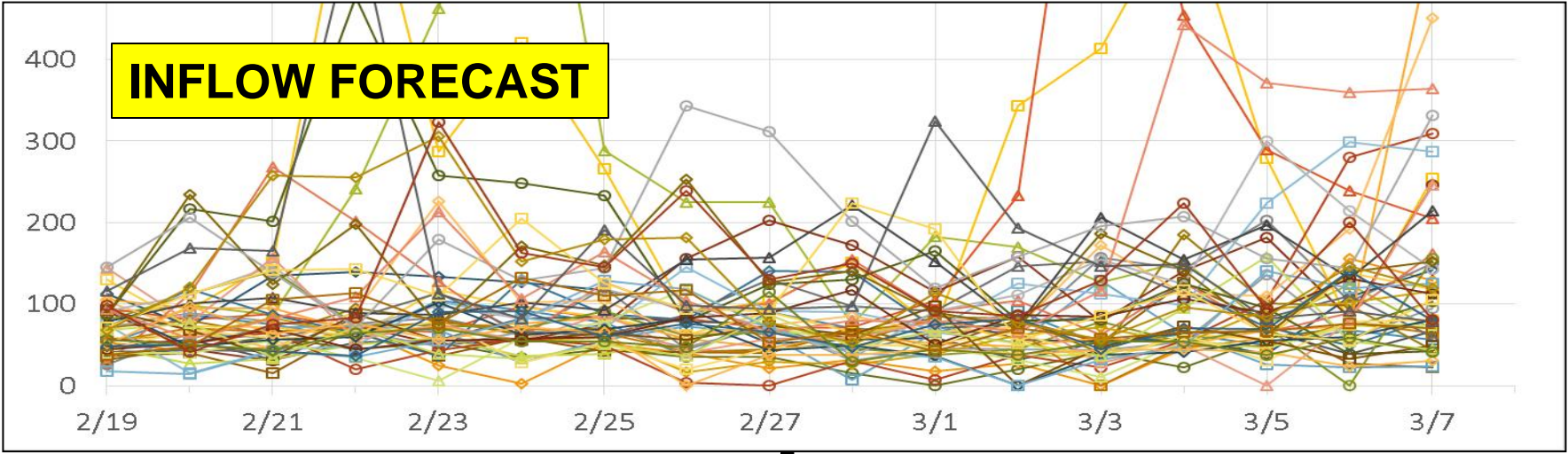


## Graphical User Interface

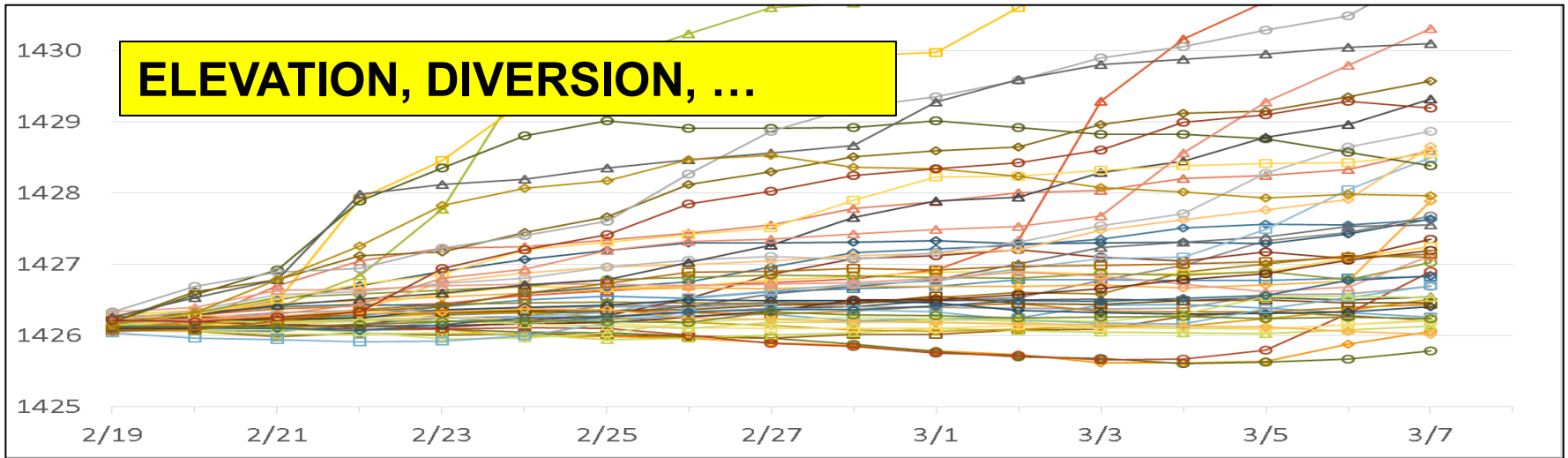


- ❖ System model – simulates entire water supply
  - Demand
  - Storage
  - Diversions
  - Releases
  - Water quality
- ❖ Daily time step
- ❖ Driven by ensemble inflow forecasts
- ❖ NWS Hydrologic Ensemble Forecast Service (HEFS)
  - Include meteorological drivers and snow pack data
  - DEP funded accelerated development

