

**Ensemble Forecast-Informed  
Drought Monitoring and Management  
for Improved Decision Making  
in New Jersey  
Using a RiverWare Model**

**Foram Desai**



## Section's Mission:

- Water supply planning and modelling
- Ensuring state's water supplies will satisfy current and future demands

## Not system operators:

- Provide technical support to permitting and enforcement programs
- Advise on and develop policy
- Convey information to regulated community and public

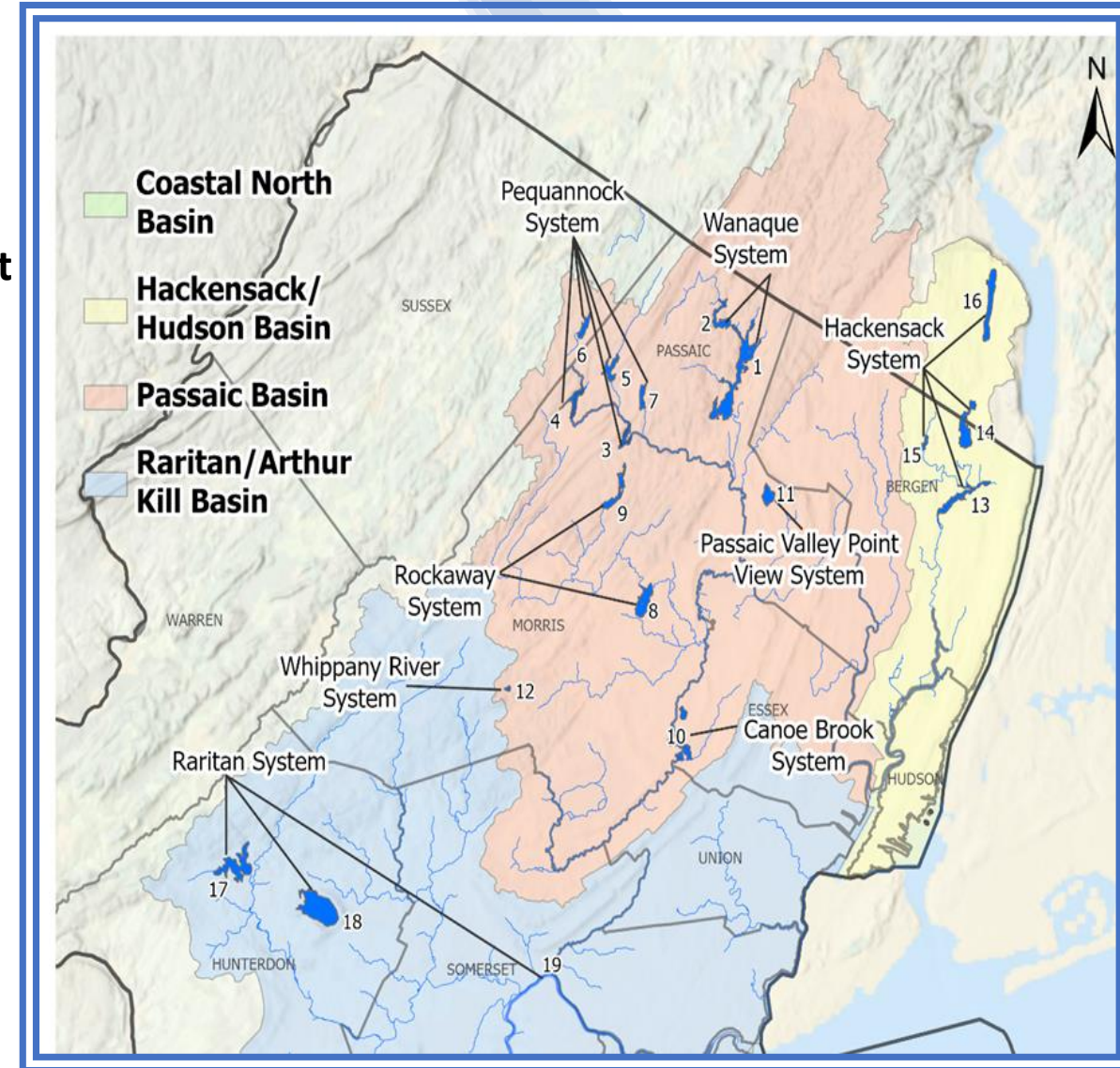
## No water accounting:

