Practical Considerations for Developing RiverWare Models for Hydropower Operations

RiverWare User Group Meeting
August 27, 2026

Abby Watson I RTI International

RTI's River Forecasting & Operations Team

Water capabilities extend beyond to Integrated Water Resources Management, Water Supply Planning, Nature-Based Solutions, Hydrologic Risk Assessment, and Hydrometeorology

Forecast-Centered Research

- Forecast evaluation and dashboards TEEHR
- Developing and testing ML techniques for improved snow data assimilation
- Implementing NexGen advancements and distributed datasets into RFC modeling workflows

CIROH

BUREAU OF RECLAMATION

Colorado Basin River Forecast Center
National Weather Service

CALIFORNIA-NEVADA RIVER FORECAST CENTER
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Research-to-Operations

Operational System Development and Maintenance

- Implement Deltares Flood Early Warning Systems (FEWS) as well as RTI's Amanzi web-based system
- Develop hydrologic, hydraulic, and operational models and integrate within forecast systems

DUKE ENERGY

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

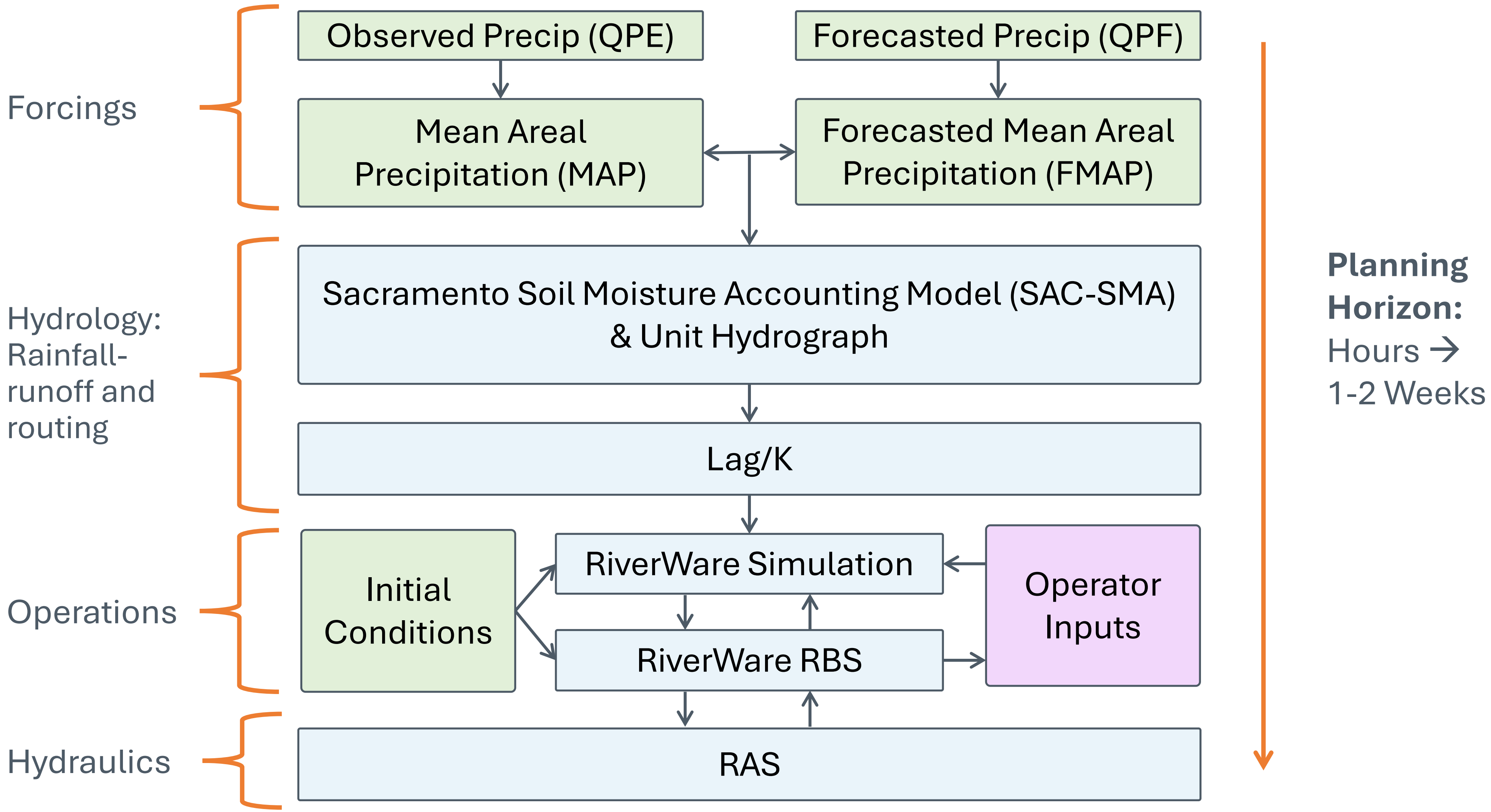
Southern Company

CANAL DE PANAMÁ

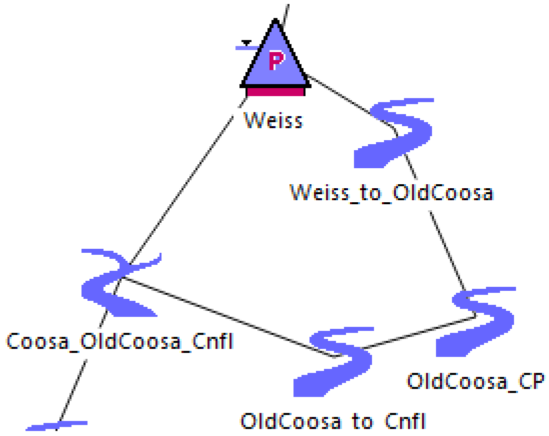
Ameren

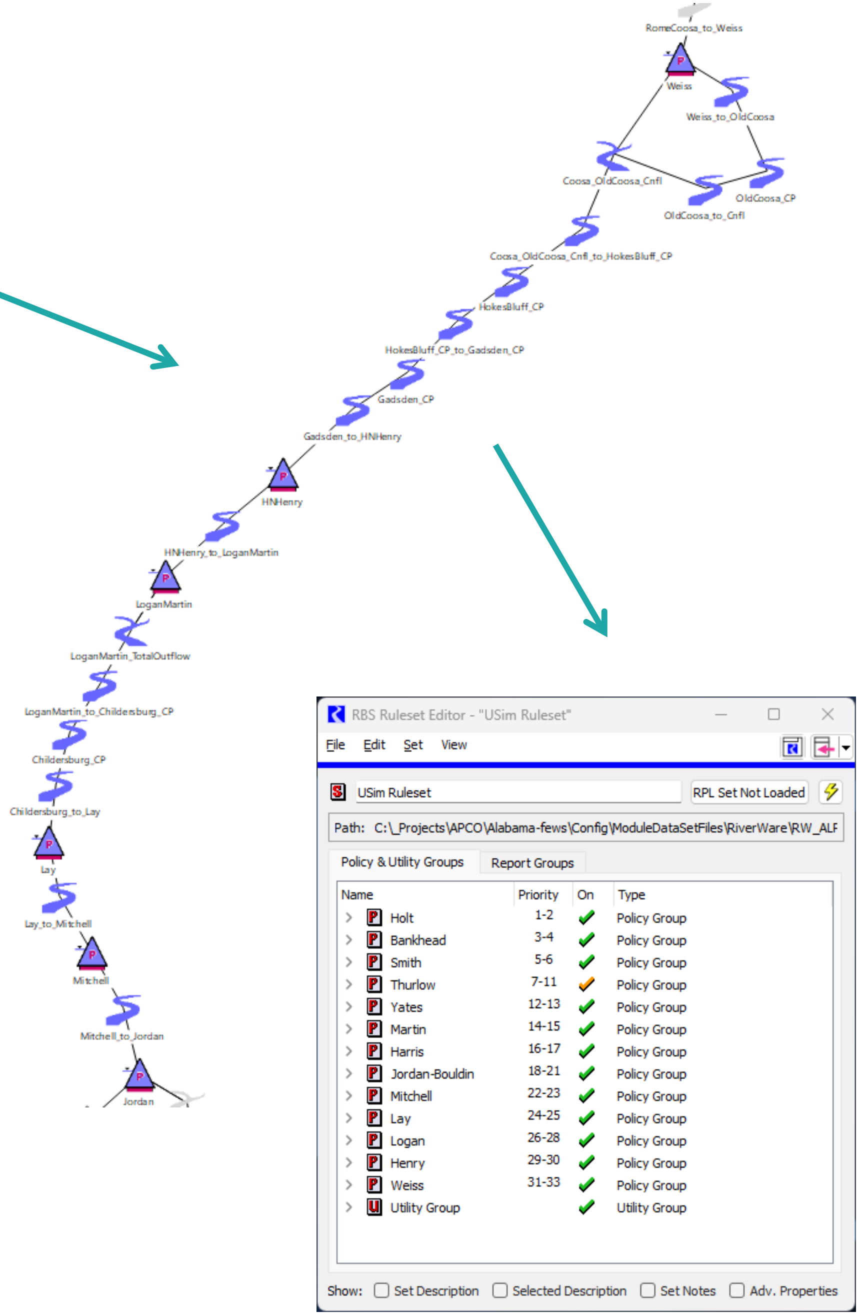
Wisconsin Valley Improvement Company

River Forecast Systems for Hydropower Operators



Start small.



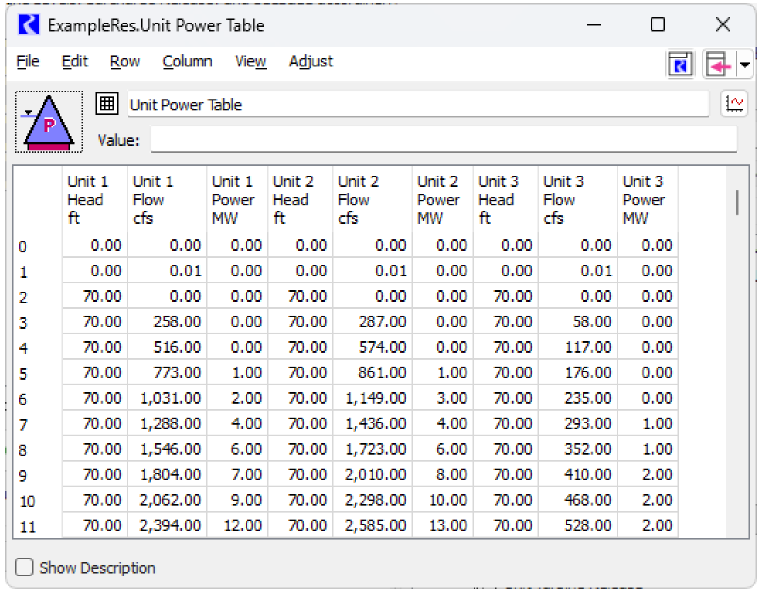


