Use of Intra-Seasonal and Seasonal Forecasts to Reduce Risk in Regional Public Water Supply Management

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Overview

- Project Partners
- Project Background & Goals
- Methods
- Results
- Lessons Learned
- Relevance

Funded by NOAA's Climate Program Office
SARP-Water program

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Background

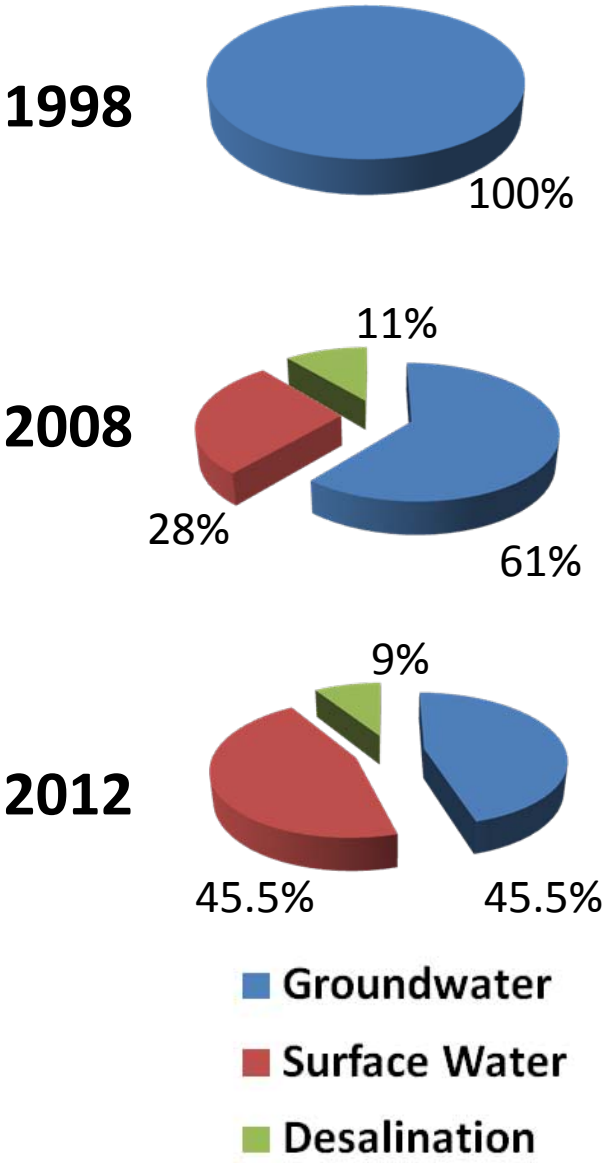
- Current sources:
  - Groundwater (13 wellfields)
  - Tampa Bypass Canal/Hillsborough River
  - Alafia River
  - C.W. Bill Young off-stream reservoir
  - Desalination Plant

(12-month moving average)

Groundwater Permit

Pre-1998	192 MGD
1998	158 MGD
2002	121 MGD
2008	90 MGD

Percentage of Water by Source



Source Allocation Decisions

- Multiple decision scales:
  - Water year plan (6-months prior)
  - Month to month adjustments
  - Operational decisions (weekly)

- Multiple constraints:
  - Permitted groundwater (12-month moving average)
  - Minimum streamflows
  - Streamflow extraction ratio (maintain Fluoride limit)
  - Costs of different sources

Project Goals

- Integrate forecast information into decision making
  - Multiple temporal scales
  - Relevant spatial scales
  - Integrate forecasts into suite of models used by Tampa Bay Water
- System-wide Decision Support
  - What is the system-wide benefit/risk of adopting forecast information?
  - What is the reliability of the current system?
  - Value judgments under different scenarios?