- Public owns the water collectively
- State manages water in trust for the public

## Tools Available:

- In-house RiverWare modeling staff
- NJ RiverWare model – major SW systems (expanding)
- Water supply plan/policies/funding

## Overview :



# NJ Water Supplies:



Current reservoir systems date to late 1800's



Historical flow data available from 1921 and some before that



NJ model has 98 years of flow data from 1921 to 2019



77% of public/potable water comes from surface water



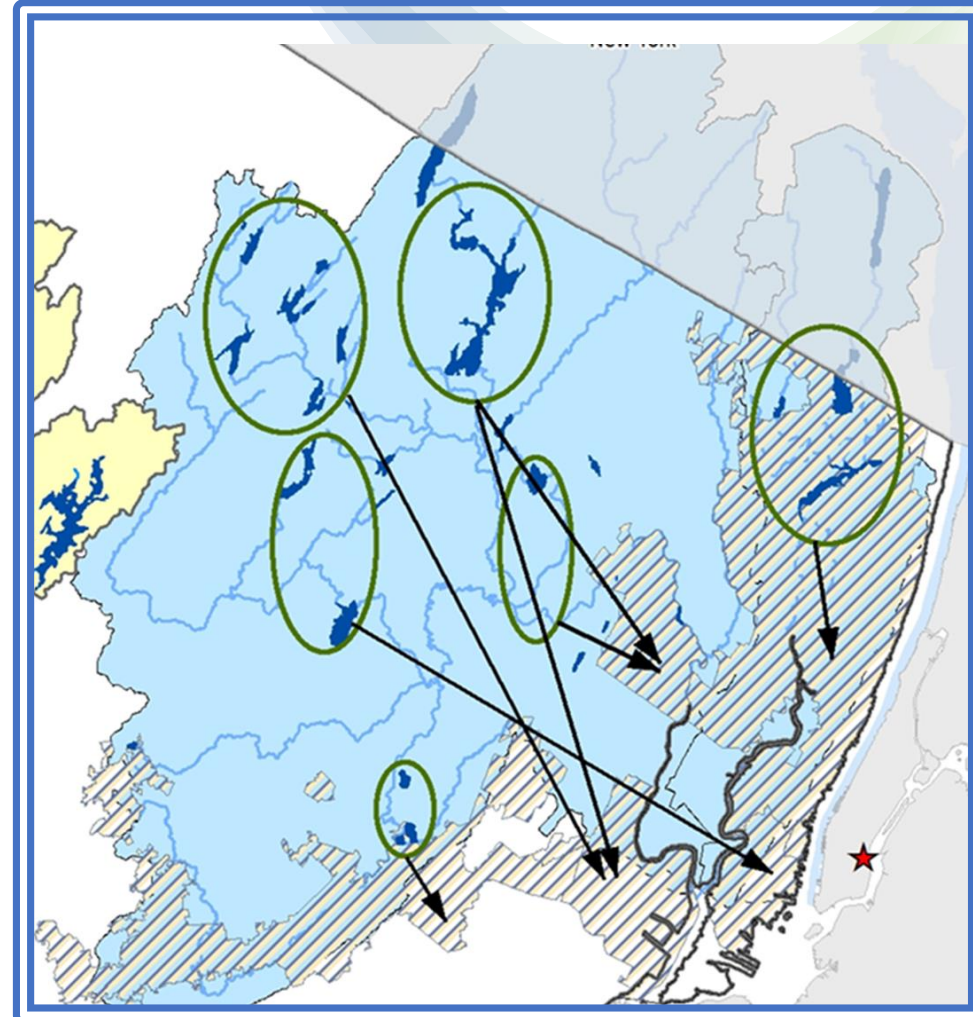
NJ Hydrology and Climate is distinct from the western part of USA



Reservoir drawdown and refill periods are normally one year with a few multi-year drawdowns



NJ has significant potable supply pumped storage (not for power generation)



