A Prototype Forecast-Informed Reservoir Operation (FIRO) for Lake Conroe, TX
## – Application of NOAA/WPC's QPF and CPC's Outlooks in Reservoir Operational Modeling

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Water Availability Program
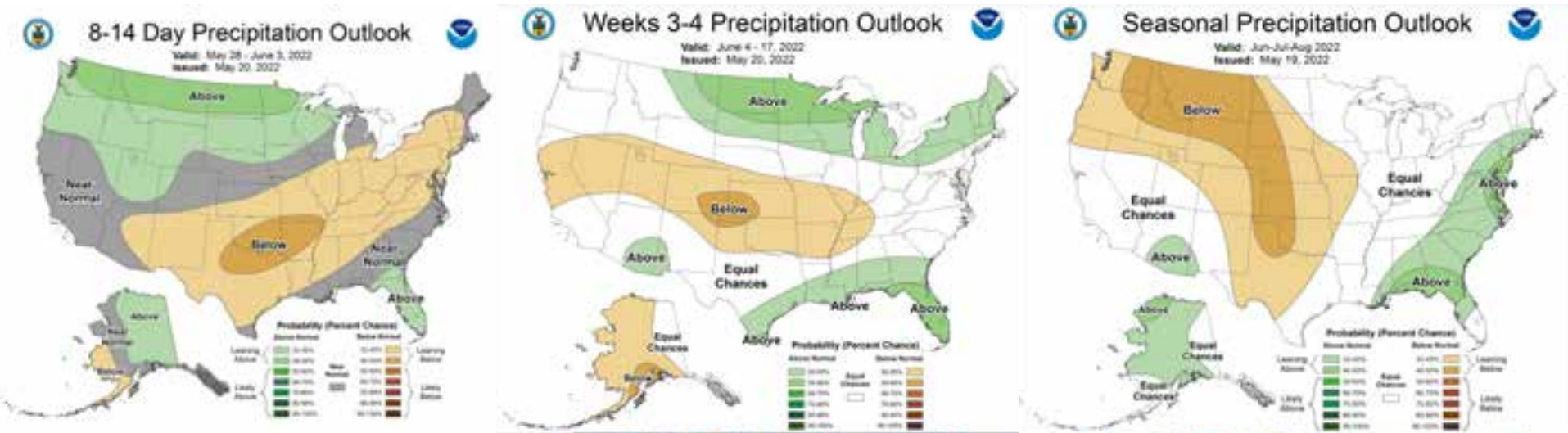Surface Water Division

Background and Motivation

- Forecast-informed reservoir operations (FIRO) is a reservoir-operations strategy that uses … weather and water forecasts to inform decision making to selectively **retain or release** water from reservoirs to optimize water supply reliability and … to enhance flood-risk reduction. (drought.gov)

- Lake Conroe is selected as the prototype because it is a water supply reservoir that must consider flood control operations, post Hurricane Harvey.