- Understand the daily scheduling practice, current tools, and pain points first.
- Simulate a single plant to develop user experience, incorporate user feedback, and refine the forecast workflow setup.
- Expand to the full system and operational rulesets focused on regular everyday operations tested by real users under real events.

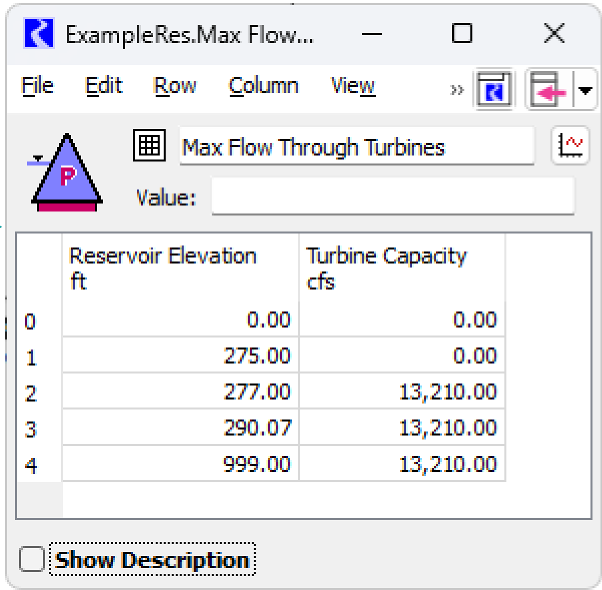
Match power representation to operator needs.

Thinking in units of flow

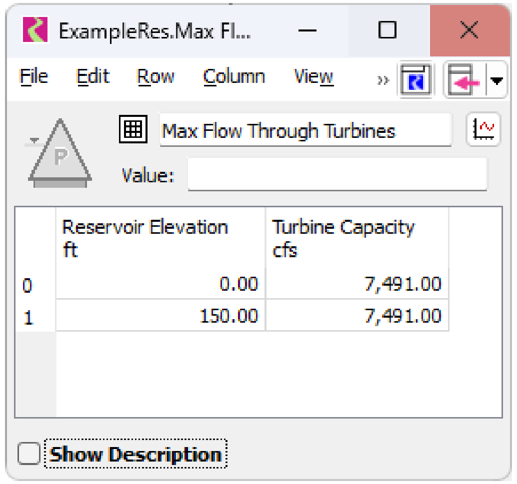
Unit Power Table Method too complex if operators think of efficient and maximum capacity values statically



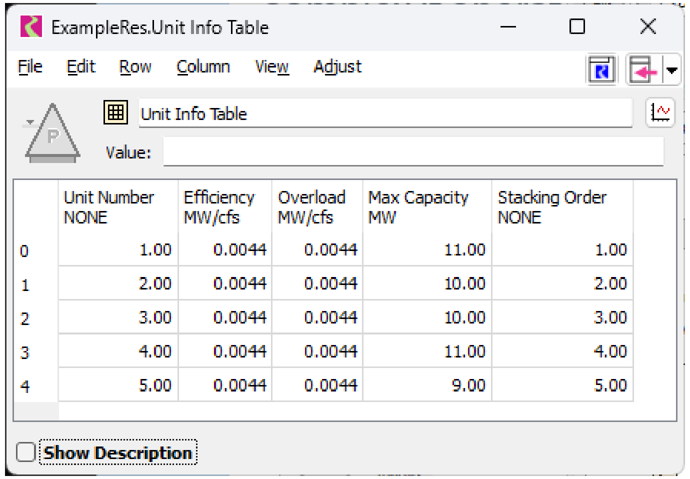
	Unit 1 Head ft	Unit 1 Flow cfs	Unit 1 Power MW	Unit 2 Head ft	Unit 2 Flow cfs	Unit 2 Power MW	Unit 3 Head ft	Unit 3 Flow cfs	Unit 3 Power MW
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.00
2	70.00	0.00	0.00	70.00	0.00	0.00	70.00	0.00	0.00
3	70.00	258.00	0.00	70.00	287.00	0.00	70.00	58.00	0.00
4	70.00	516.00	0.00	70.00	574.00	0.00	70.00	117.00	0.00
5	70.00	773.00	1.00	70.00	861.00	1.00	70.00	176.00	0.00
6	70.00	1,031.00	2.00	70.00	1,149.00	3.00	70.00	235.00	0.00
7	70.00	1,288.00	4.00	70.00	1,436.00	4.00	70.00	293.00	1.00
8	70.00	1,546.00	6.00	70.00	1,723.00	6.00	70.00	352.00	1.00
9	70.00	1,804.00	7.00	70.00	2,010.00	8.00	70.00	410.00	2.00
10	70.00	2,062.00	9.00	70.00	2,298.00	10.00	70.00	468.00	2.00
11	70.00	2,394.00	12.00	70.00	2,585.00	13.00	70.00	528.00	2.00