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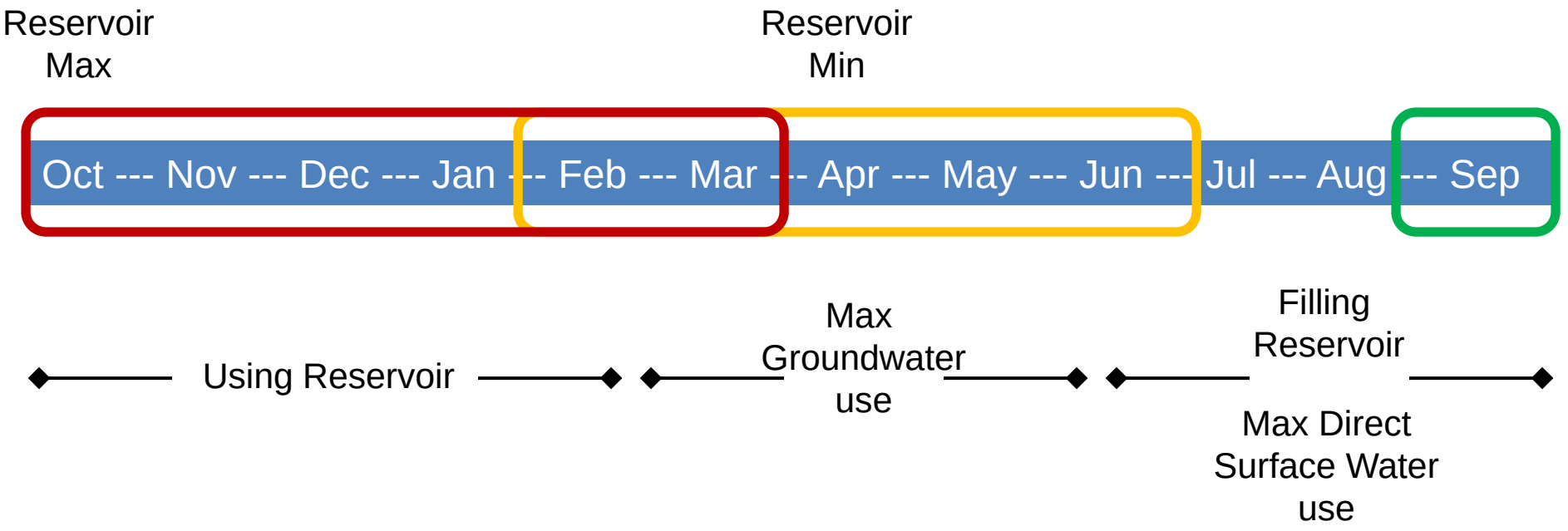
Links Between Climate/Hydrologic Information and Decisions by Tampa Bay Water

Decision	Time-Scale	Required Information Climate/Hydrology
Set Prices and monthly Source Allocation for water-year	18 months in advance	•Estimate of initial reservoir volume •Scenarios of historical conditions •Demand forecasts
Update water-year Allocations	Monthly, out to 12 months	•Precipitation and Streamflow forecasts
Operational Allocations	Weekly, out to 4 weeks	•Precipitation, Streamflow and Demand forecasts

“Typical” Water Year



- Estimate of end of year reservoir level needed for plan for next water year
- Greater than expected groundwater pumping impacts next water year plan
- Seasonal forecasts can be used to determine expected higher/lower groundwater pumping in winter months

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Different Products for Different Time-Scales

- Operational – Ensemble Precipitation, Streamflow and Demand forecasts derived from medium-range forecast products
- Monthly/Seasonal – Probabilistic Precipitation and Streamflow/Withdrawal Climate-based Forecasts
- Water-Year – Decision Support, taking into account previous and next 12 months

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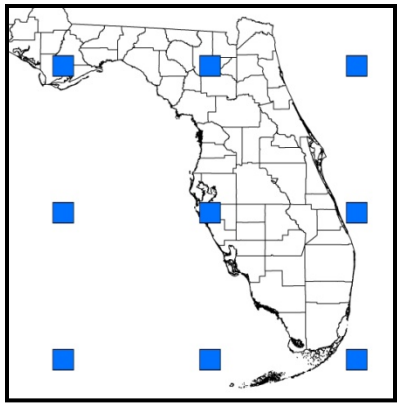
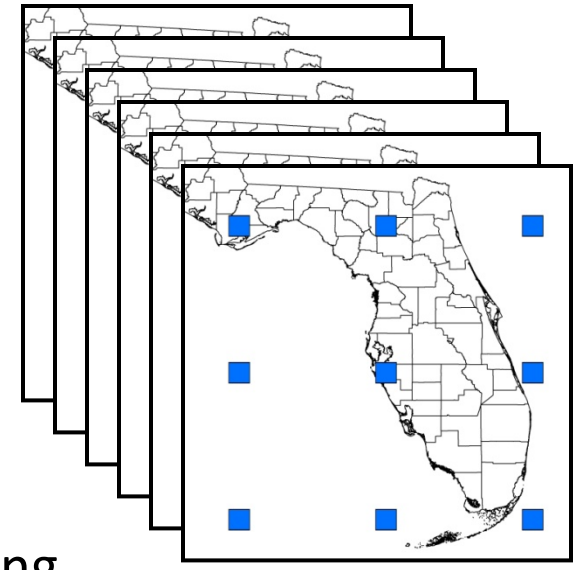
Operational Time-scale