Conroe

Unreasonably Released

No space before Hurricane Harvey
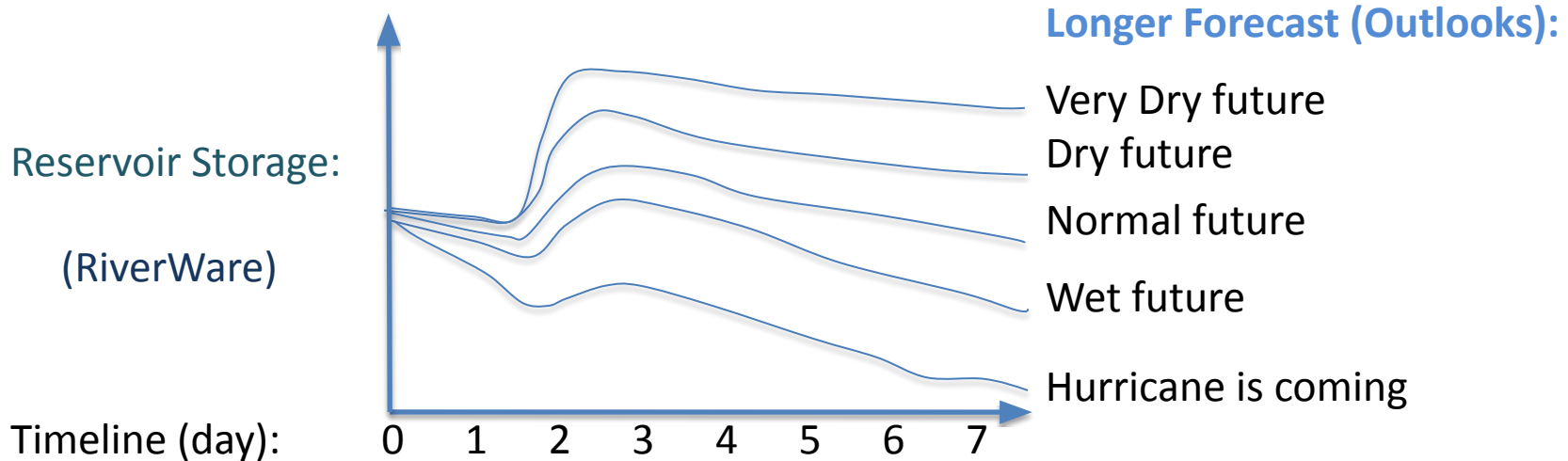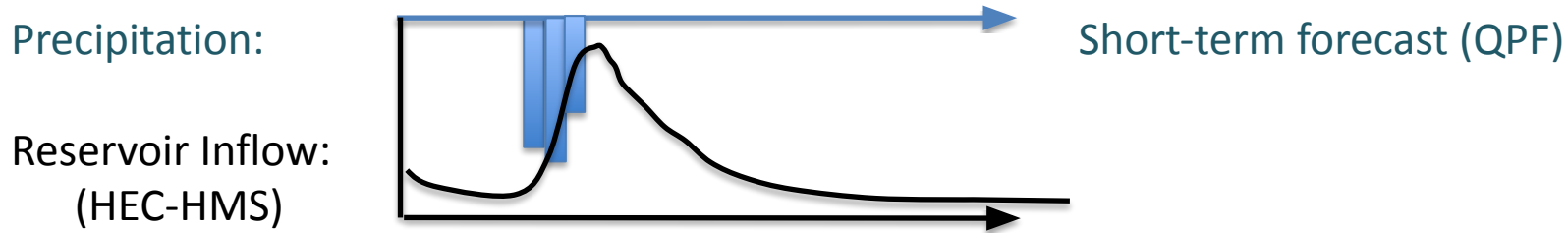
2007   2012   2017
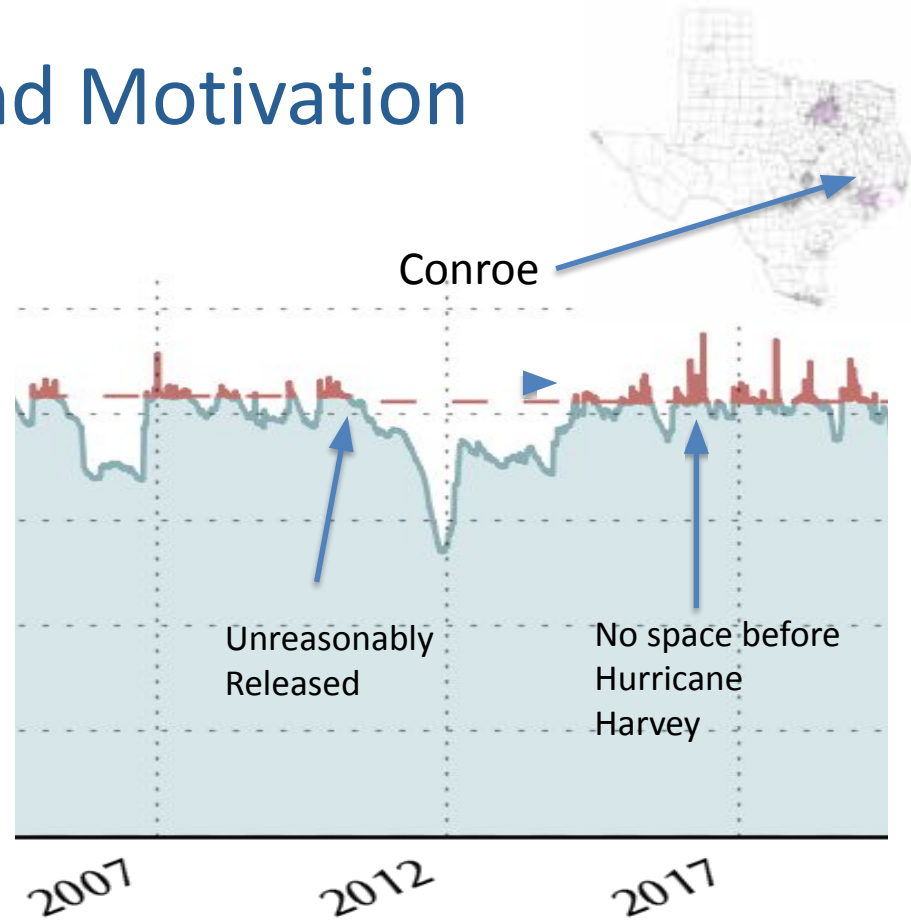
NOAA's Forecasts and Outlooks