	Reservoir Elevation ft	Turbine Capacity cfs
0	0.00	0.00
1	275.00	0.00
2	277.00	13,210.00
3	290.07	13,210.00
4	999.00	13,210.00



	Reservoir Elevation ft	Turbine Capacity cfs
0	0.00	7,491.00
1	150.00	7,491.00

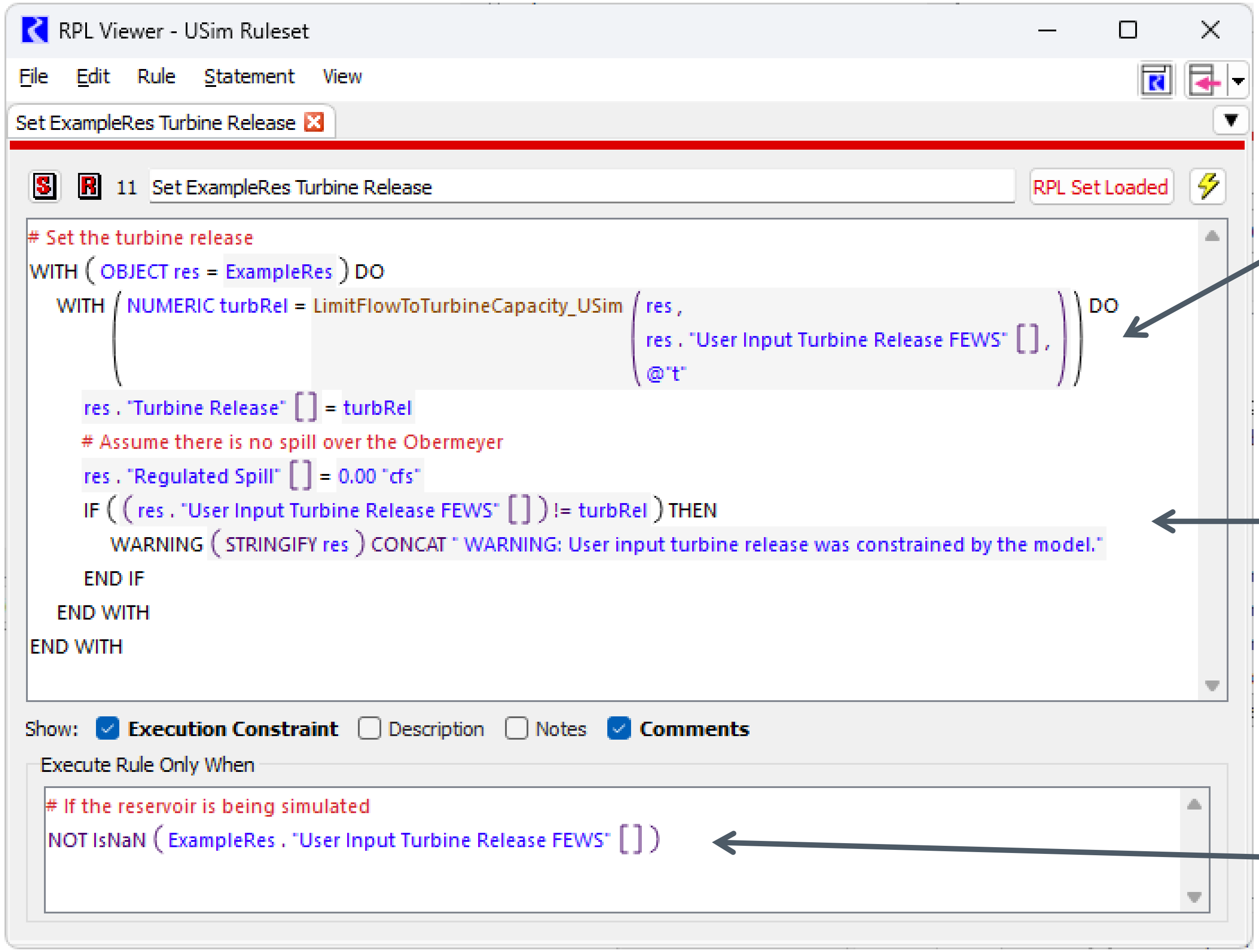


	Unit Number NONE	Efficiency MW/cfs	Overload MW/cfs	Max Capacity MW	Stacking Order NONE
0	1.00	0.0044	0.0044	11.00	1.00
1	2.00	0.0044	0.0044	10.00	2.00
2	3.00	0.0044	0.0044	10.00	3.00
3	4.00	0.0044	0.0044	11.00	4.00
4	5.00	0.0044	0.0044	9.00	5.00

Thinking in units of power

Manually covert power to flow using tabular data entry to mirror existing operator methods and thought processes

Use RPL to improve simulation model robustness.