Current Forecast

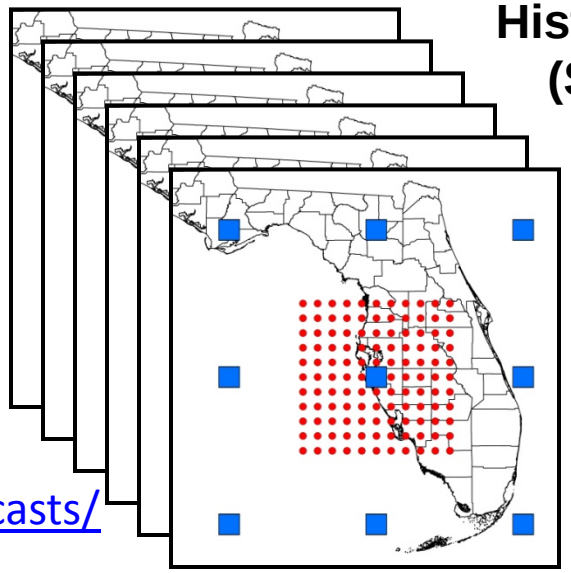


Historical Forecast Analogs



- +/- 30 day search window
- 100 analog forecasts

- Forecast analogs using the ESRL/PSD GFS Retrospective forecast archive
  - 1-15 day
  - 2.5° x 2.5°
  - 1979-present
- Analog selection can be tailored to need