# How does OST work?

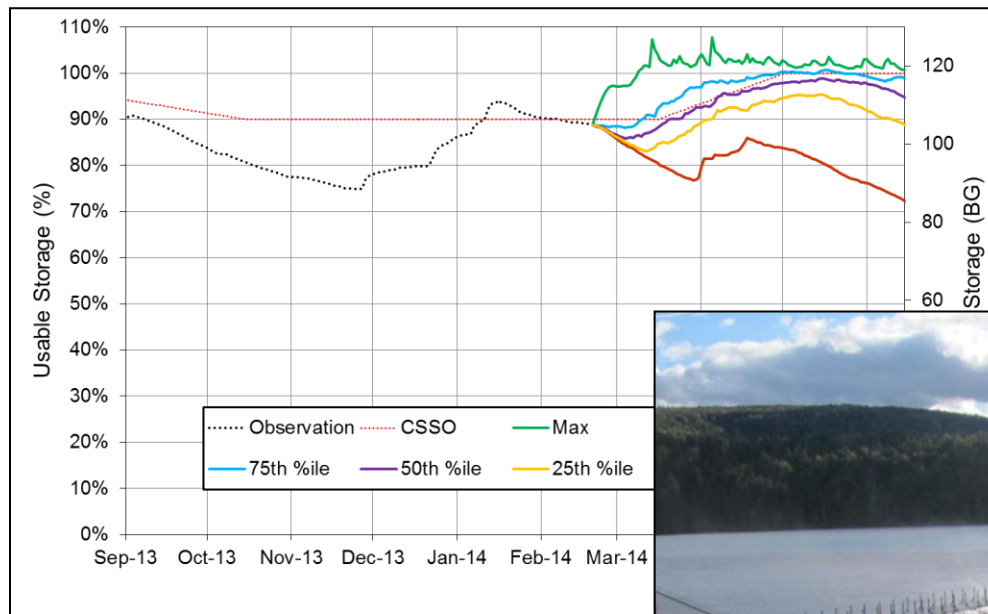


**MODEL PROCESSING**

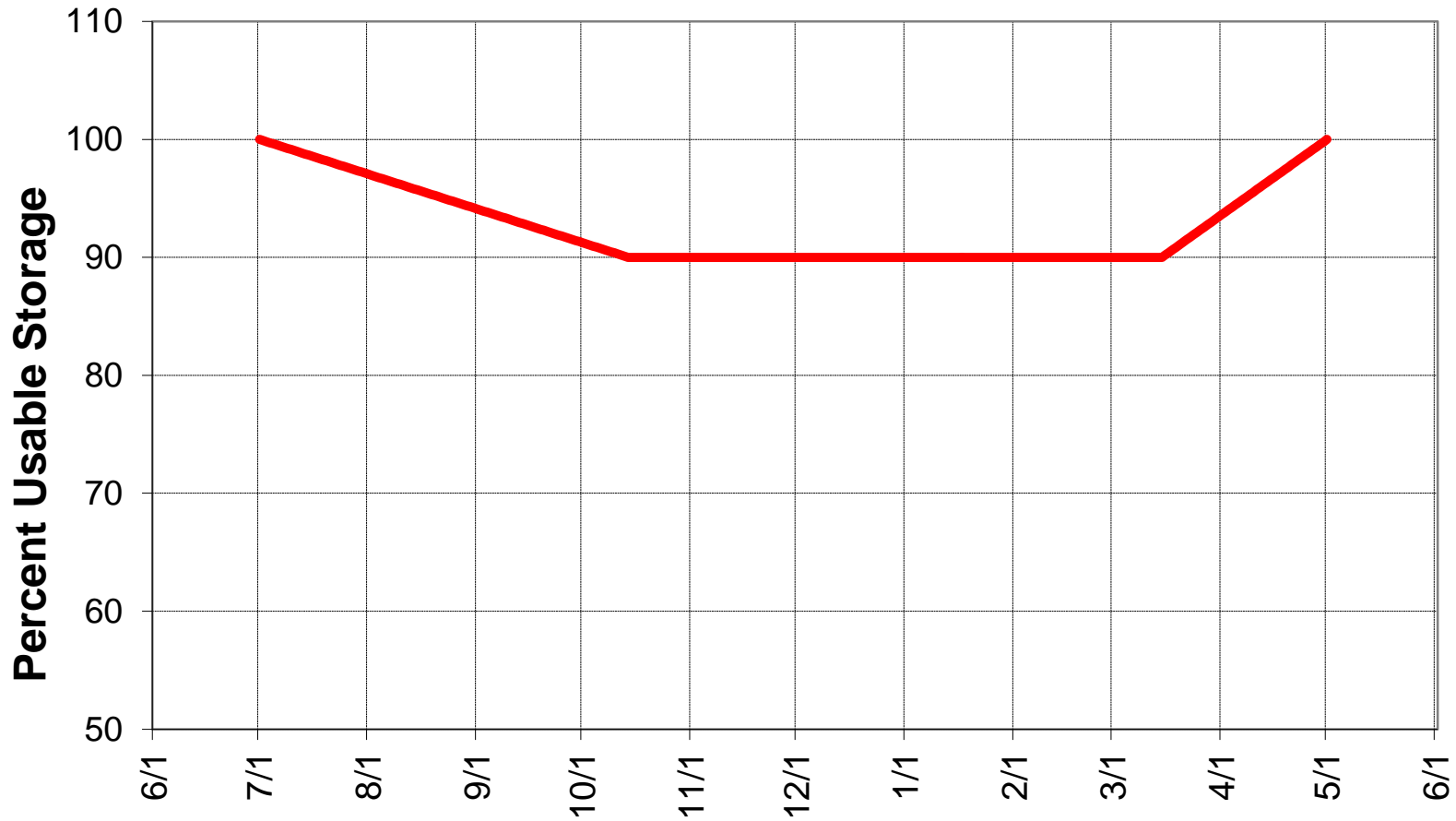


## ❖ Ashokan Storage Objective

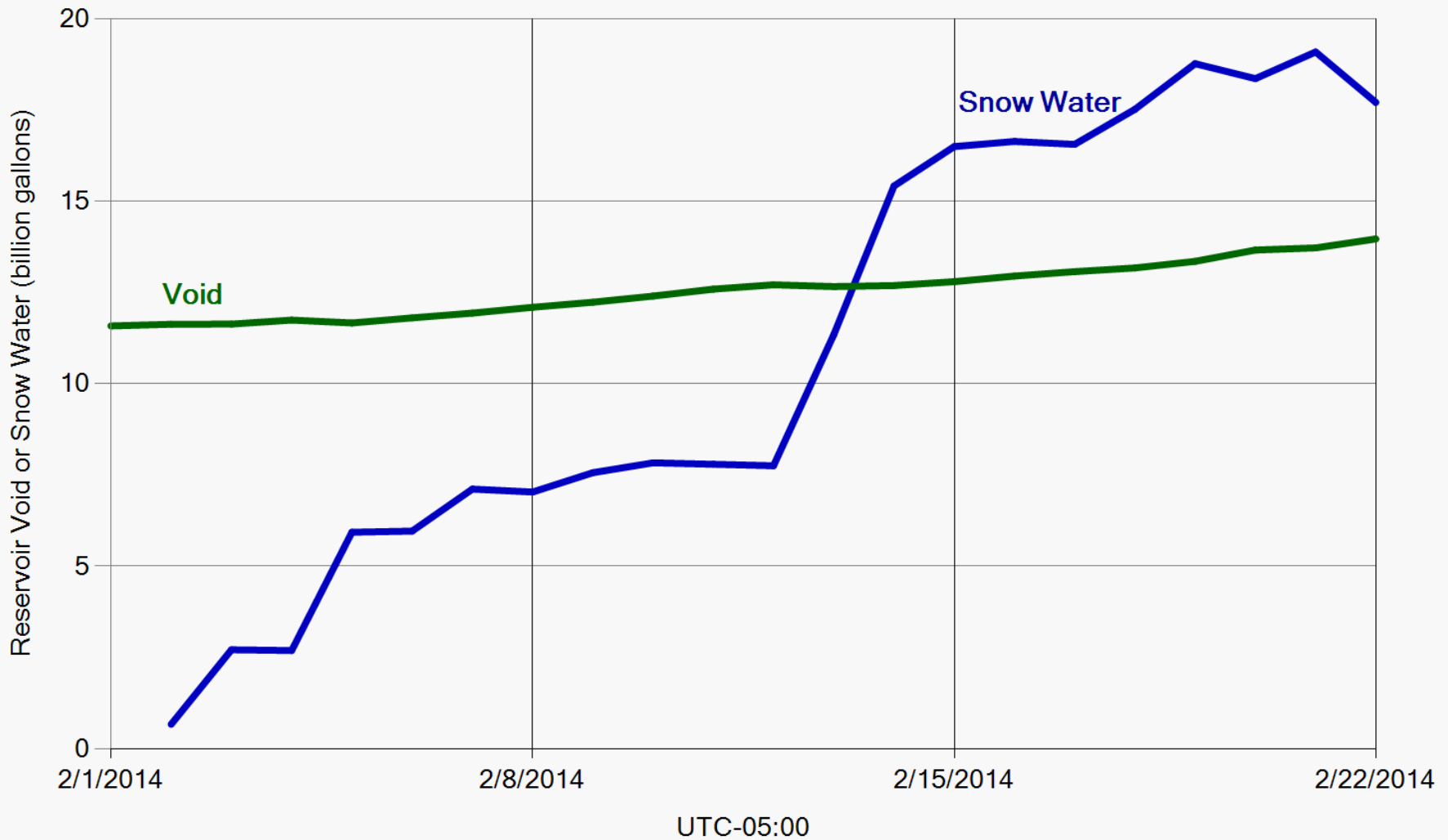
## ❖ Gilboa Construction Support



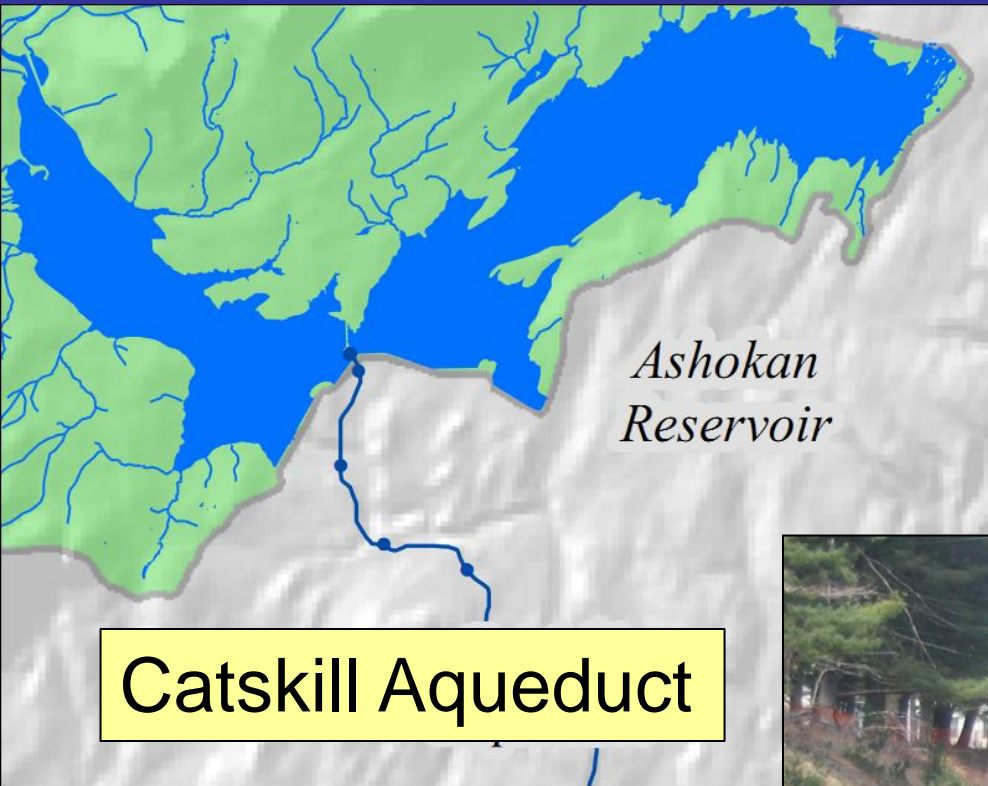
## Conditional Seasonal Storage Objective (CSSO)