# NJ RiverWare Model Uses:



**Drought  
monitoring and  
management**



**Review/evaluate  
permit modifications**



**Improved data and  
decisions making**



**General water supply  
questions using in-house  
modeling capabilities**



**Calculate the  
pumping cost for  
alternatives**

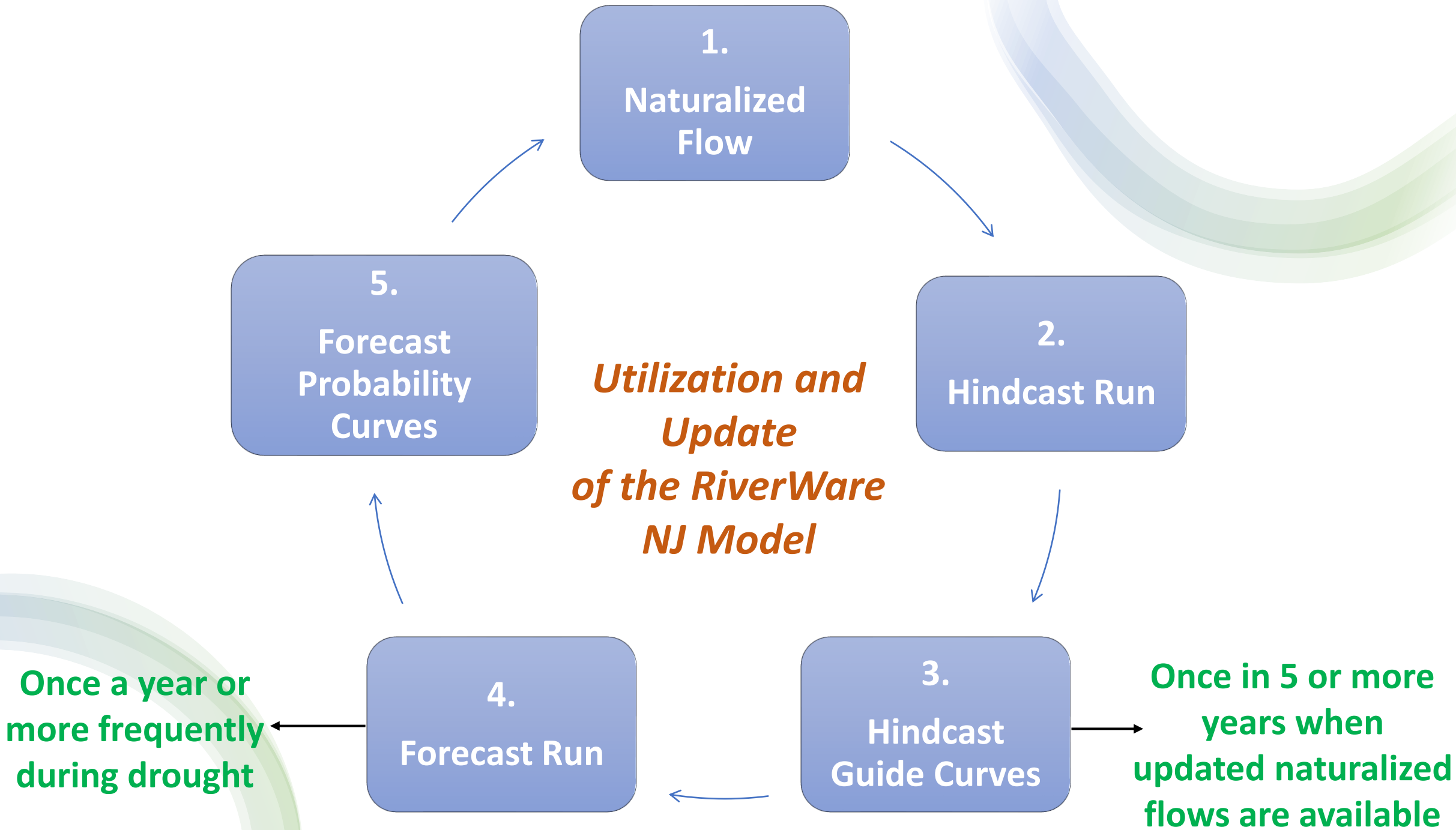


**Future reliability of water  
supply**



**Assess risk and  
alternative  
operations**





**1.**

## **Naturalized Flow**

- **“Naturalized flow” is the observed stream flow in the absence of the modification caused by the existence and operation of the reservoir systems**
- **Utilizes observed flow and storage change data**
- **Missing data filled in using MOVE-1 and other statistical methods**

