trwd
Tarrant Regional Water District

Hydros
Consulting

Water
Balance
Consulting

Modeling Forecast Operations for the Tarrant Regional Water District

Kevin Wheeler, Laura Blaylock, John Carron, Nick Mander

Outline

General Overview of the TRWD System and Conceptual Model Development

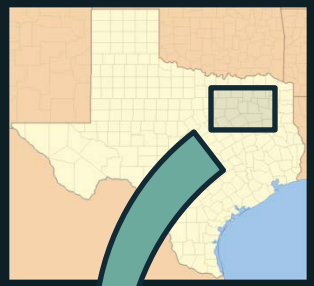
Model Structure and Data Management

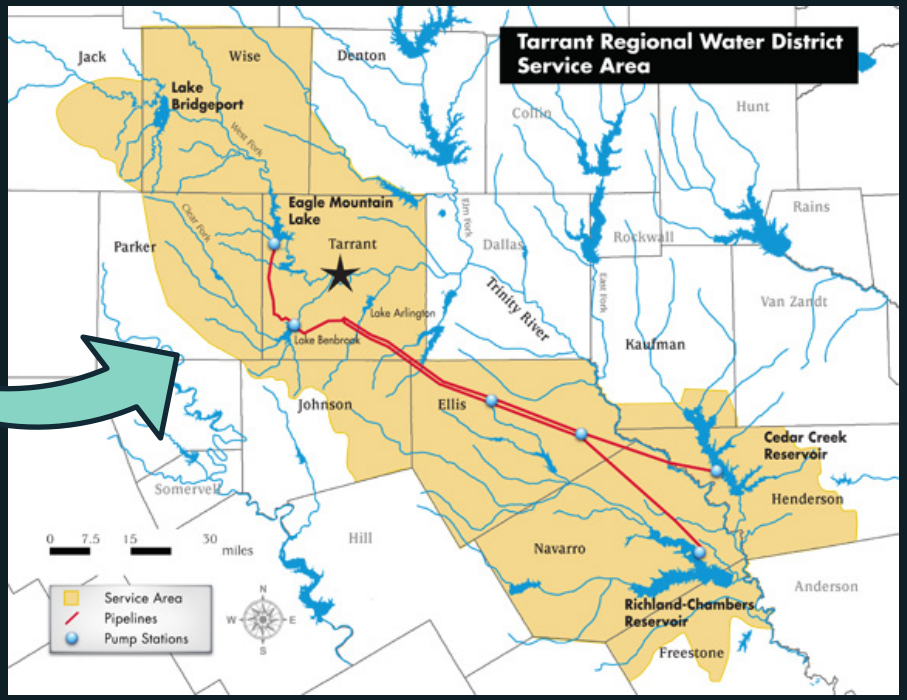
Monthly Model and Long-Term Daily Model

Short-Term Forecasting Models

System Description

TRWD Service Area





Water Balance Consulting

trwd
Tarrant Regional Water District

Hydros Consulting

System Description

TRWD Service Area

Owns and Operates Four Major Reservoirs

- Richland-Chambers Reservoir
- Cedar Creek Reservoir
- Lake Bridgeport
- Eagle Mountain Lake