# Ashokan 2014 Snow Water and Void

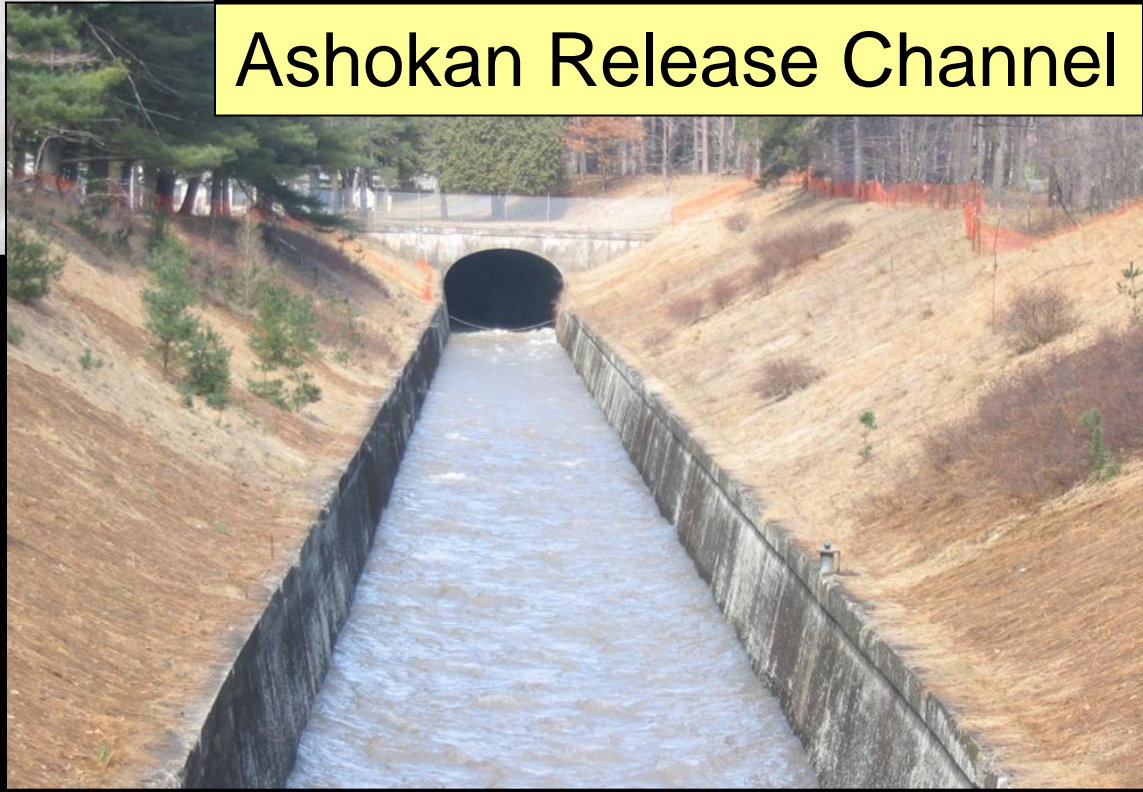


# Ashokan Reservoir Diversion and Release

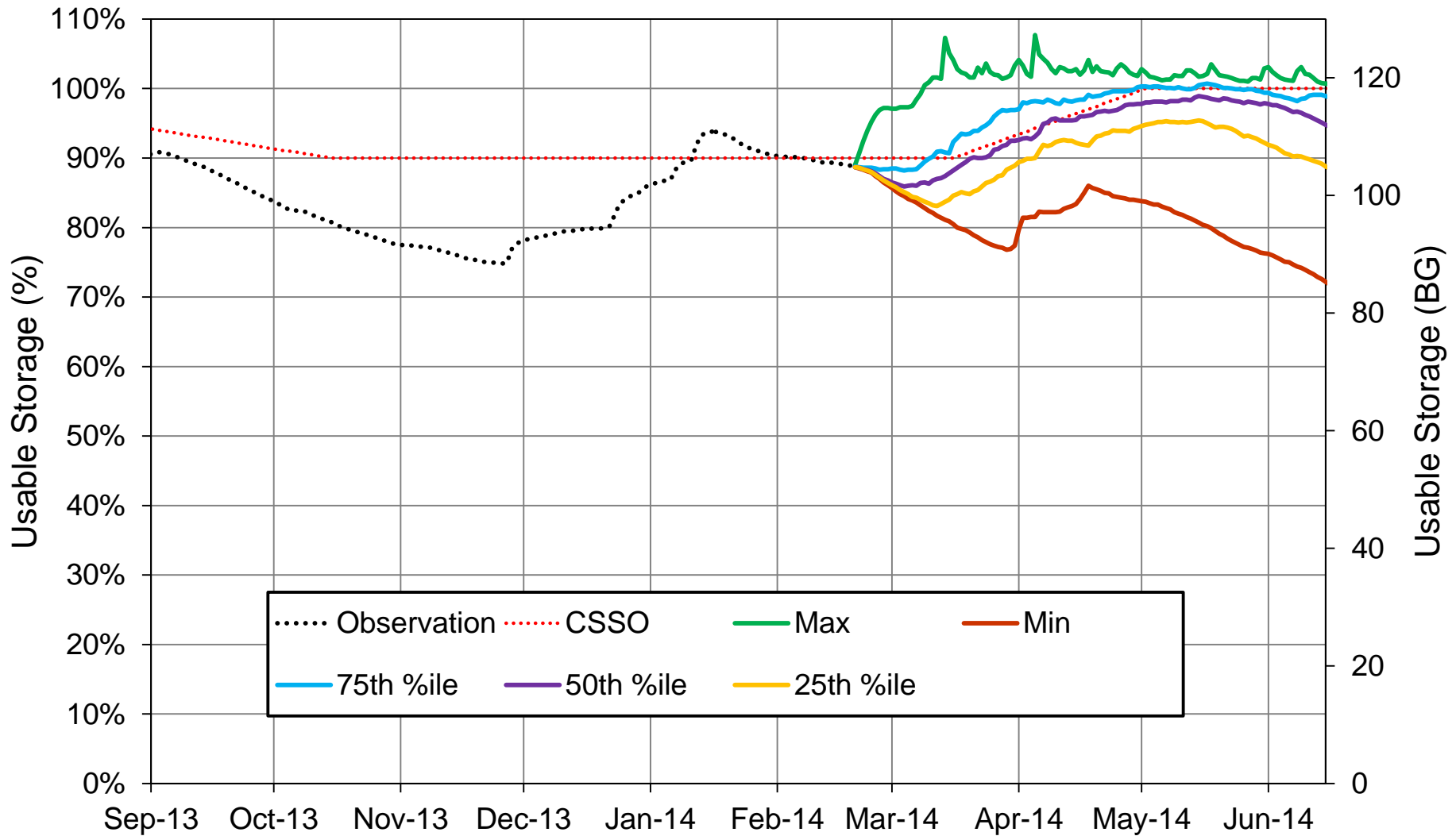


Catskill Aqueduct

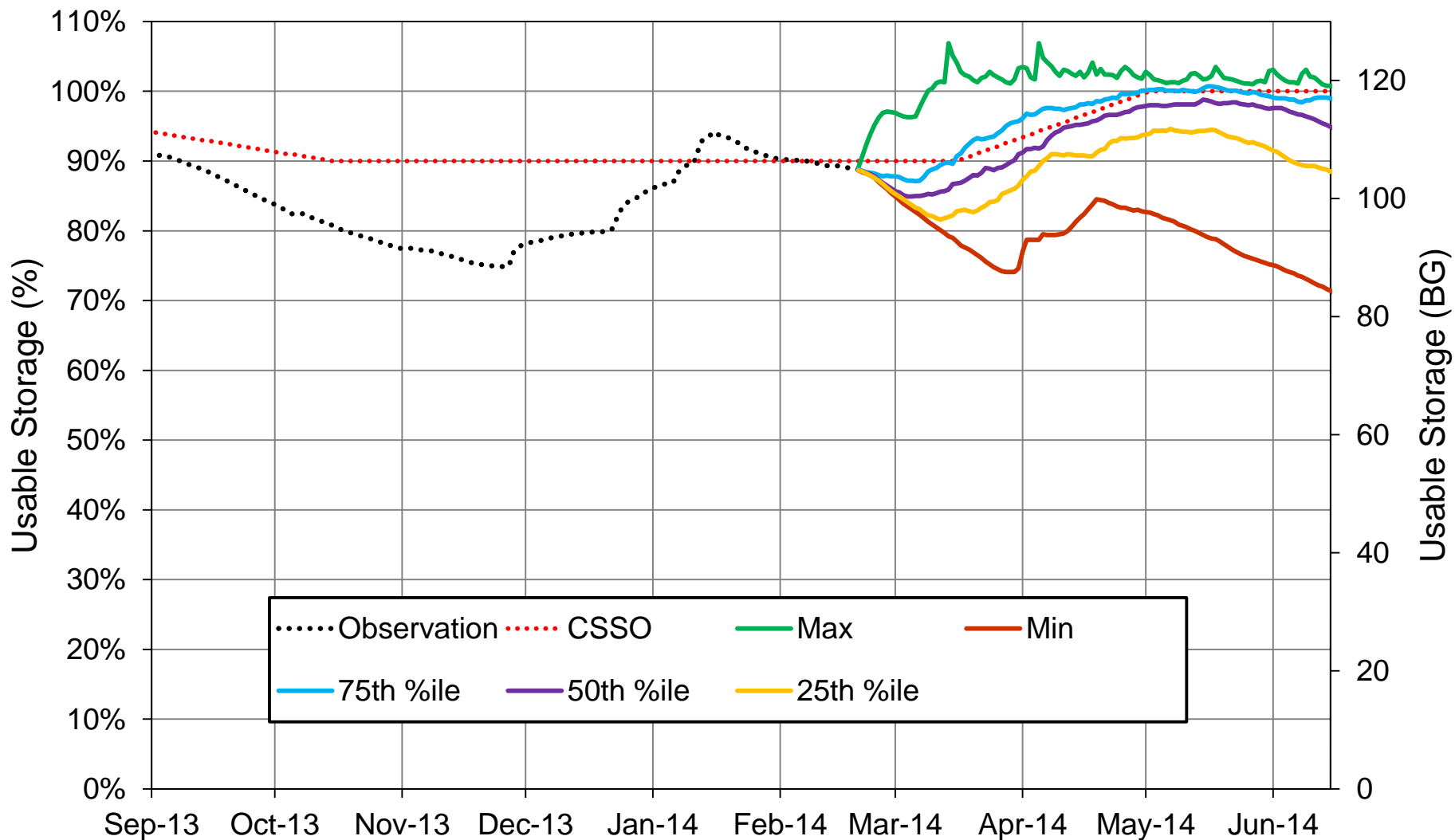