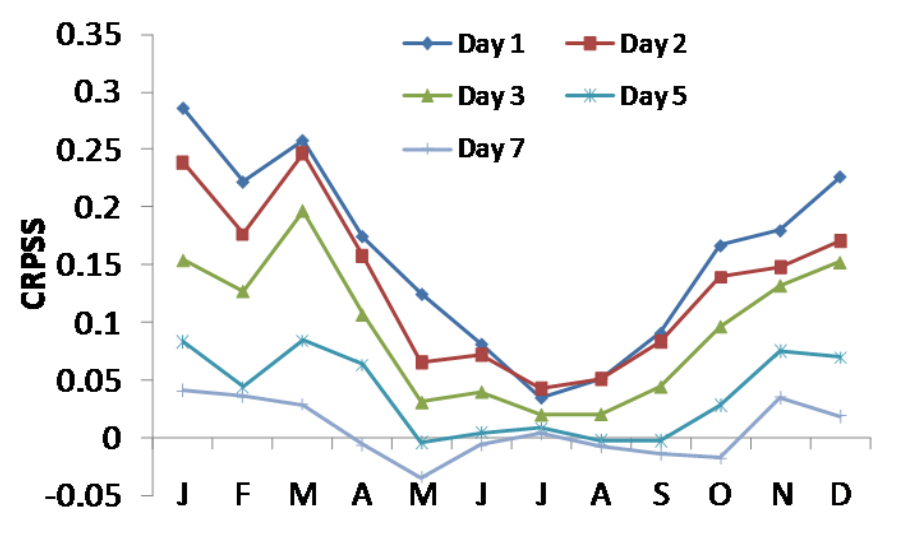


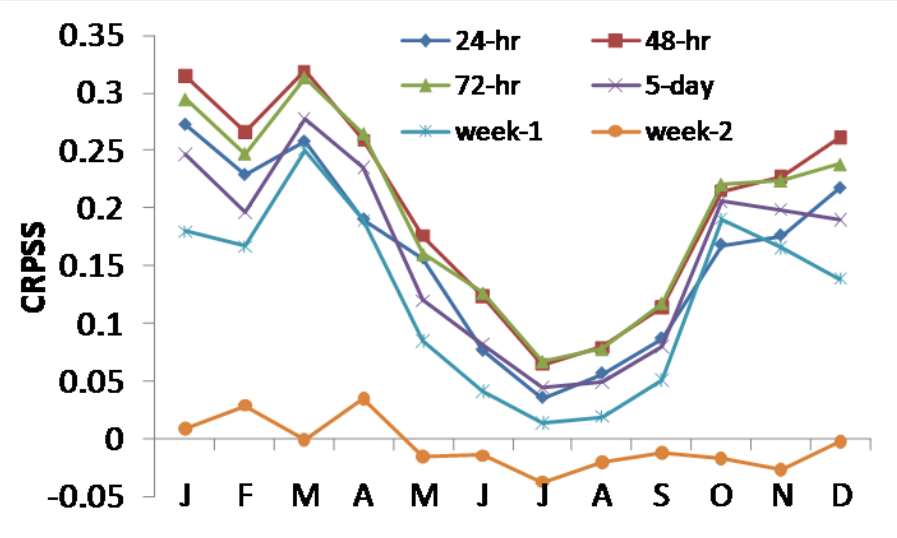
Historical Observations (Stations or NARR)

Ensemble of Hydrologic Forecasts

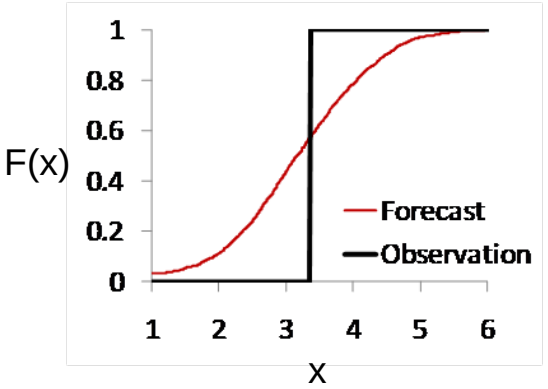
http://www.esrl.noaa.gov/psd/forecasts/reforecast/

Precipitation Forecast Skill





CRPSS: Continuous Ranked Probability Skill Score



$$\mathrm{CRPS} = \int_{-\infty}^{\infty} \left[F(x) - F_o(x) \right]^2 dx$$

$$\mathrm{CRPSS} = 1 - \frac{\mathrm{CRPS}_{\mathrm{Forecast}}}{\mathrm{CRPS}_{\mathrm{Ref}}}$$