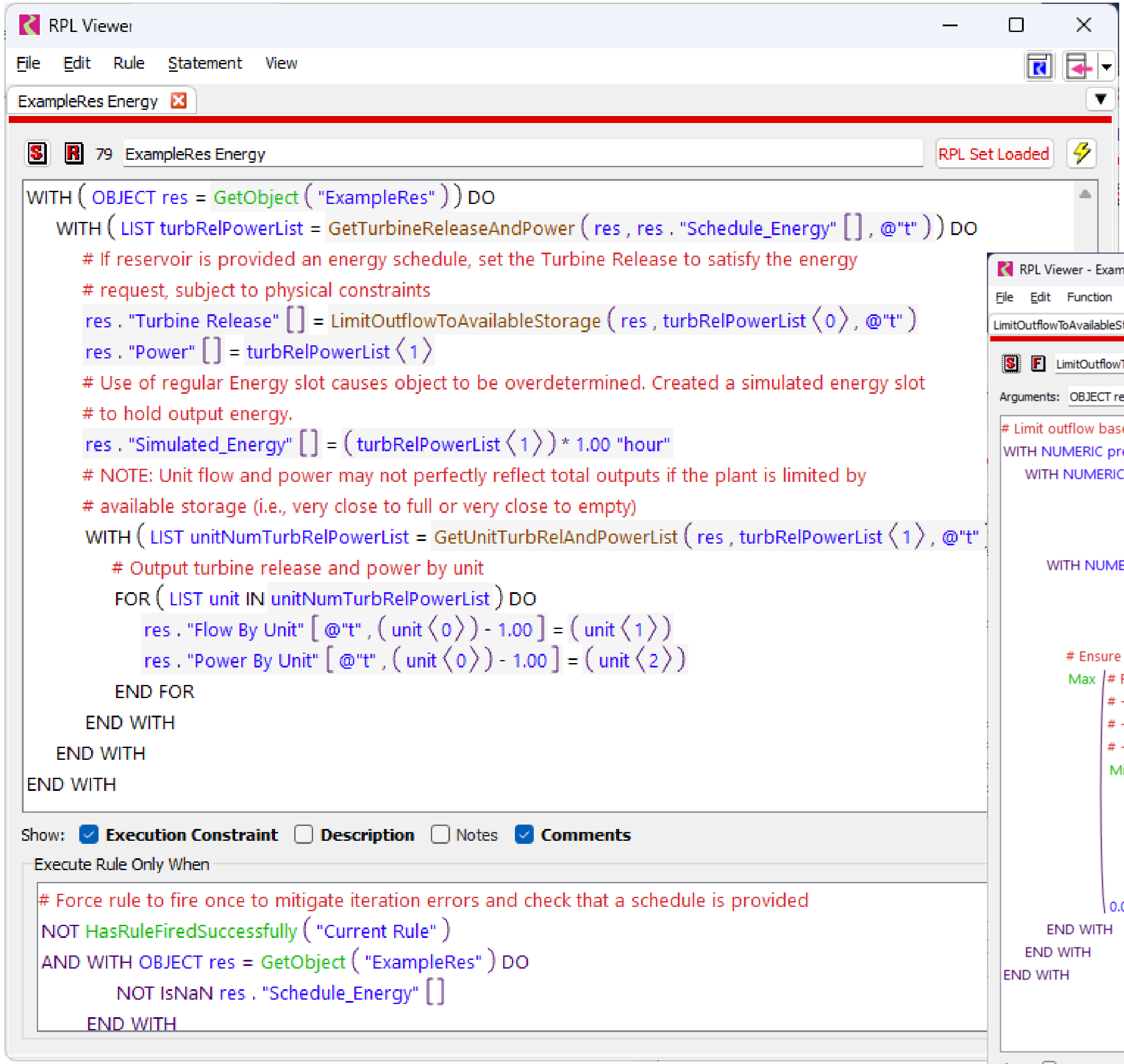
Use RiverWare RPL to validate and adjust user inputs

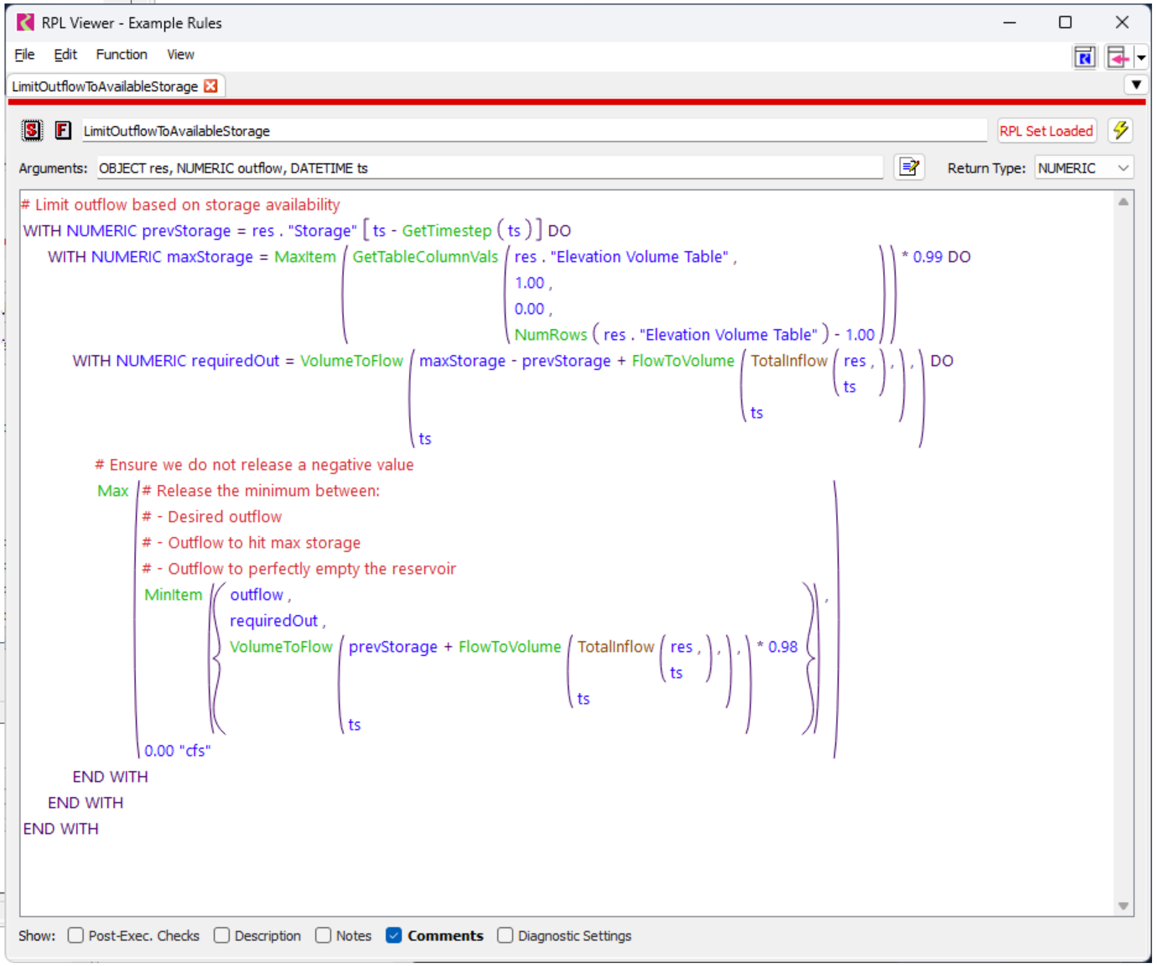
Use RiverWare `WARNINGS` to translate issues to operators