- Quantitative Precipitation Forecast (QPF) for 7 days (6-hrs per file and total 28 grib2 files – retrieved by python scripts) https://www.wpc.ncep.noaa.gov/qpf/qpfloop_6hr_d17.html

Methodology of our prototype FIRO

Precipitation:

Short-term forecast (QPF)

Reservoir Inflow:
(HEC-HMS)

Longer Forecast (Outlooks):

Very Dry future

Dry future

Reservoir Storage:

Normal future

(RiverWare)

Wet future

Hurricane is coming

Timeline (day):   0   1   2   3   4   5   6   7

Less

More release
release
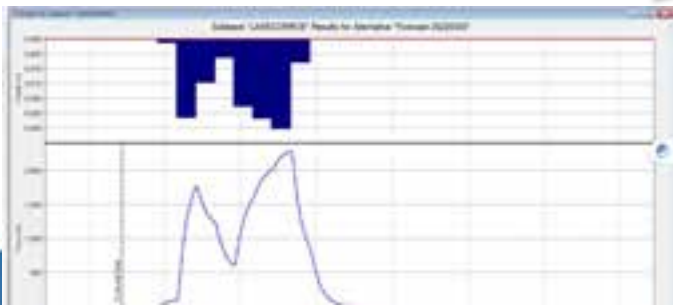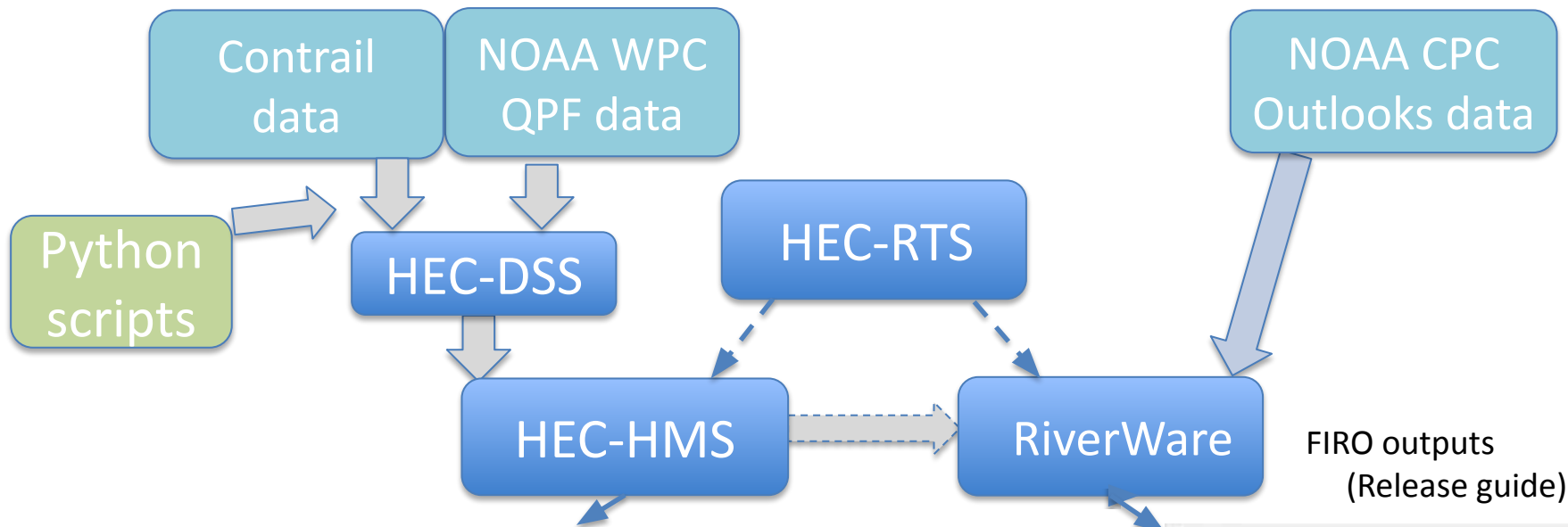
Not only is the short-term operation driven by short-term forecasts (QPF), but the operational target is also determined by the longer-lead forecast (various CPC Outlooks).