**2.**

## **Hindcast Run**

- **October 1, 1921, to September 30, 2019**
- **Simulation of today’s infrastructure using naturalized flows for simulation period**

**3.**

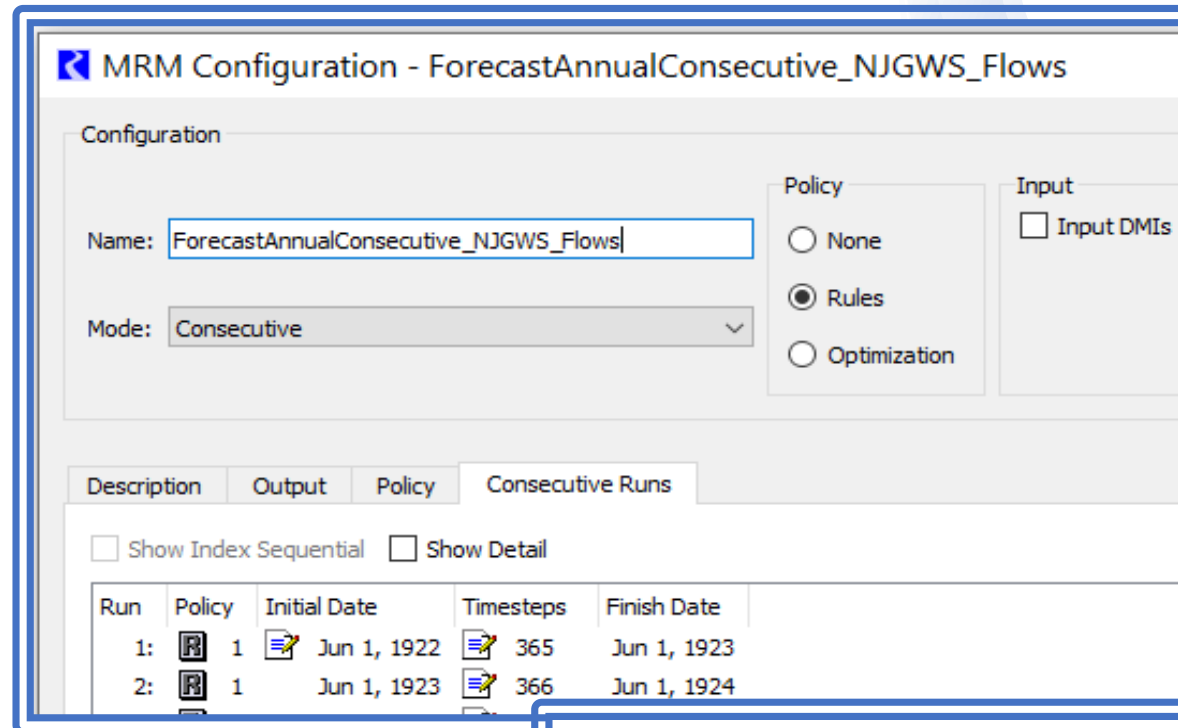
## **Hindcast Guide Curves**

- **Set of storage volume guide curves based on hindcast model run for drought management**

4.