Manages Three Additional Reservoirs by Contract

- Benbrook Lake
- Lake Arlington
- Lake Worth

180 Miles of Pipeline

Supplies Water to 1.8 Million People

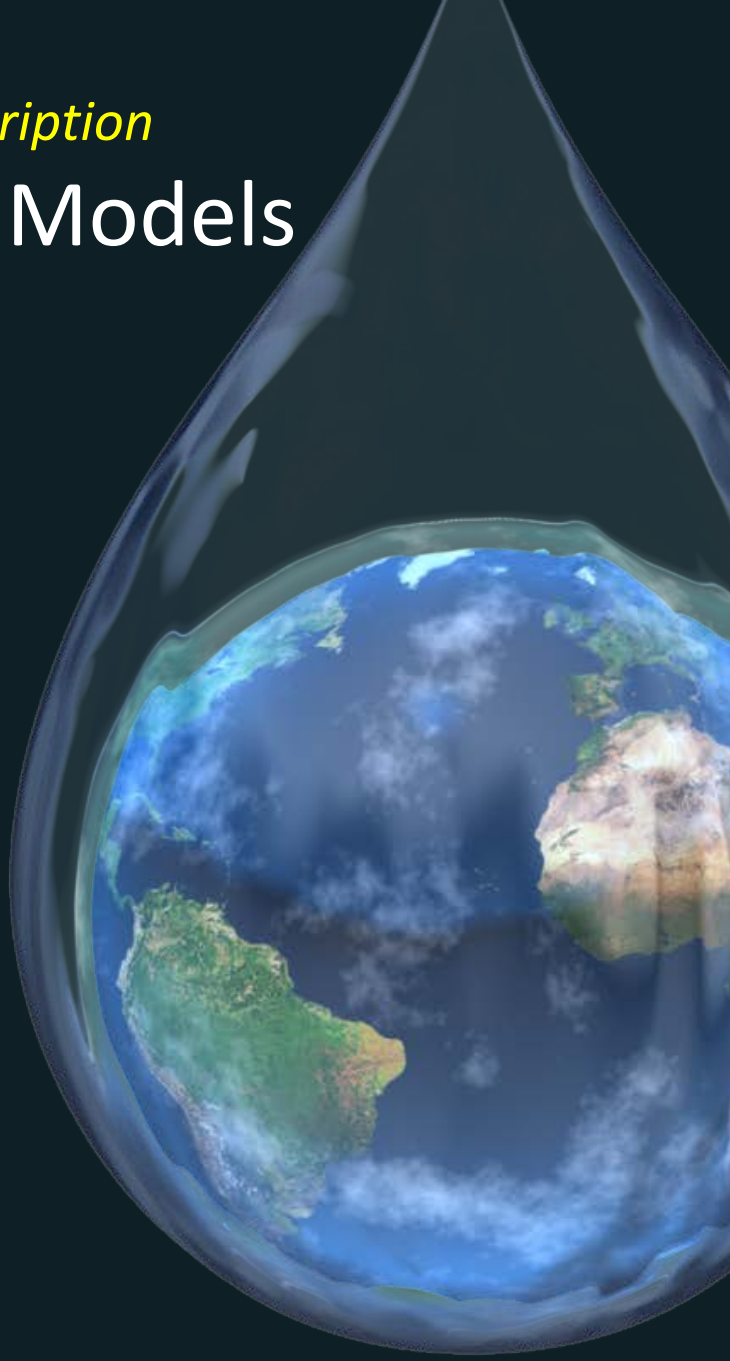
30 Wholesale Customers