Use execution constraints to increase model flexibility

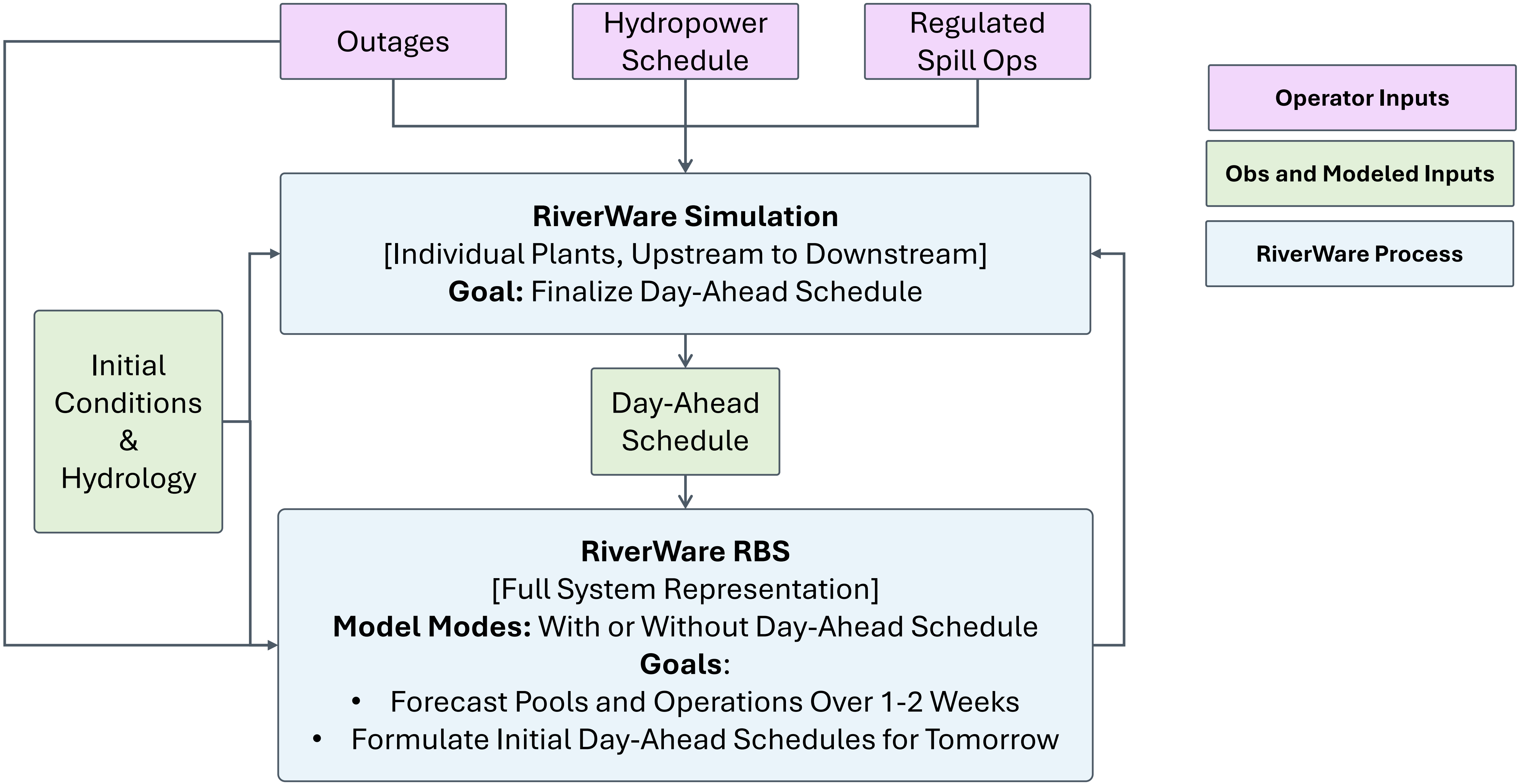
Use RPL to improve simulation model robustness.

Functions to constrain user inputs depend on reservoir characteristics

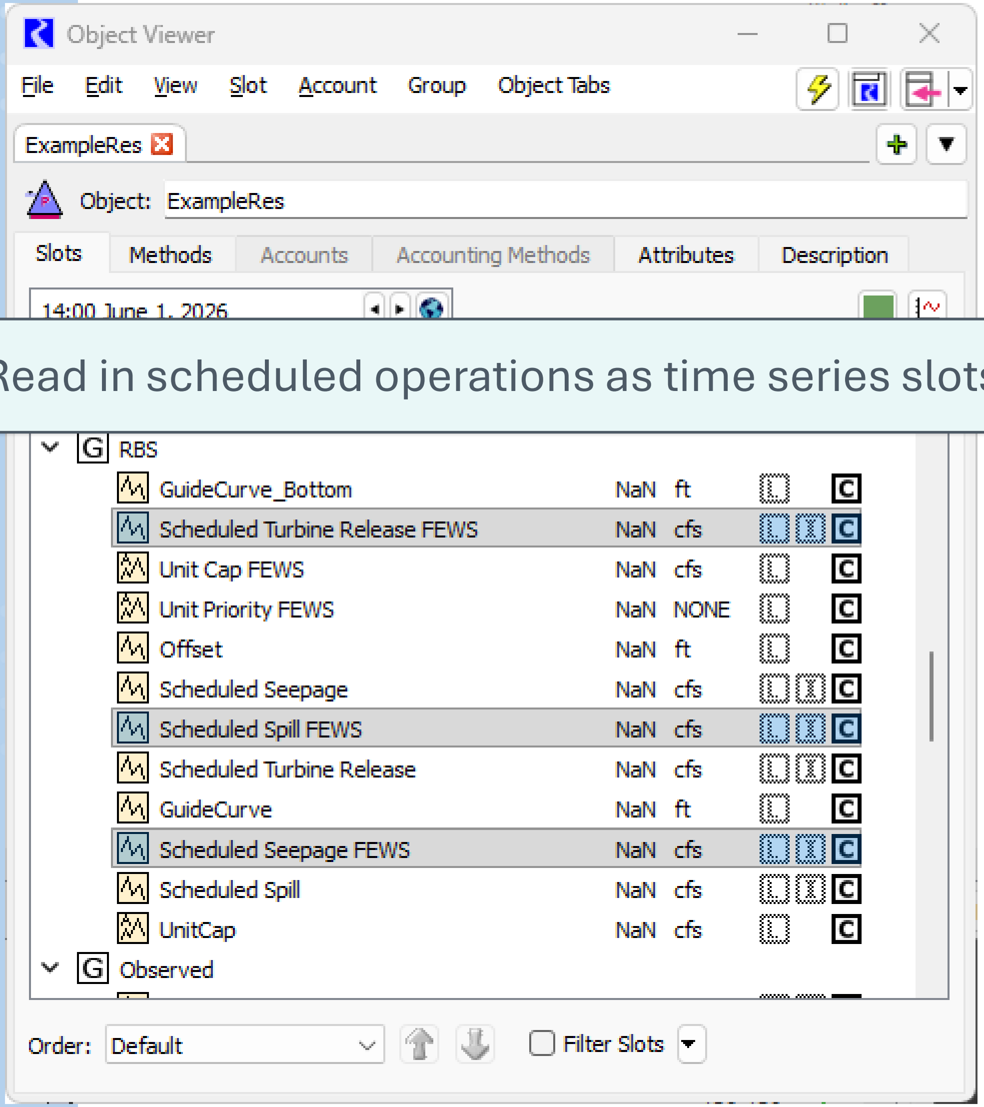




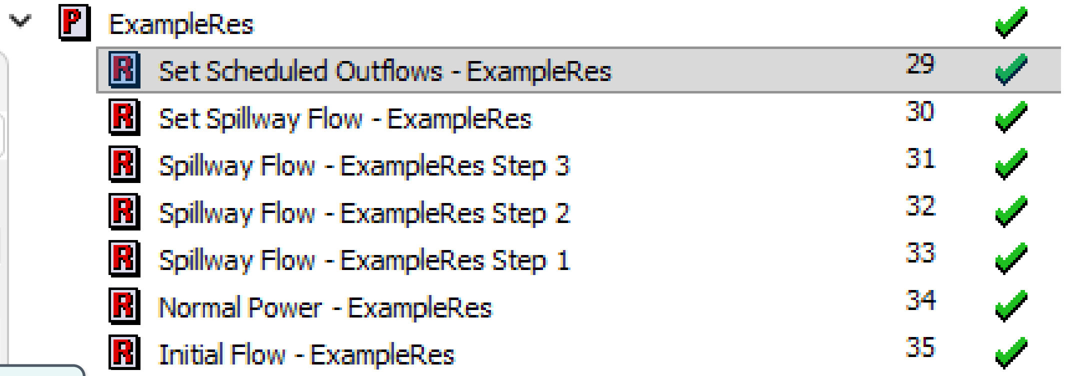
Leverage RiverWare's different run capabilities.