Data, toolsets, and workflow
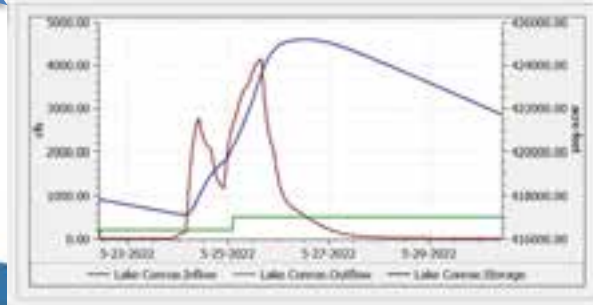
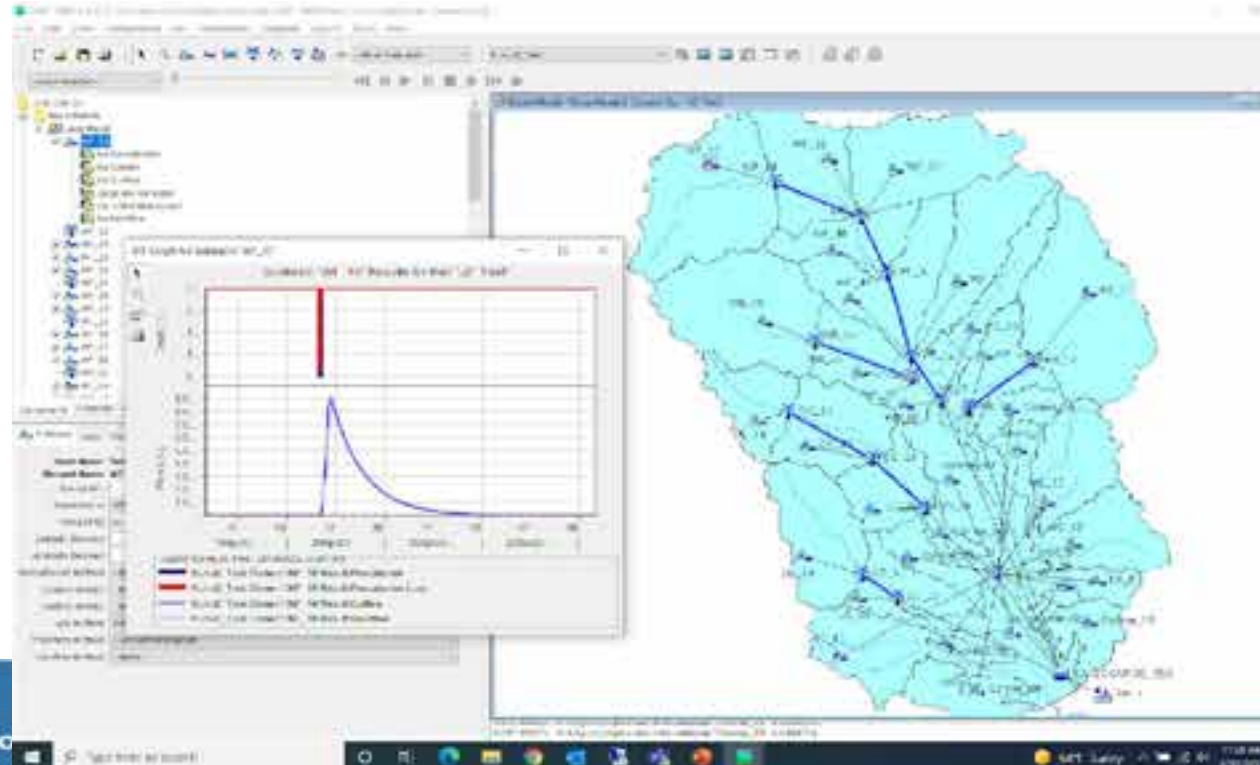# Lake Conroe

- Built in 1973; and jointly owned the San Jacinto River Authority (SJRA) and the City of Houston; it is operated by SJRA for water supply purpose.