- Including Ft. Worth, Arlington, Mansfield, Trinity River Authority

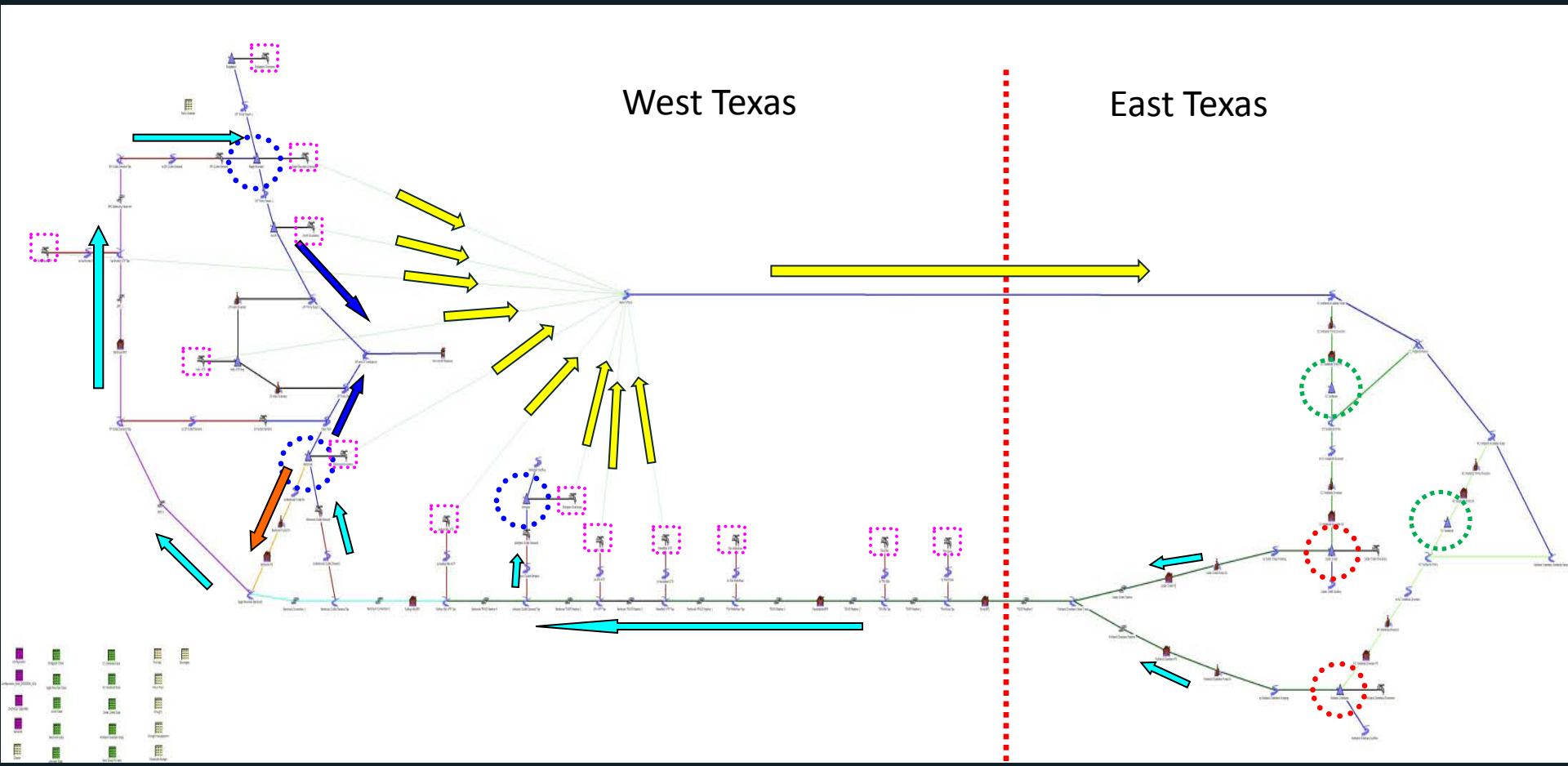
System Description

Purpose of Models

- Long-Term Water Management Planning
- Operational Efficiency Improvement Studies
- Short-Term Pumping Operations