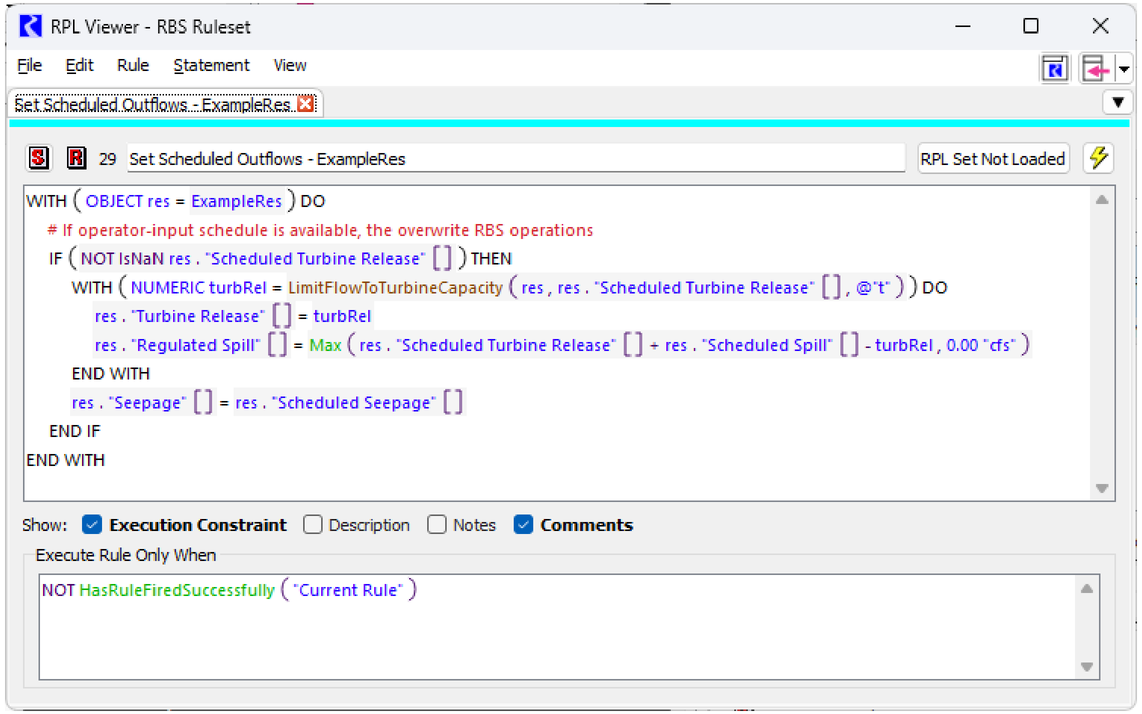
Allow operators control over outputs.



Read in scheduled operations as time series slots



Highest priority rule to overwrite RBS operations



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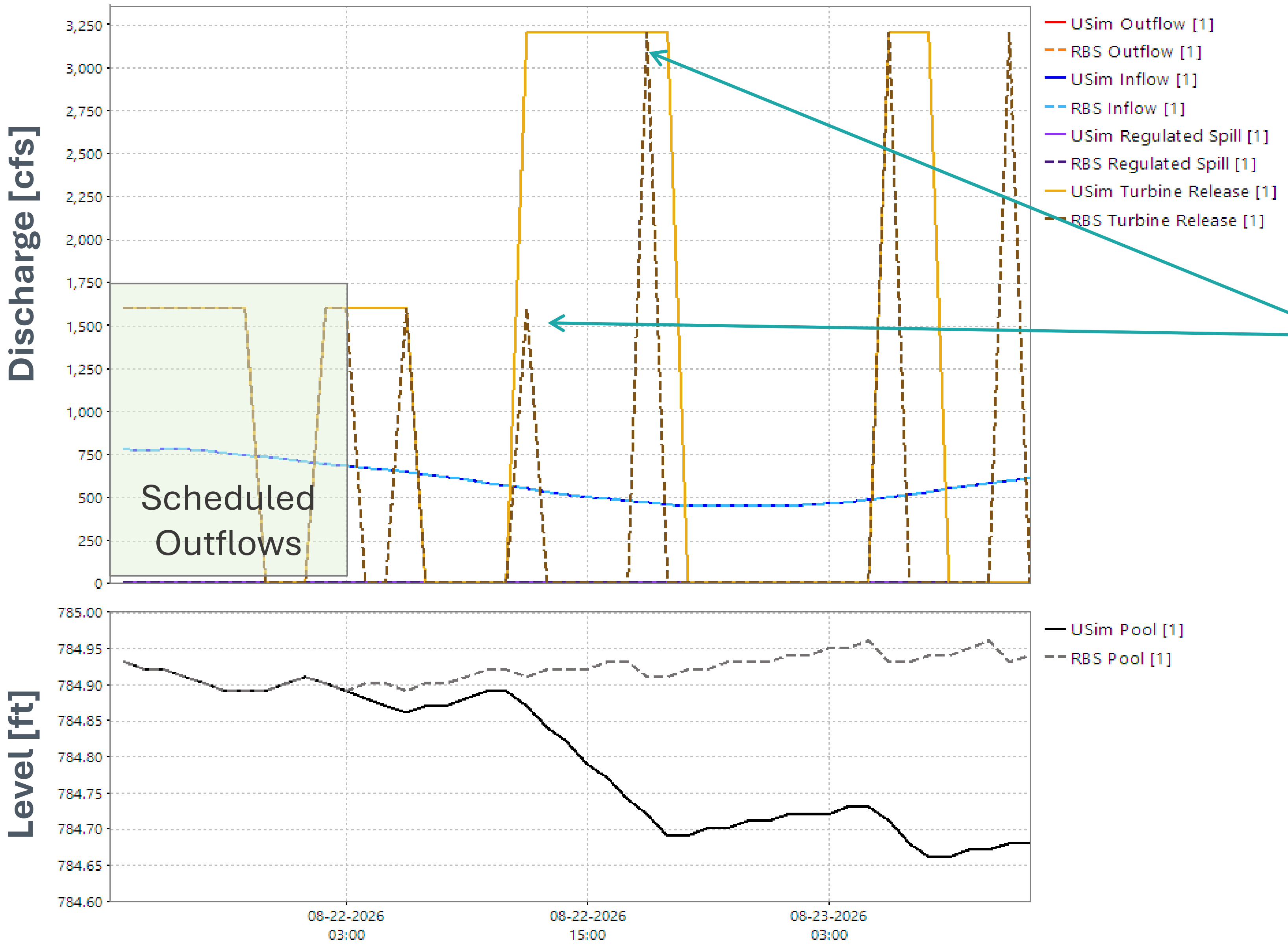