Monthly/Seasonal Time-scale

- Forecast analogs using CFS retrospective forecast archive http://cfs.ncep.noaa.gov/
  - Week 2
  - Monthly
  - Seasonal

- Climate-based probability of exceedance streamflow forecasts

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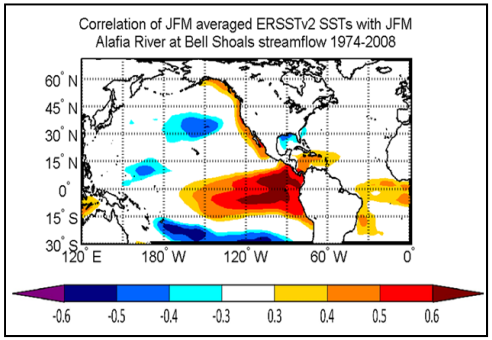
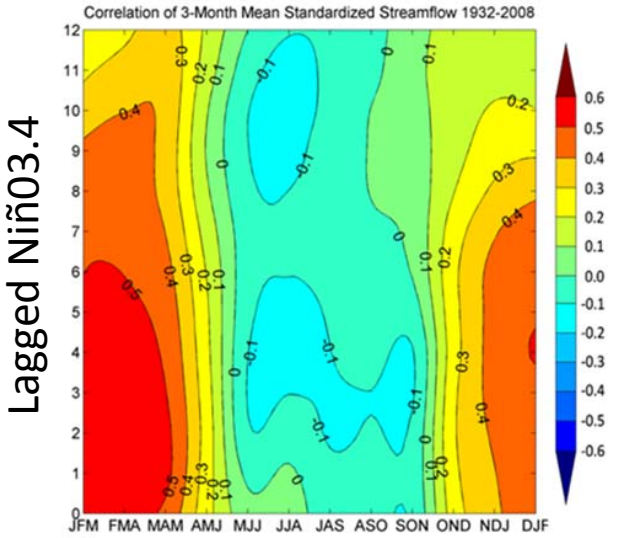
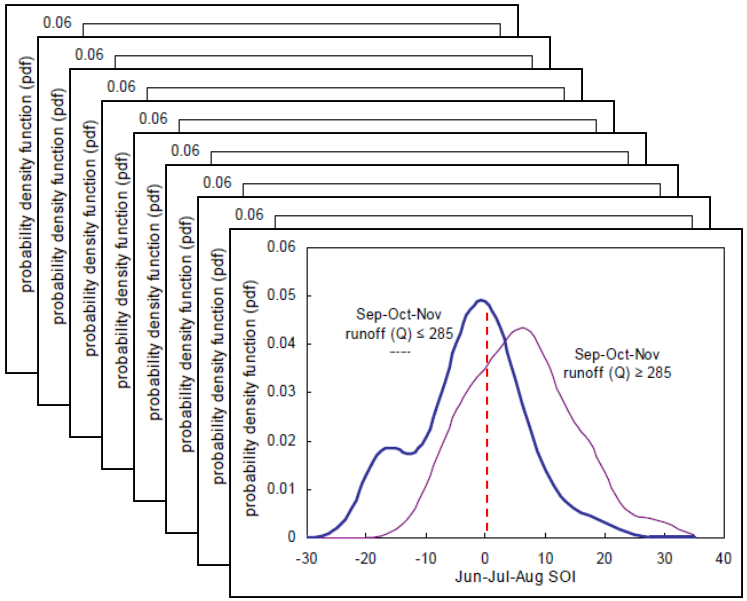
Probability of Exceedance Streamflow Forecasts