Ashokan Release Channel



# Ashokan Observed and Projected Storage - ARC 100 mgd

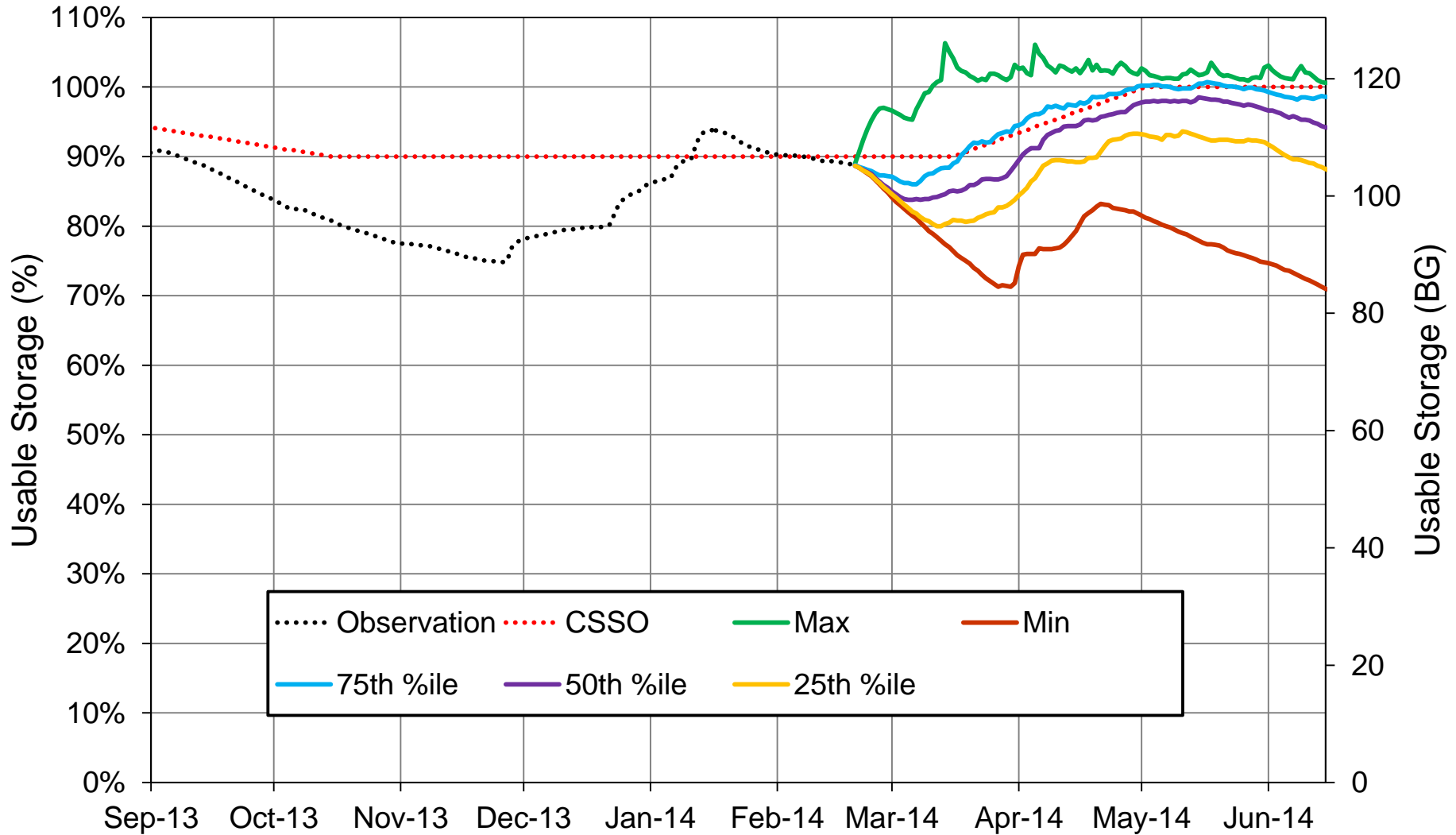


# Ashokan Observed and Projected Storage - ARC 200 mgd

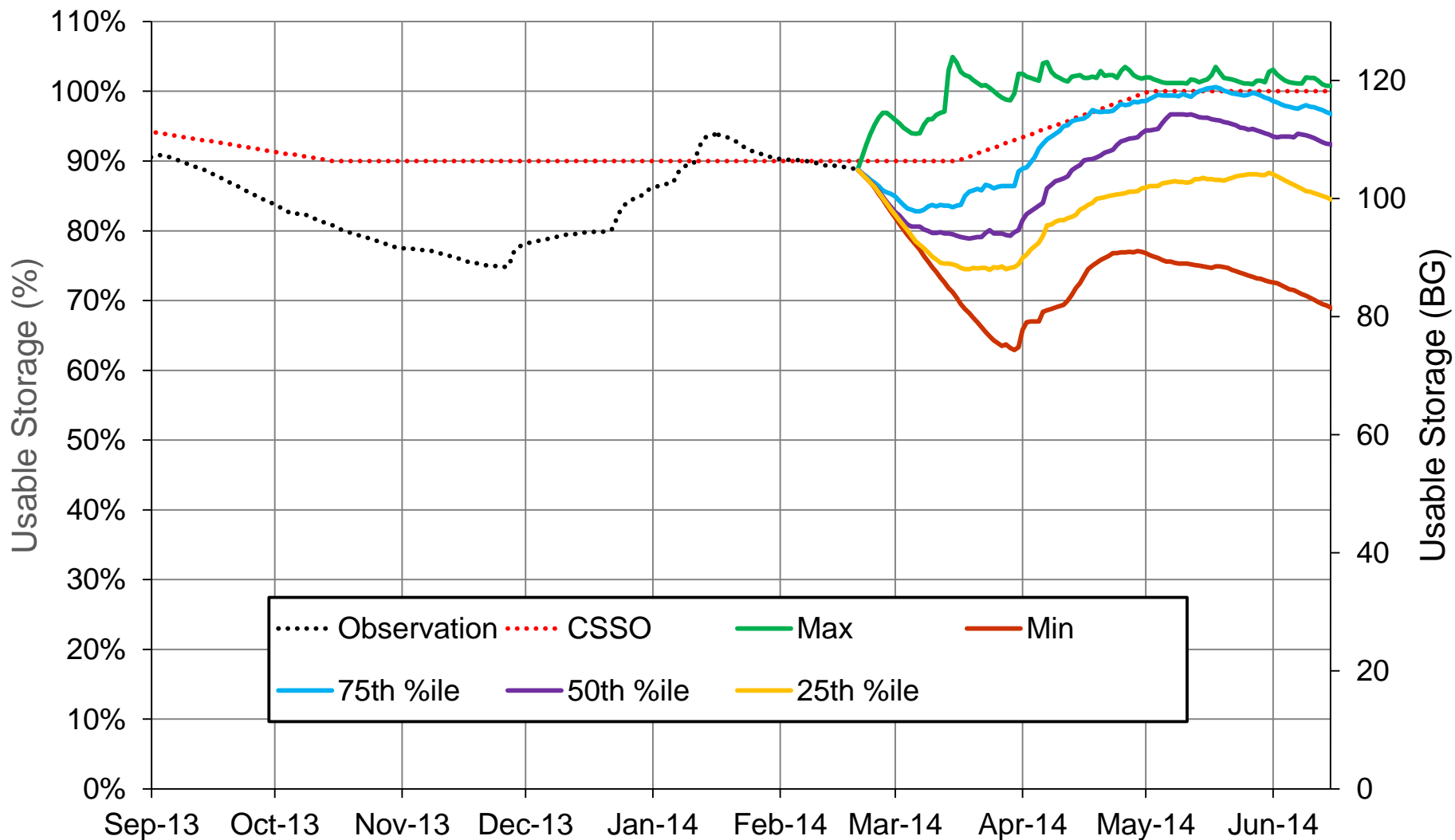