- Added flood control operation after Hurricane Harvey.

- Total conservation capacity is 411,022 acre-feet at top of conservation pool at 201 feet msl.
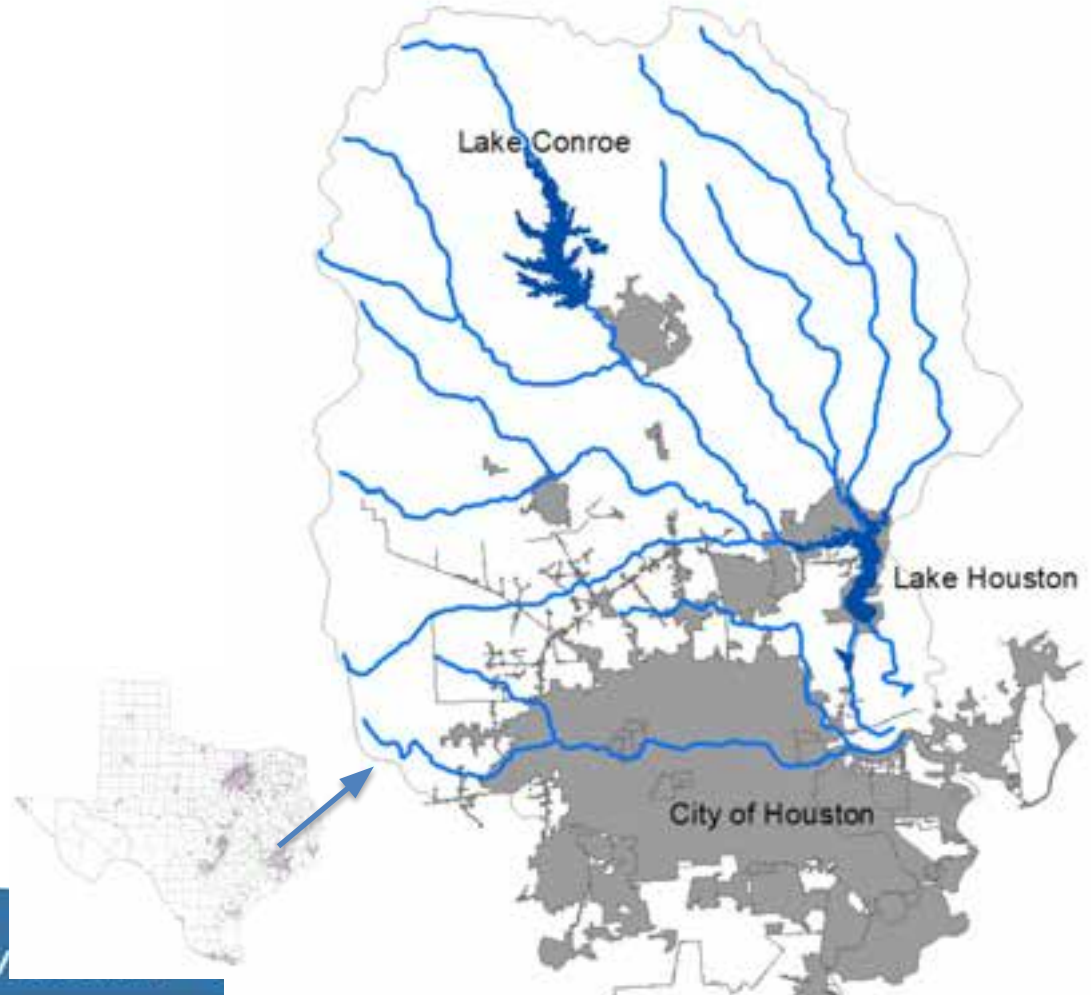
HEC-RTS and HEC-HMS for Conroe watershed

HEC-HMS model for Lake Conroe Watershed

RiverWare model for Lake Conroe

Covering entire watershed
5 reaches, 1 reservoirs, 1 confluences, 6 diversions.