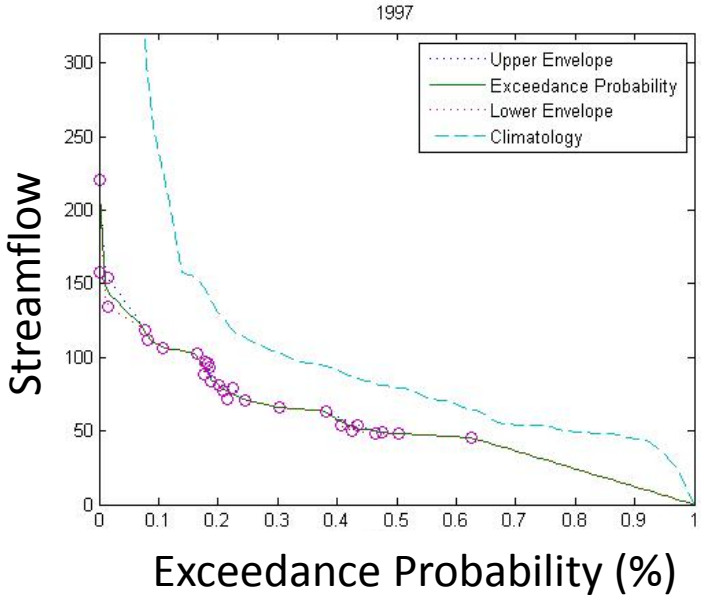
Correlation of Streamflow w/ ENSO



Posterior probability of streamflow conditioned on predictor

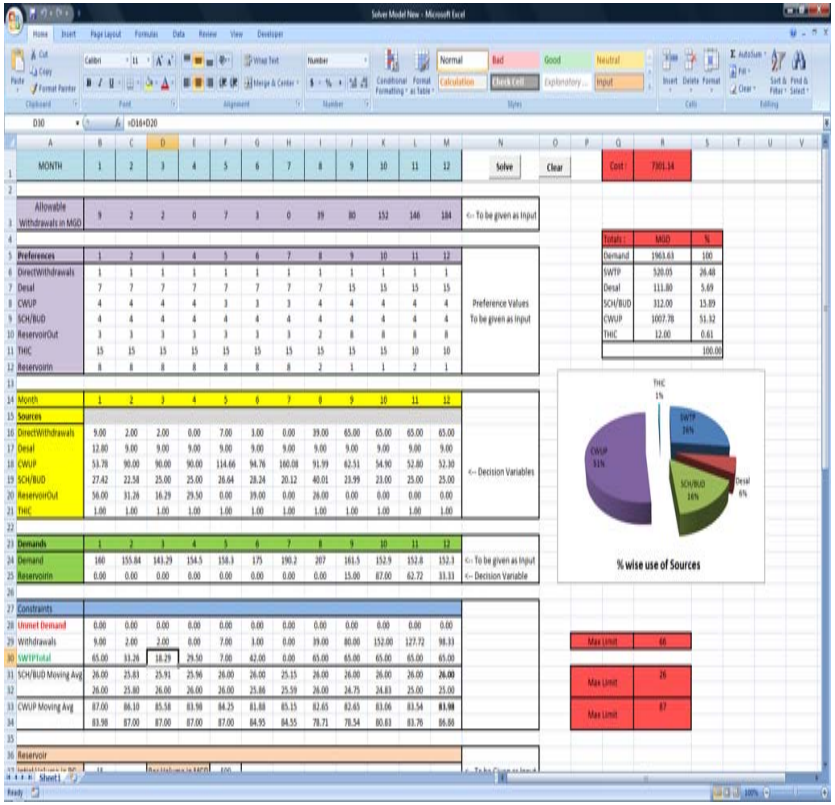


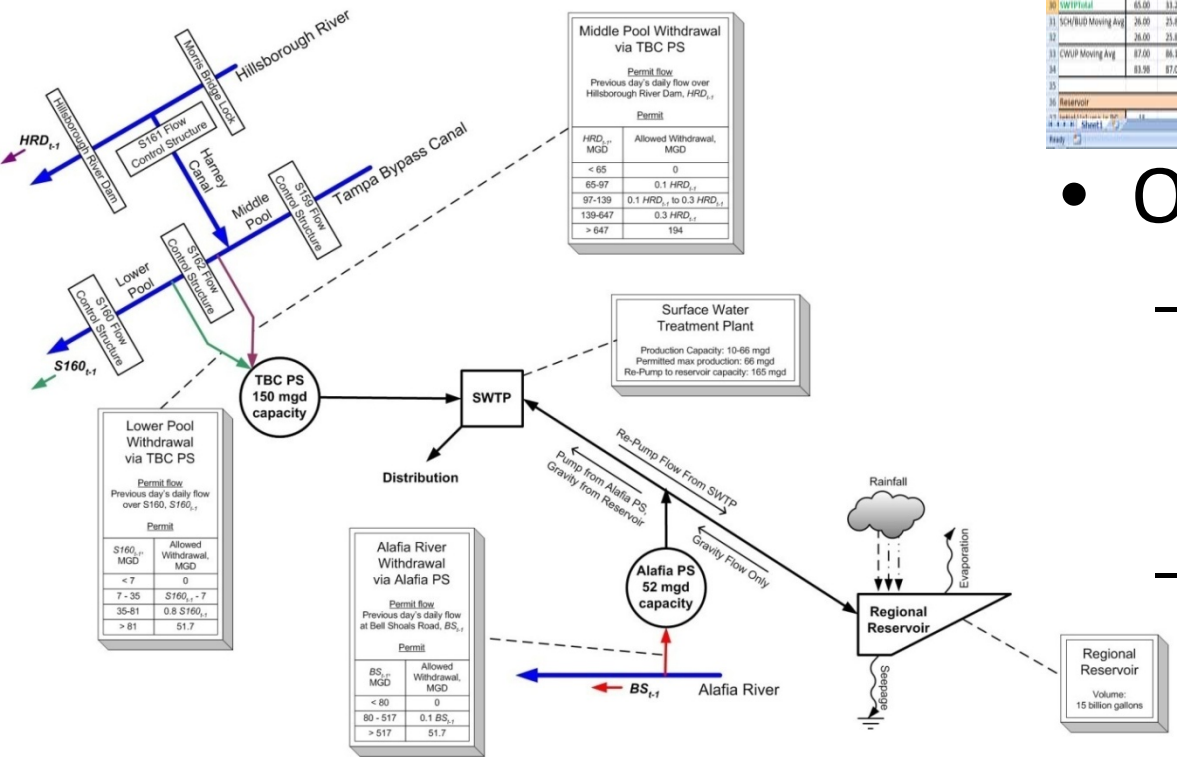
Streamflow Forecast



Decision Support + Scenarios

- Inputs:
  - Forecasted Demand
  - Forecasted Withdrawal





- Outputs:
  - Optimized source-water allocations based on preferences/constraints
  - End of year reservoir volume

Lessons Learned

- There is a learning curve associated with using weather/climate datasets!!!
  (for hydrologists/engineers, at least…)

- Limited number of forecasted variables archived in retrospective archives may limit usefulness

Relevance

- Tools/approaches that can easily be replicated in other regions
  - Analog forecasts
  - Exceedance streamflow forecasts