# Ashokan Observed and Projected Storage - ARC 300 mgd

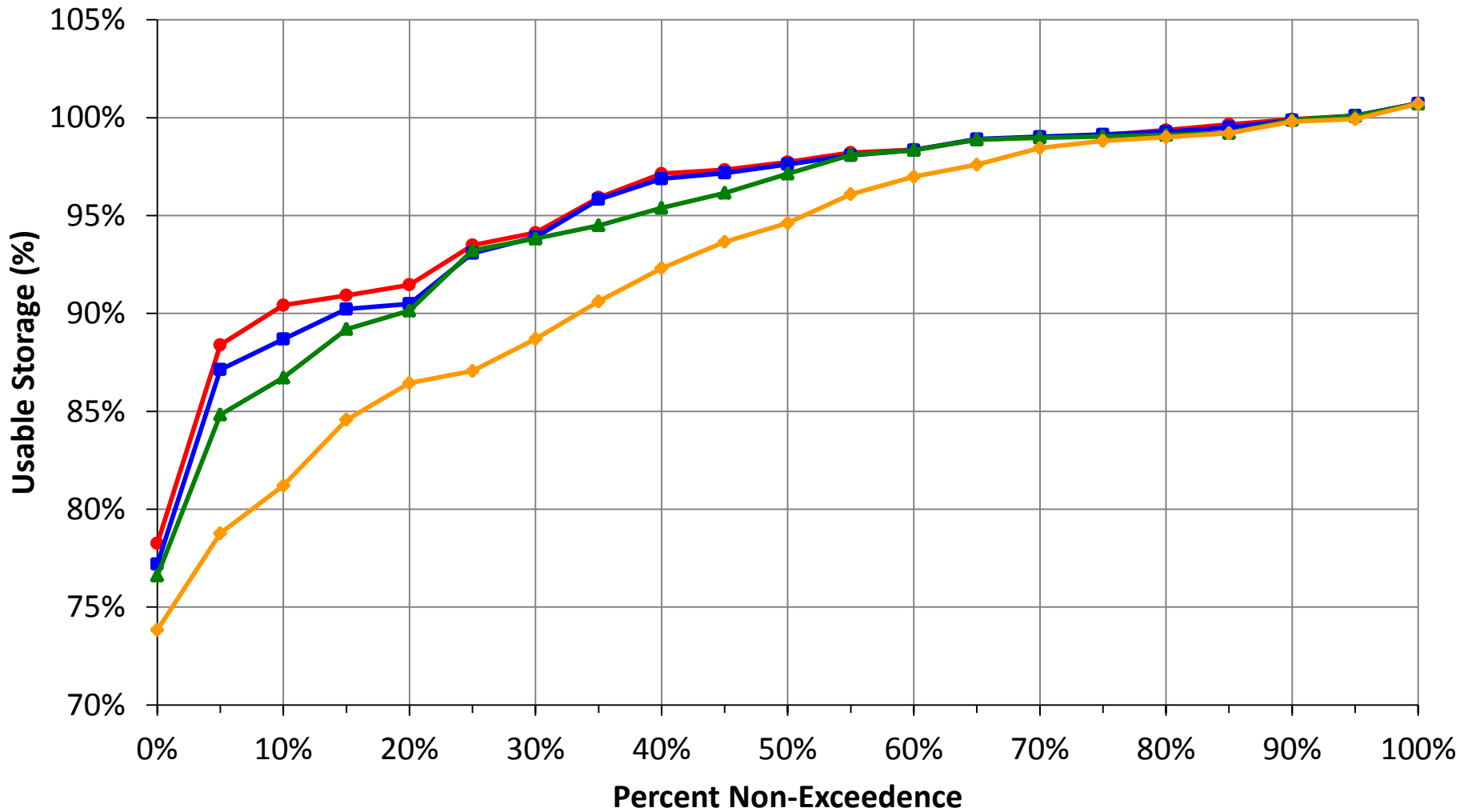


# Ashokan Observed and Projected Storage - ARC 600 mgd

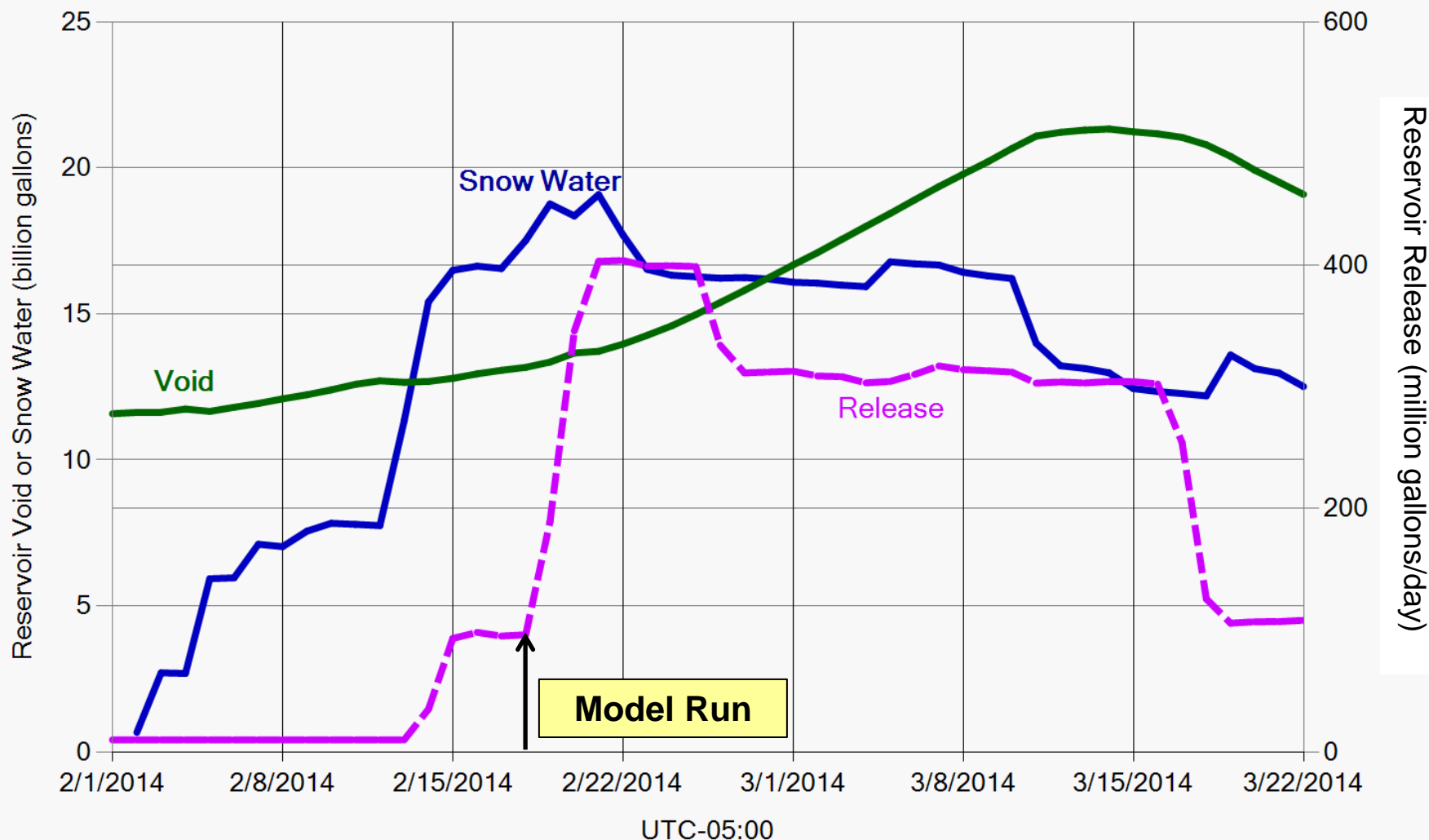