Before first 4am

Alignment of operations during first day of operations

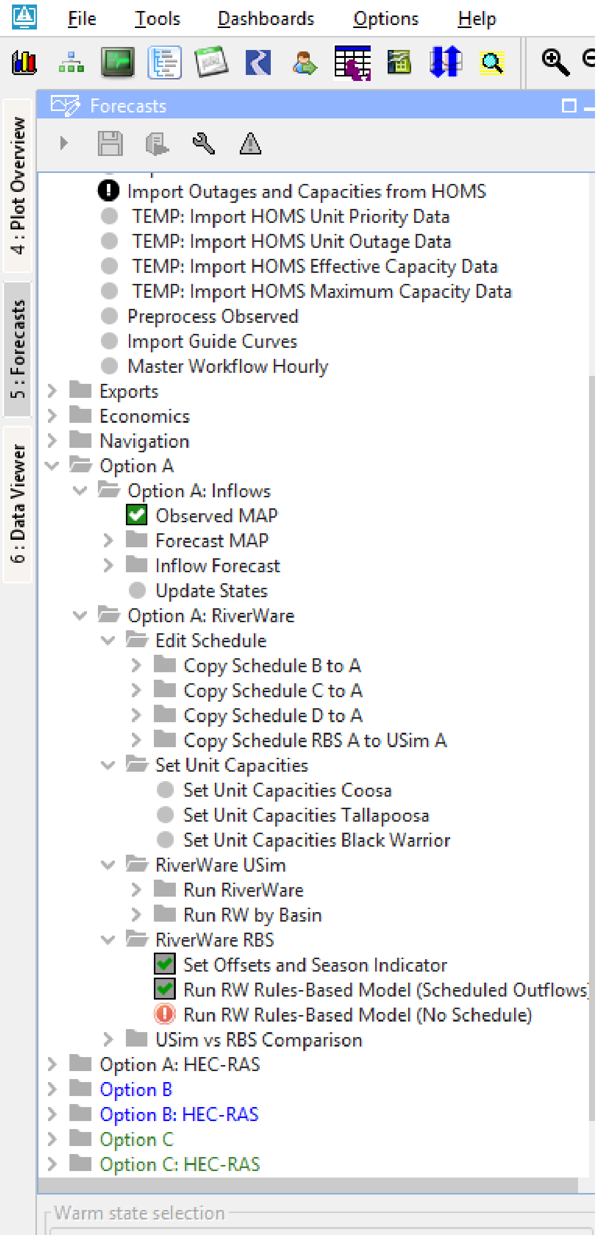
After first 4am

Operations in RBS model vary from the User Input Simulation model

Solid Line = Simulation Model

Dashed Line = RBS Model

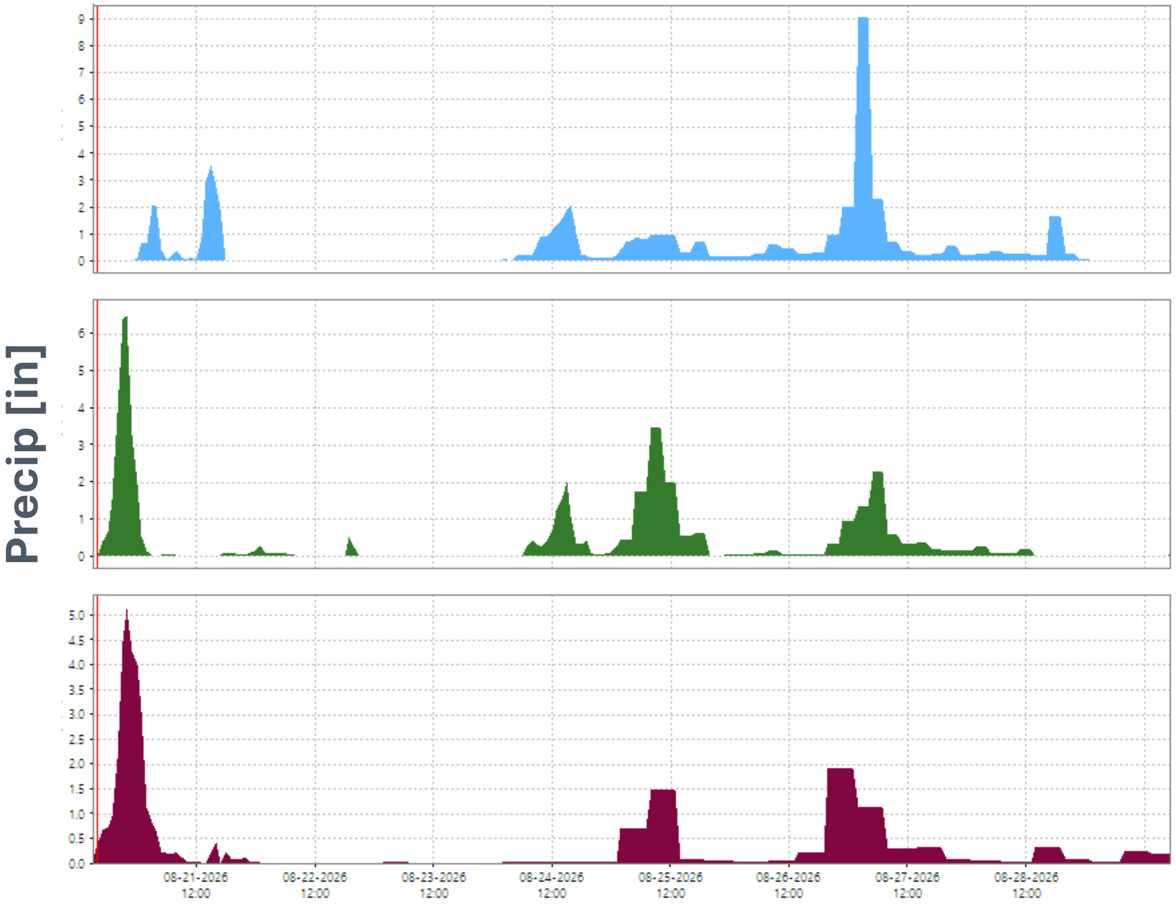
Create a flexible framework for scenario planning.



Four scenario planning workspaces: Options A-D

1. Ability to simulate different precipitation forecasts
2. Ability to revise outage conditions and unit capacities
3. Ability to revise targeted guide curve elevations
4. Ability to copy schedules across options
5. Ability to compare alternative scenarios directly

Create a flexible framework for scenario planning.



Selected Rainfall
A: No Rain (not shown)
B: HRRR/GFS Merge
C: GFS
D: NBM

- Provide a broader range of plausible outcomes and help quantify forecast uncertainty.
- Different precipitation models perform better for different storm types, locations, and forecast horizons.
- Redundancy improves operational resilience when a forecast source becomes unavailable.