Use latest reservoir hydrographic survey - 2020 rating curve

15-minute timestep

Contrail rainfall and QPF data fetching

- Past 24 hours rainfall data are retrieved through Contrail API.

- 6-hour NOAA-NWS-WFC Quantitative Precipitation Forecast (QPF) for next 7 days are downloaded into HEC-DSS.

- Data are disaggregated into 15-minute intervals to feed the HEC-HMS model.

- Past 24 hours streamflow at an upper stream of the lake is also retrieved for HEC-HMS model warming up.

- All done using python scripts.

Algorithm for determining operational target

Targeted pool elevation (feet) for the 7-days operation
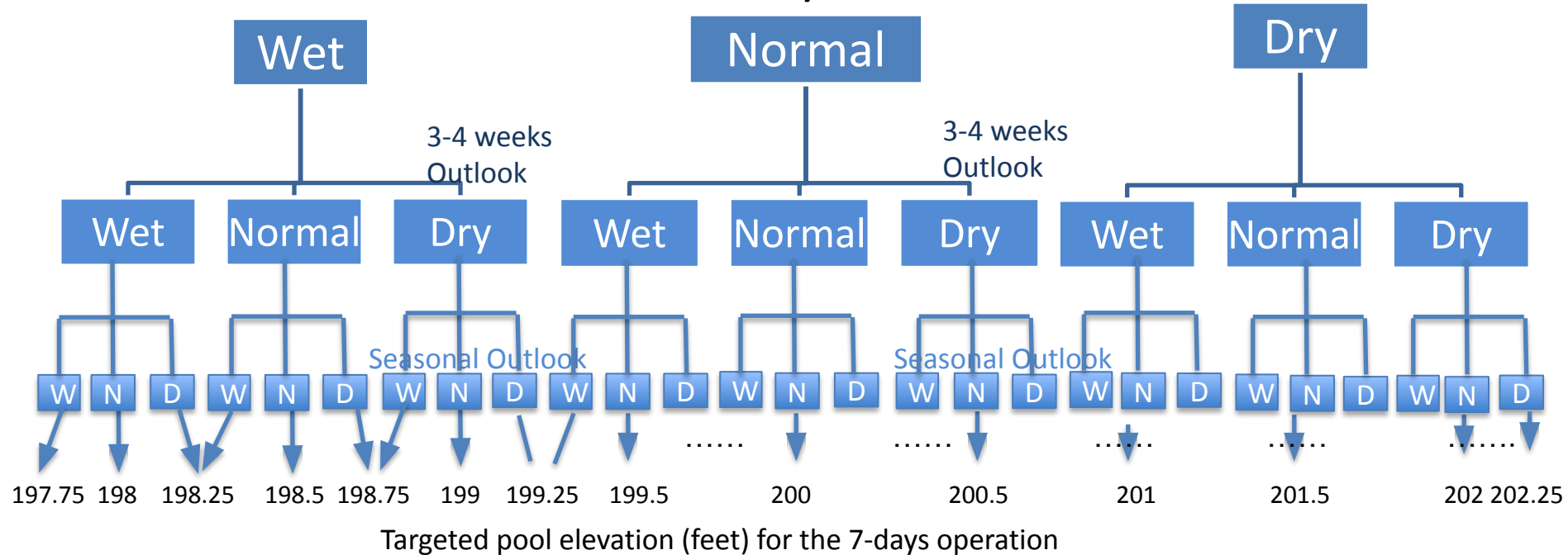
Note: All wet and dry must have a probability (percent chance) above 50%, otherwise, it is deemed as

Rule implementation in RiverWare model

Rules for Operational target:

Rules for release:

Large storm (Hurricane) pre-release

- Pre-release or lowering down pool elevation is determined by forecasted total inflow of the **third** day from current day.

- The release rate and lowering level depend on amount of forecasted total inflow.

- The release time is before the third day's peak time of the inflow.