# Probability of Refill

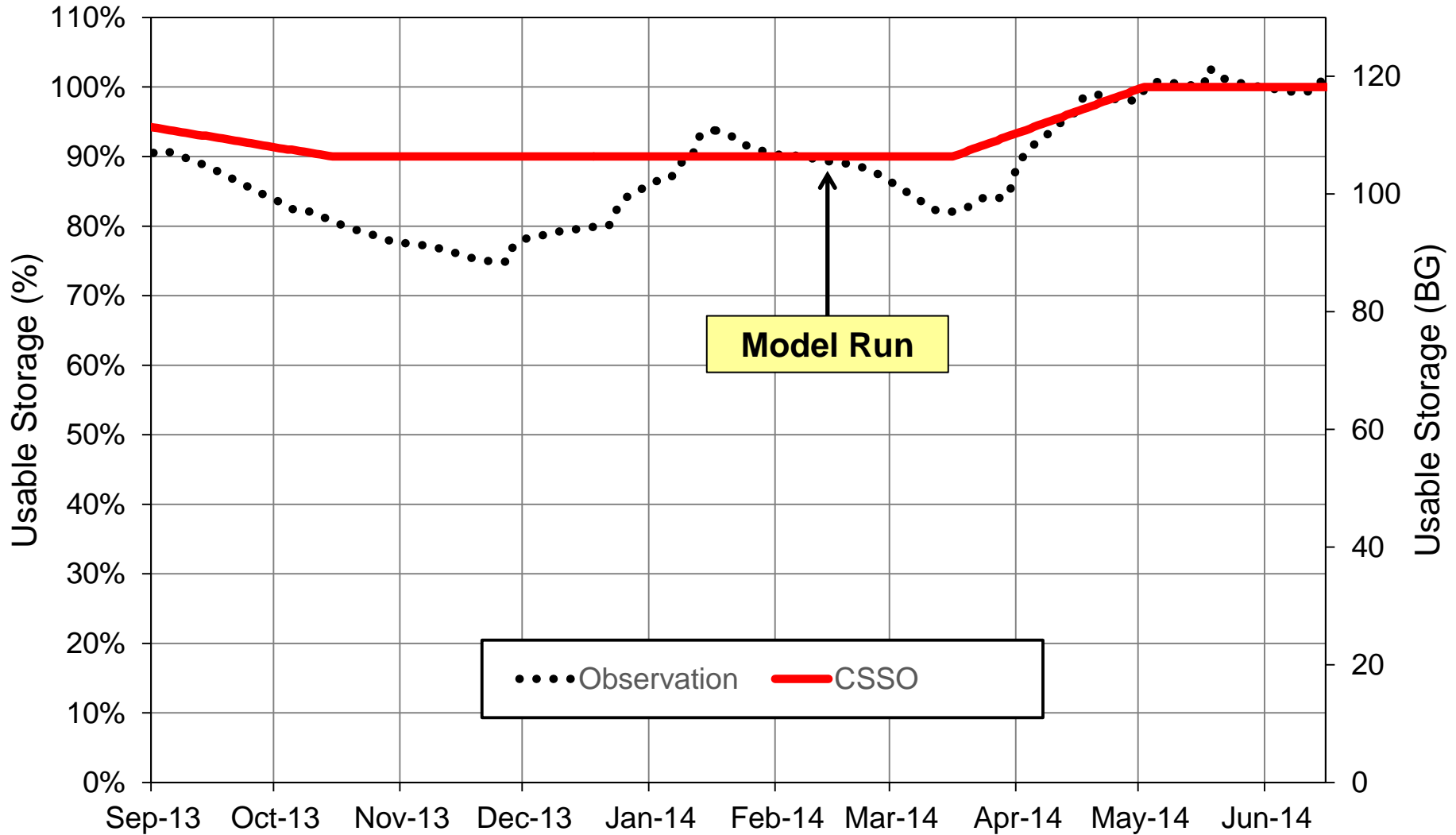
ARC\_100    ARC\_200    ARC\_300    ARC\_600



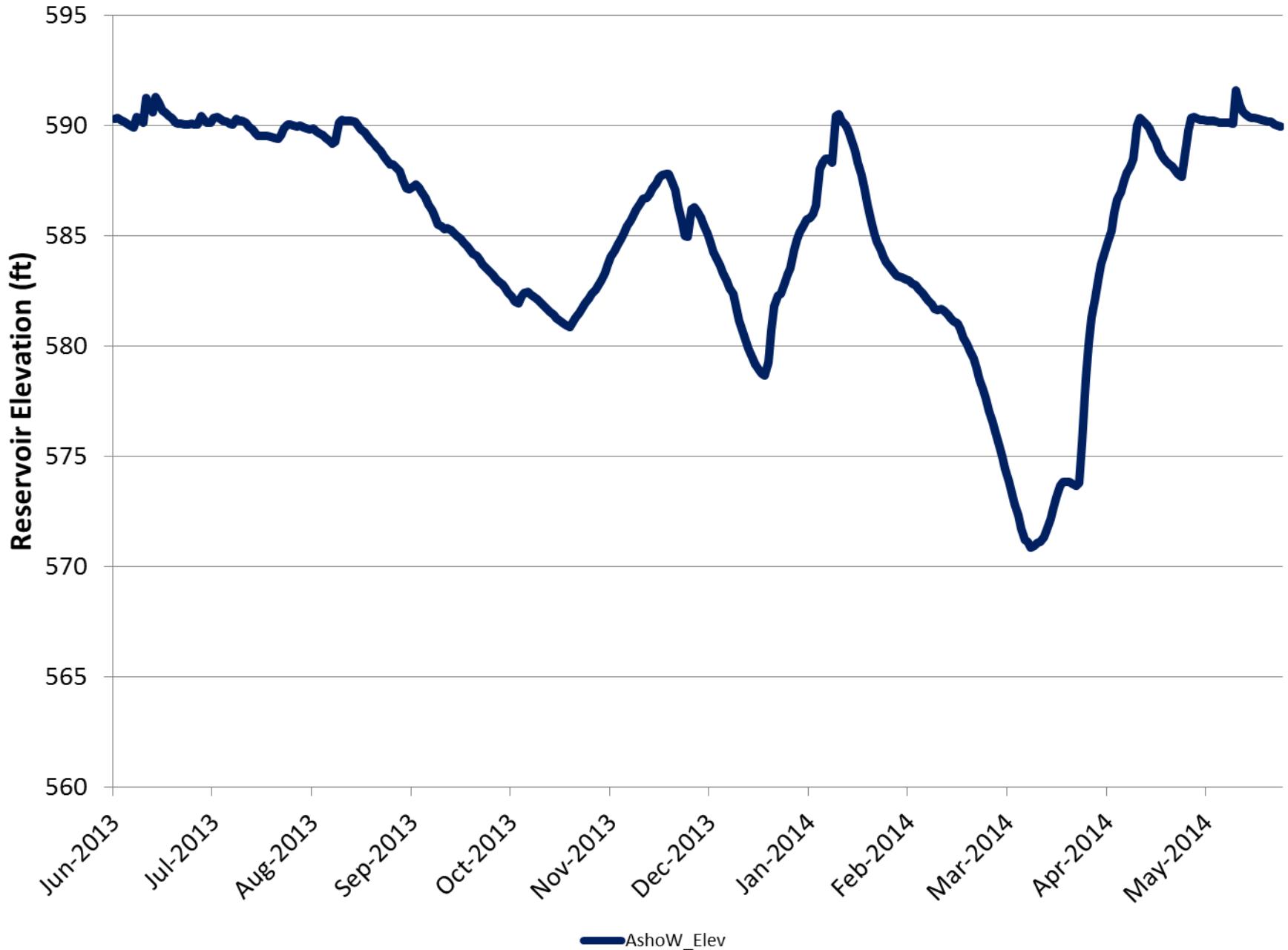
# Ashokan 2014 Snow Water, Void, and Release