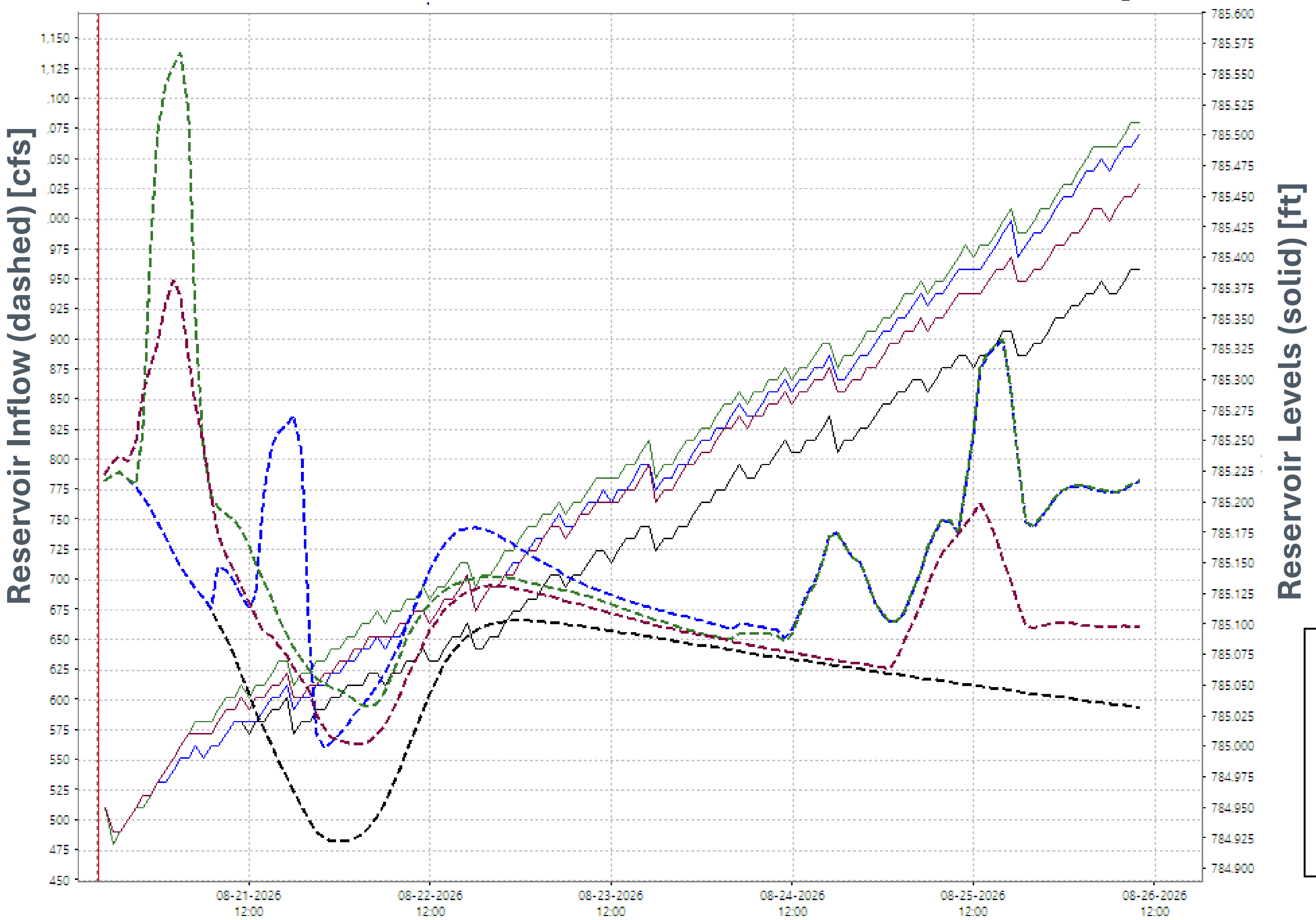
Example Products	
HRRR (High-Resolution Rapid Refresh)	ECMWF (European Centre for Medium-Range Weather Forecasts): IFS and AIFS
GFS (Global Forecast System)	Custom vendor forecasts (e.g., Upstream Tech)
NBM (National Blend of Models)	NAM (North American Mesoscale Model)

Create a flexible framework for scenario planning.

Different precipitation forcings yield different inflows.

Selected Rainfall
A: No Rain
B: HRRR/GFS Merge
C: GFS
D: NBM

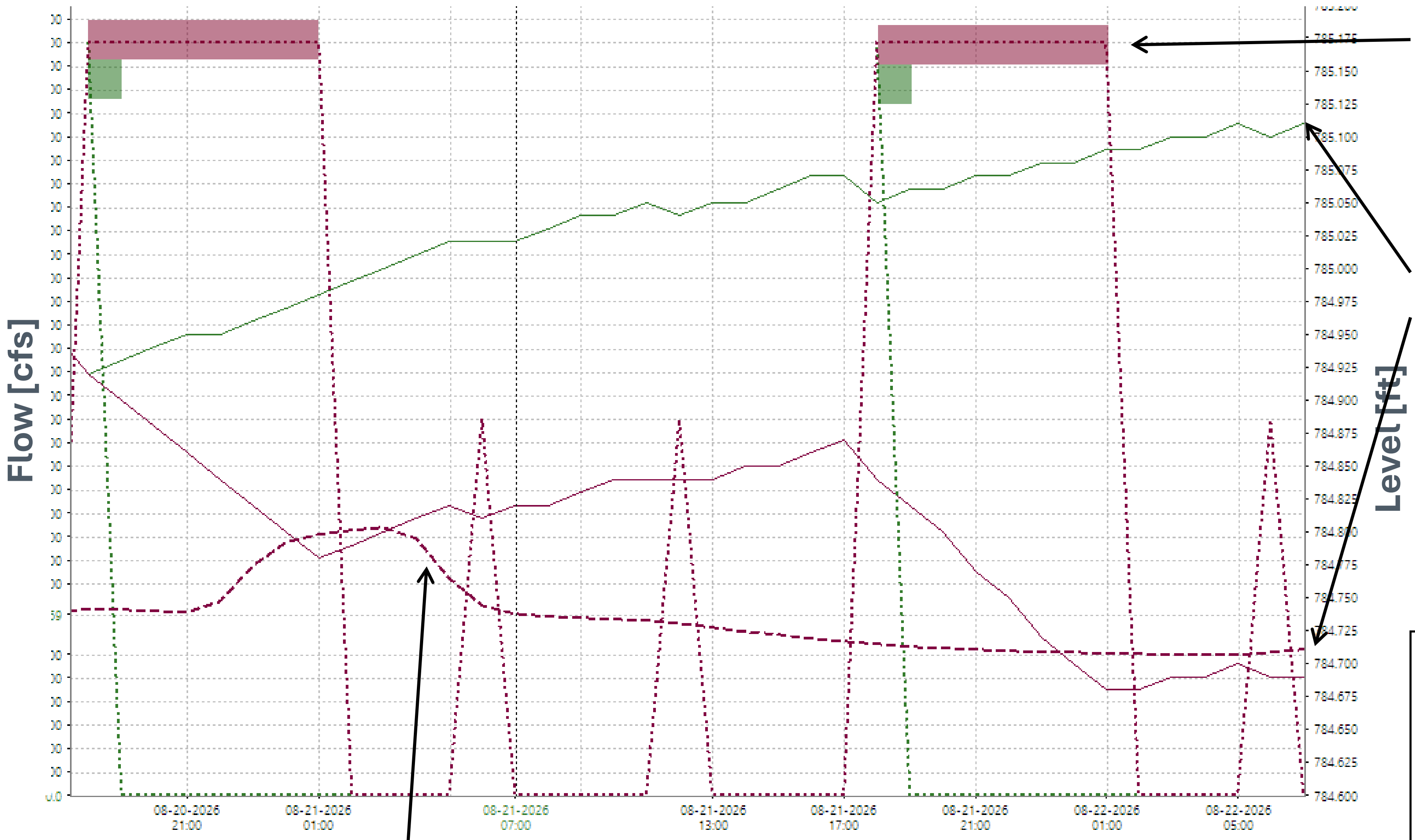
Create a flexible framework for scenario planning.



Same operations, different inflows.

Selected Rainfall
A: No Rain
B: HRRR/GFS Merge
C: GFS
D: NBM

Create a flexible framework for scenario planning.



Matching Inflows for Options C & D

Operational Change:
C: 1 hr turbine pulses
D: 6 hr turbine pulses

Resulting Final Pool:
C: 785.1 ft
D: 784.7 ft

Same inflows, different operations.

Selected Rainfall
~~A: No Rain~~
~~B: HRRR/GFS Merge~~
C: GFS
D: GFS

Summary.

1. Start small and build incrementally.
2. Match the model's power representation to how operators actually think.
3. Build models to be robust.
4. Provide operator control over modeled results.
5. Create scenario planning workspaces.

Abby Watson I RTI International
aawatson@rti.org