## Forecast Run

- 97 member ensembles using naturalized flows
- One-year forecast period, or
- Multi-year forecast periods



MRM Configuration - ForecastAnnualConsecutive\_NJGWS\_Flows

Configuration

Name: ForecastAnnualConsecutive\_NJGWS\_Flows

Mode: Consecutive

Policy

None

Rules

Optimization

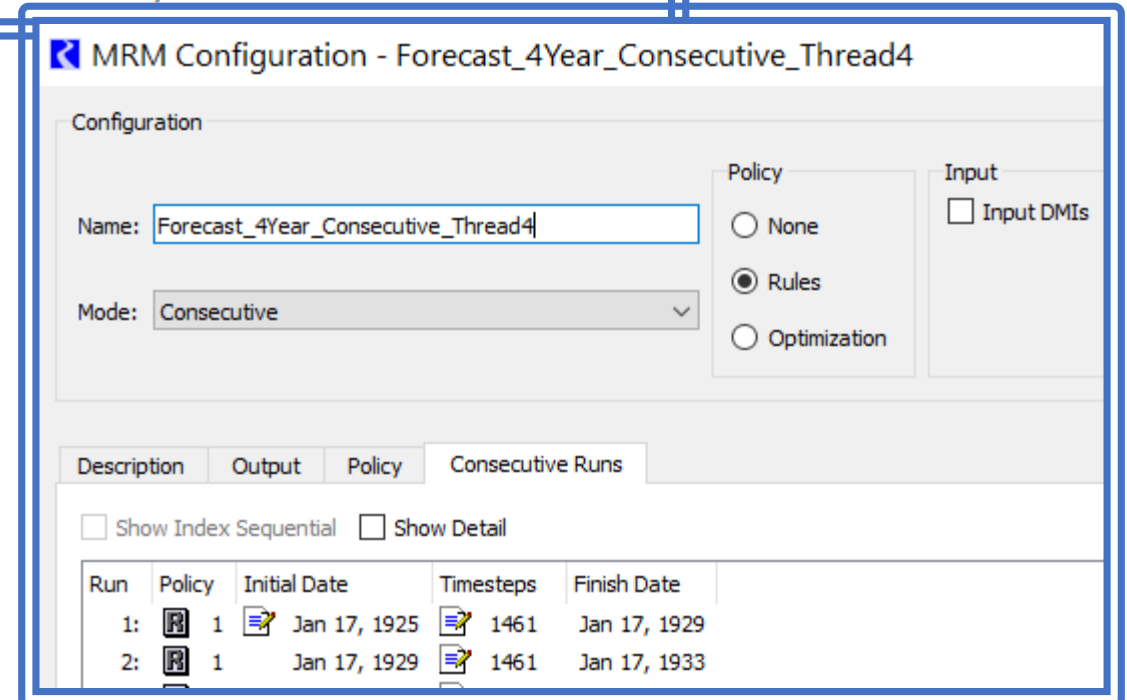
Input

Input DMIs

Description Output Policy Consecutive Runs

Show Index Sequential  Show Detail

Run	Policy	Initial Date	Timesteps	Finish Date
1:		Jun 1, 1922	365	Jun 1, 1923
2:		Jun 1, 1923	366	Jun 1, 1924



MRM Configuration - Forecast\_4Year\_Consecutive\_Thread4

Configuration

Name: Forecast\_4Year\_Consecutive\_Thread4

Mode: Consecutive

Policy

None

Rules

Optimization

Input

Input DMIs

Description Output Policy Consecutive Runs

Show Index Sequential  Show Detail

Run	Policy	Initial Date	Timesteps	Finish Date
1:		Jan 17, 1925	1461	Jan 17, 1929
2:		Jan 17, 1929	1461	Jan 17, 1933

5.

## Forecast Probability Curves

- **Exceedance is the probability that a value will be greater than a specified value**
- **Non-Exceedance is the probability that a value will be less than a specified value**
- **We use Non-Exceedance statistics to generate probability curves**
- **Non-Exceedance  $P = 1 - (m/n+1)$**
- **Non-Exceedance %  $P = 100 * [ 1 - (m/n+1)]$**