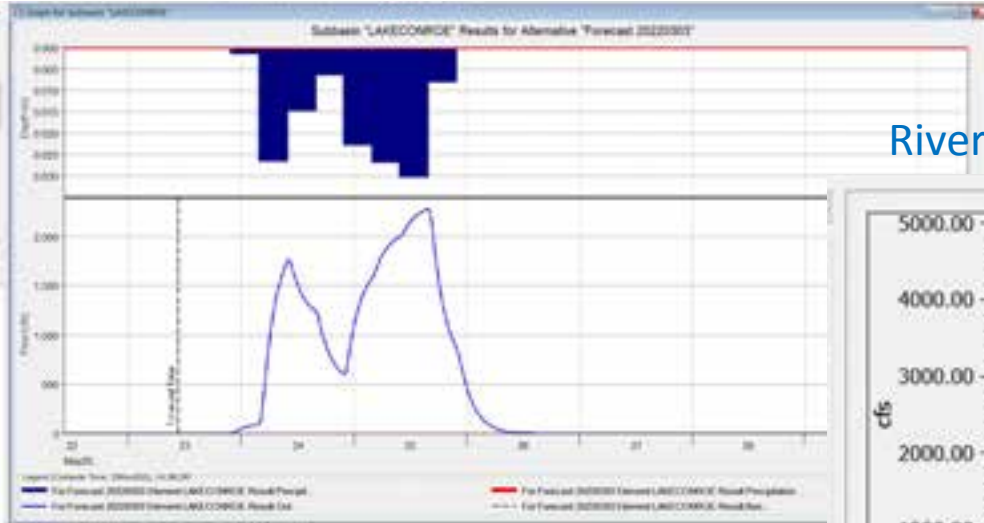- This pre-release operation is the highest priority (No.1 rule).
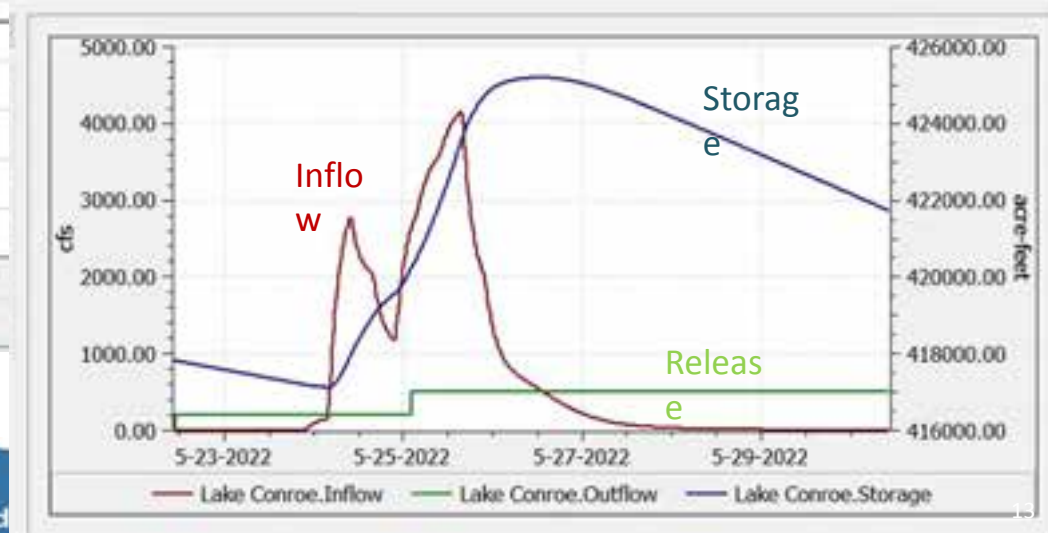
Result of simulations (May 22-30, 2022)

Regular runs set every 7 days. Flood prevention runs set every 6 hrs or every day depending situation.

HEC-HMS output:

RiverWare output for Lake operation:

Little release due to normal outlooks

Key take aways

- NOAA's QPF and Outlooks can be used for reservoir operation by FIRO modeling. QPF Grib2 data can be automatically retrieved by python program.

- HEC-RTS, HEC-HMS and RiverWare can work together for this purpose.

- QPF appears reasonable, but it would the best for QPF in variable timesteps, 1-, 2-, 3-, and 6-hr for 0-6, 6-24, 24-48, 48-168 hours, respectively.

- More efforts are needed from the prototype to a formal/pilot model.
(lake owner' data, other input data (i.e., HRRR), timesteps, model, calibration)

Questions?

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Texas Water Development Board