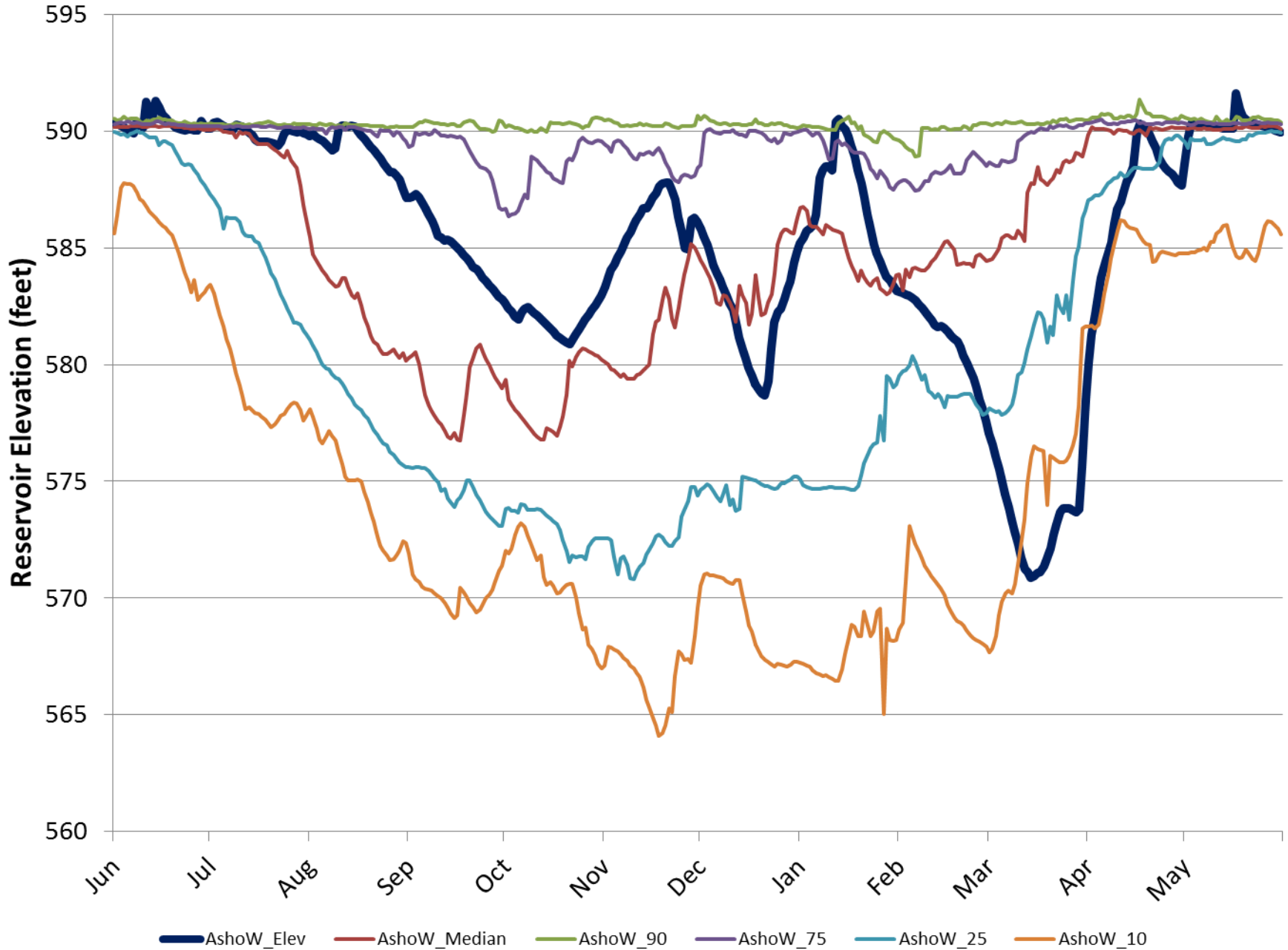
# Ashokan Observed Storage



# Ashokan West Basin



# Ashokan West Basin



# Gilboa Construction Support

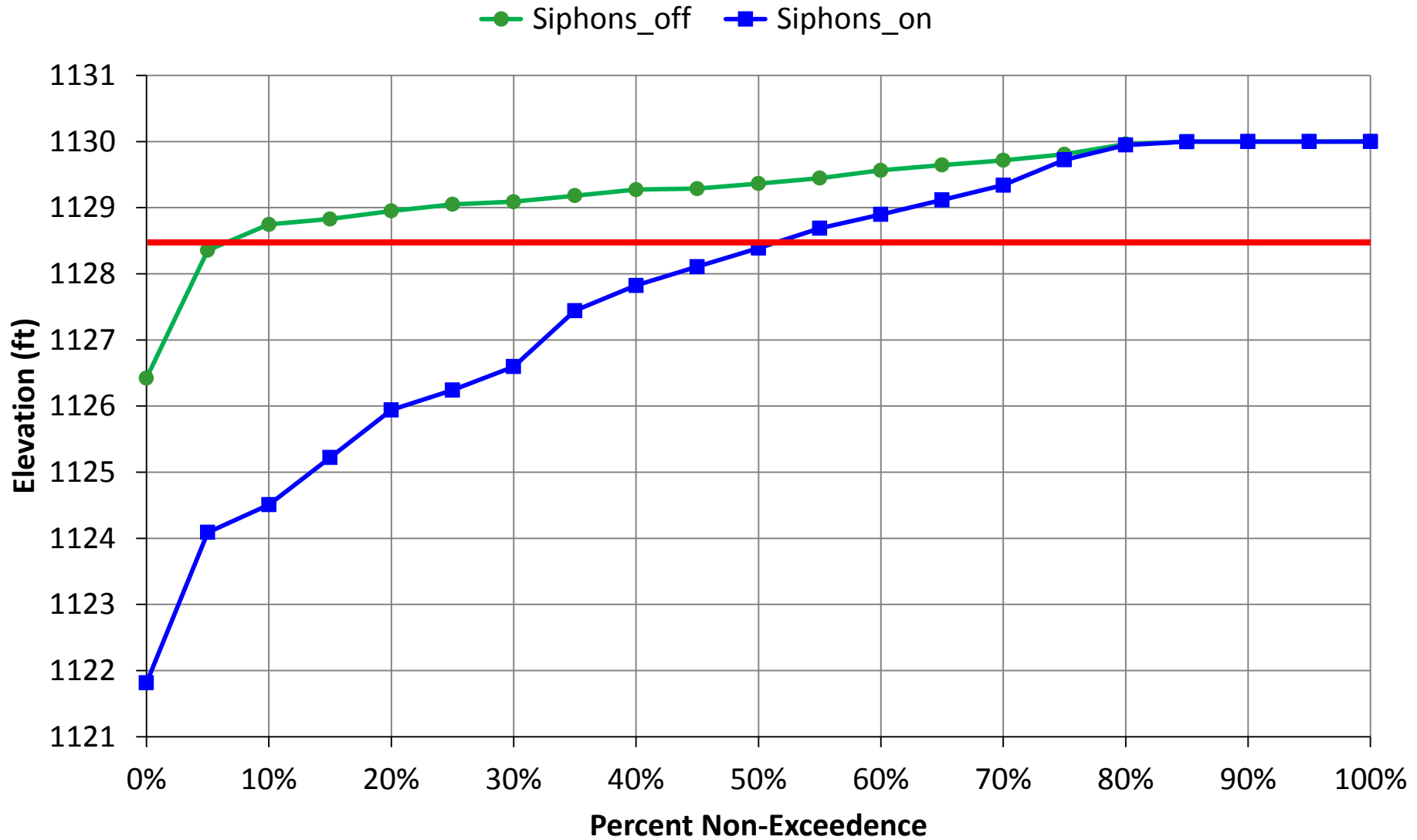




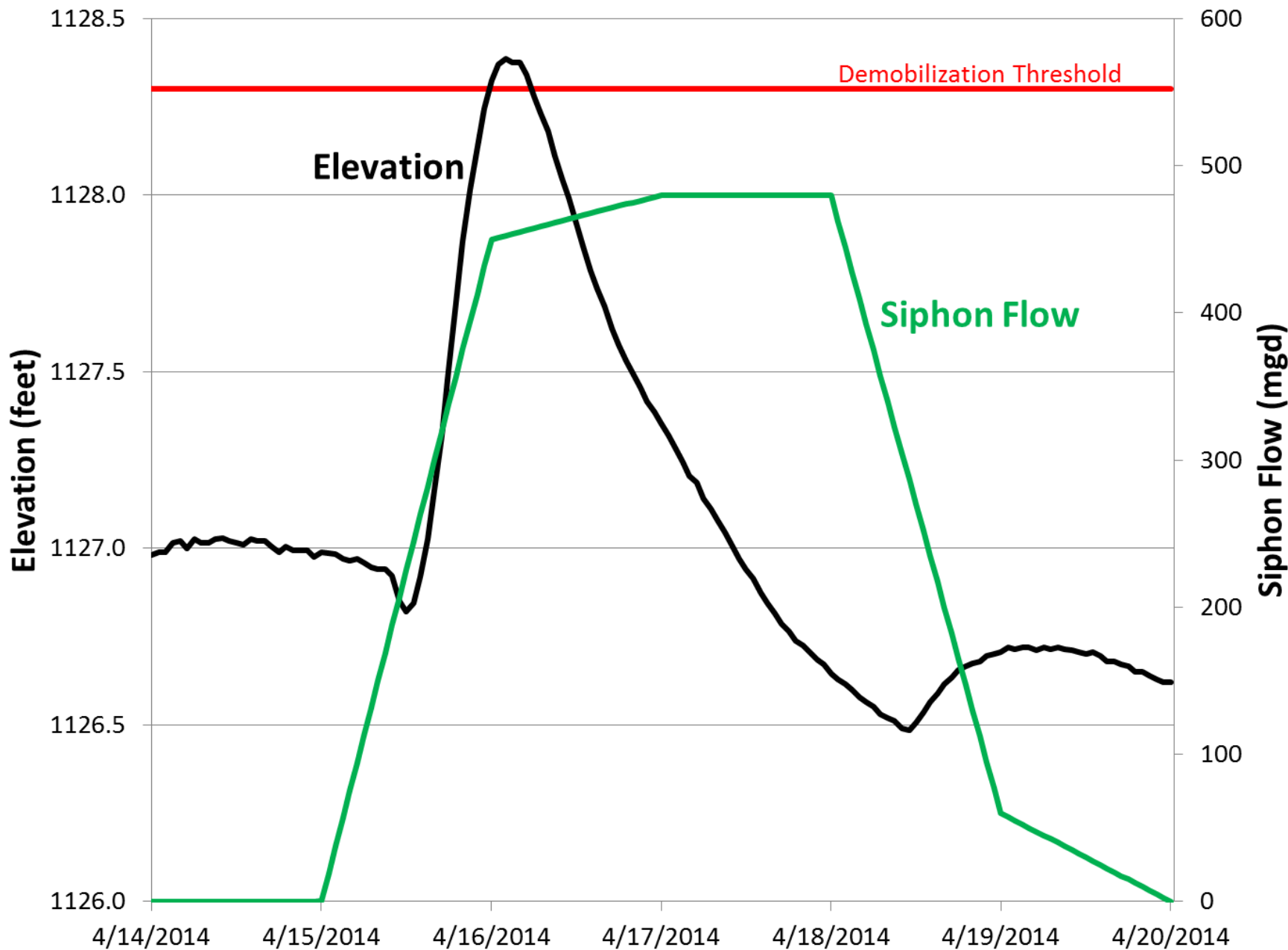
# Gilboa Construction Support



# Schoharie Siphons Off/On - Simulation



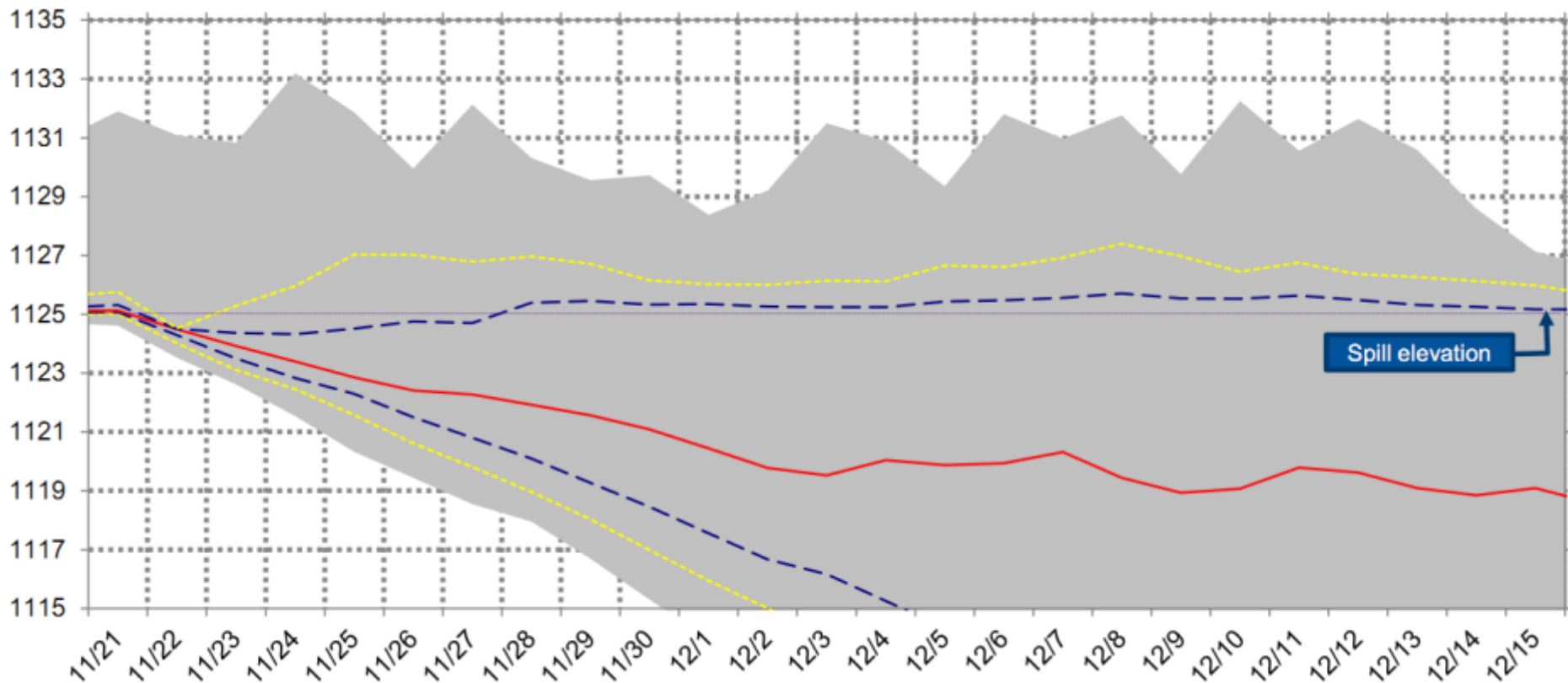
# Schoharie Siphons Off/On - Results



# Schoharie Siphon Installation

Run Date: 11/21/12

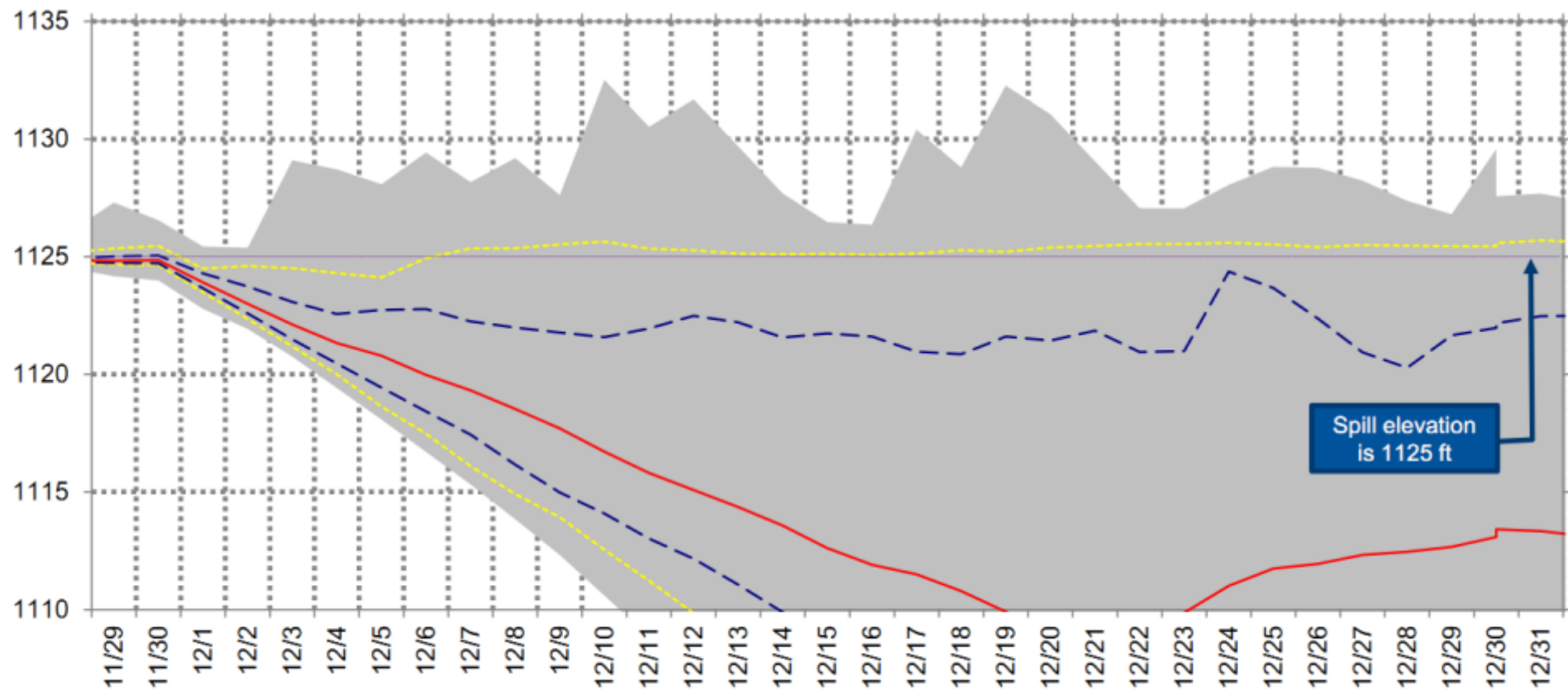
Diversion 530 mgd 11/22 – 12/14/12



# Schoharie Siphon Installation

Run Date: 11/29/12

Diversion 530 mgd 12/1 – 12/22/12



# Schoharie Siphon Installation



12/19/2012

- ❖ Use of ensembles is paradigm shift
  - Requires adaptation and education
  - Interpretation of output can be very confusing
  
- ❖ Nature of analysis driven by nature of problem
  - Need multiple ways to present ensemble output for decision making
  
- ❖ Ensembles shift some risk onto decision makers

# Thank You!



*Photo Credit: Doug Freese*