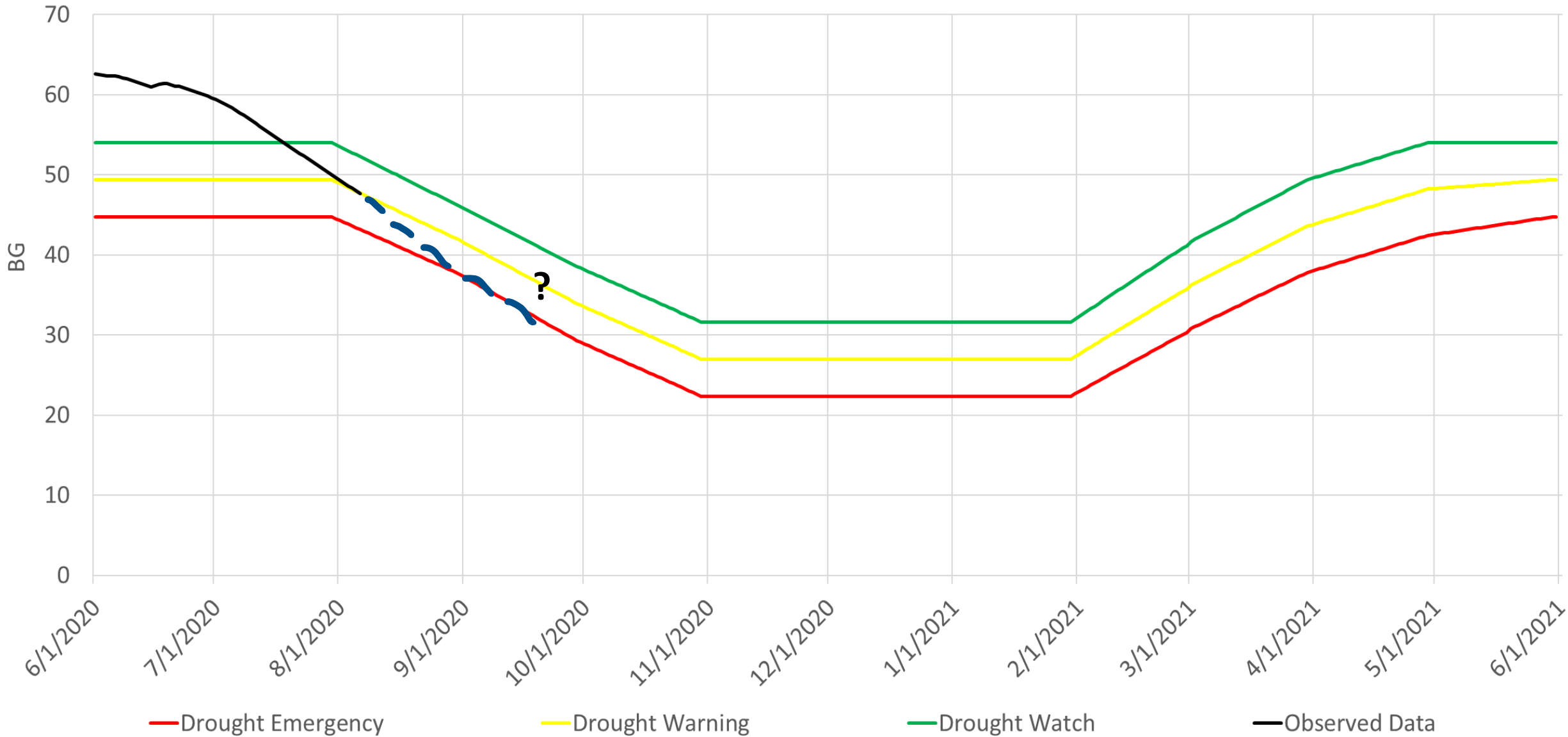
**P = Probability**

**m = Rank of the value, with 1 being largest possible value**

**n = Total number of the events or data points**

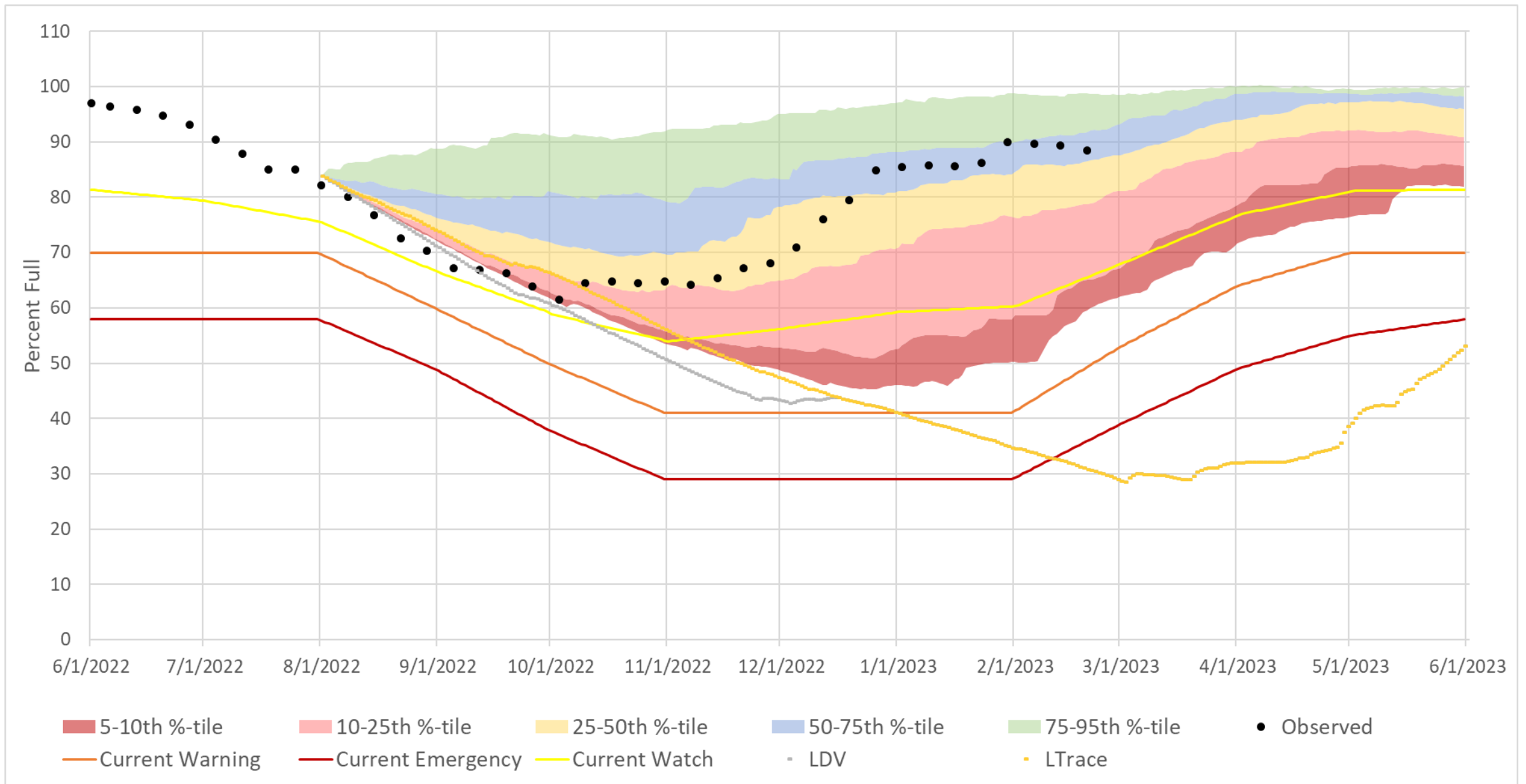


# Traditional Way



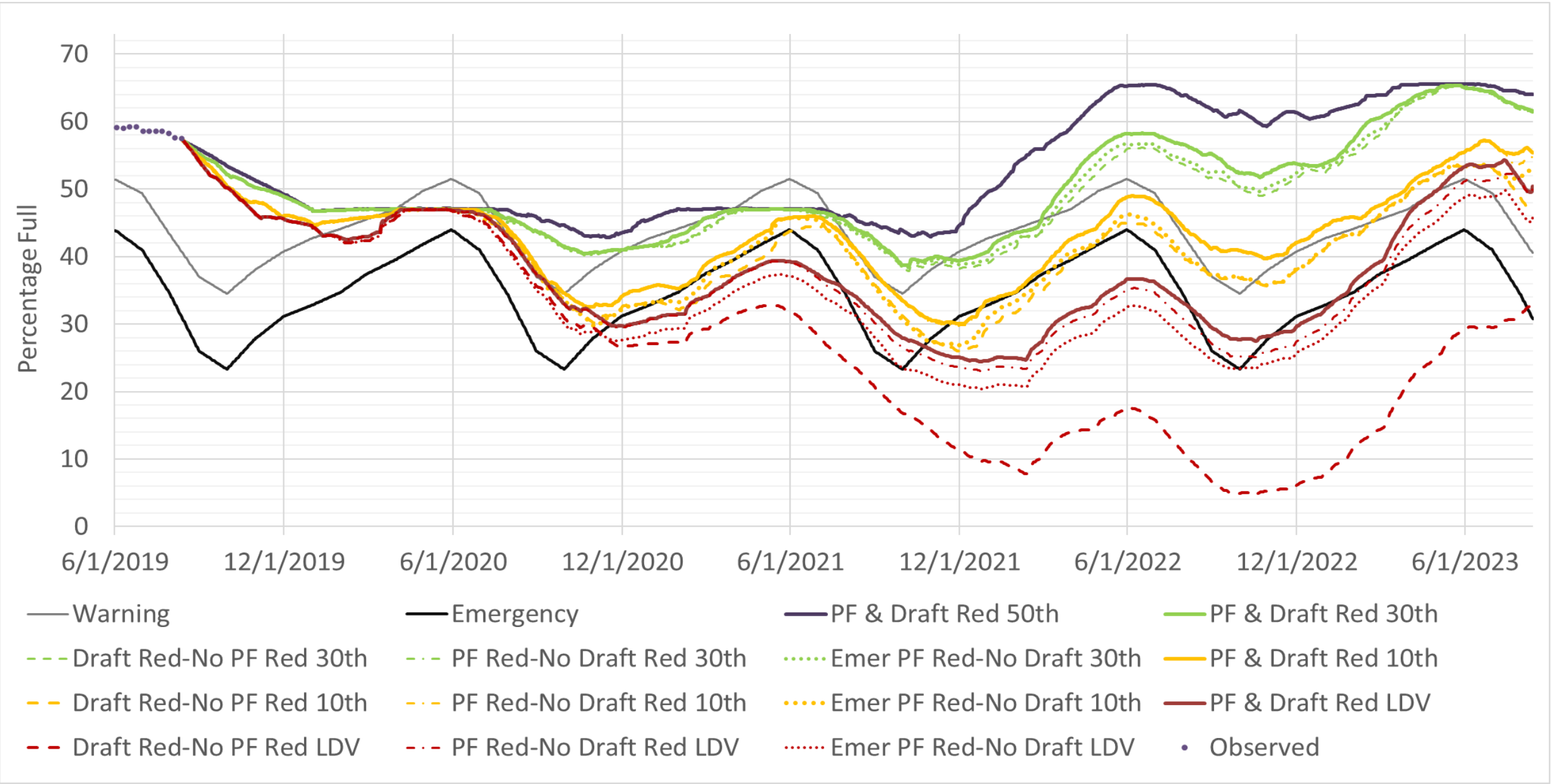
**(Drought)**

# New Improved Way – 1-Year Forecast



(Drought)

# Multi-Year Forecast for Infrastructure Improvement



**(Assess Risk)**

# Advantages of Using Forecast Models :

## ➤ Additional Data

- ❖ Provides detailed range of future storage probabilities
- ❖ Easily compare the effects of alternative operations (Draft/Passing Flow reductions)
- ❖ Pumped volume, pumping cost, simulated flows, etc.

## ➤ Additional Time

- ❖ Hours to < 1-day to run and summarize simulation that expedites the process during drought (Monthly/Weekly)
- ❖ Provides additional time for decision making

## Limitations of Forecast Models :

### ➤ Model

- ❖ Assumes stationarity - historical hydrology representative of future conditions, e.g., climate change
- ❖ Not a completely accurate representation of water-supply systems– simplifications and assumptions made
- ❖ Infrastructure, hydrology, demands, permit requirements, etc. change- periodic model updates and maintenance required

### ➤ Process

- ❖ Each forecast run requires
  - ❖ Hindcast run
  - ❖ Specific model setup sequence
- ❖ Some scenarios require RPL changes and/or verification steps
- ❖ Sometimes there are just *ghosts in the machine...*



**Thank You**

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