TRWD Model Workspace



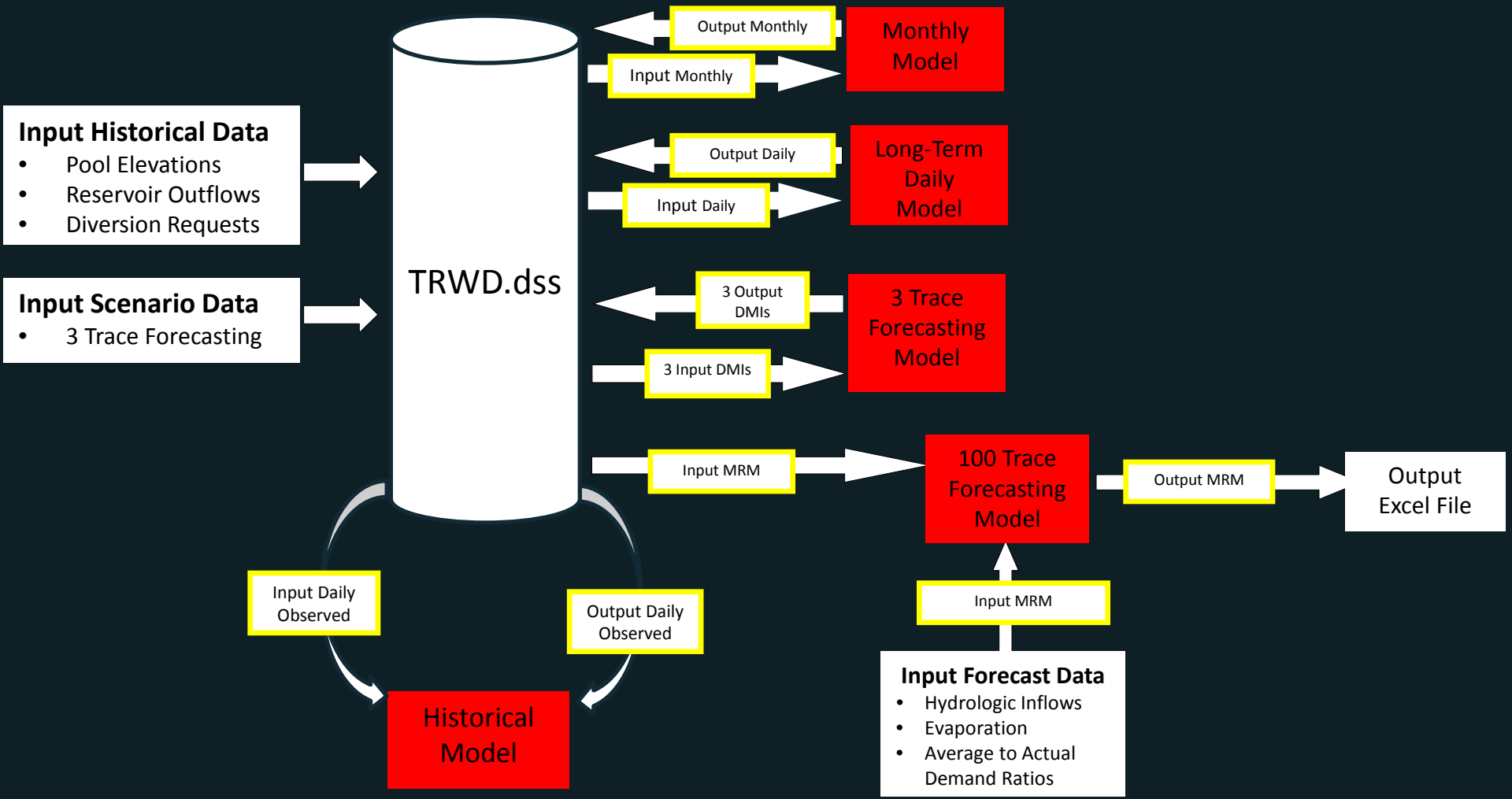
Water Balance Consulting

trwd
Tarrant Regional Water District

Hydros Consulting

Model Design

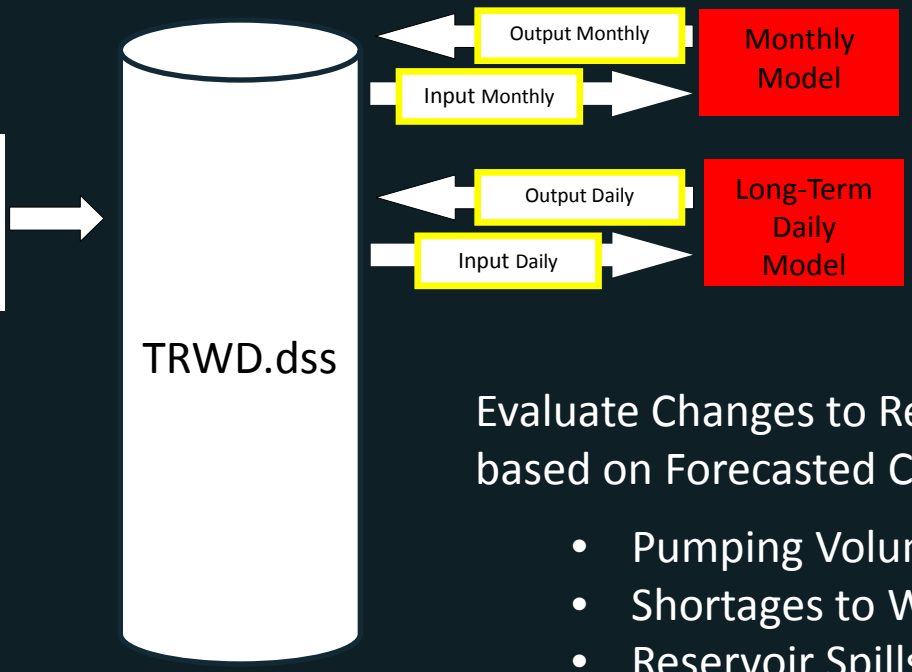
Data Flow Diagram



Planning Application

Climate Based Policies

Input Historical Data
- Pool Elevations
- Reservoir Outflows
- Diversion Requests



Evaluate Changes to Reservoir Operations based on Forecasted Climate Conditions

- Pumping Volume
- Shortages to Water Users
- Reservoir Spills
- Evaporation Losses

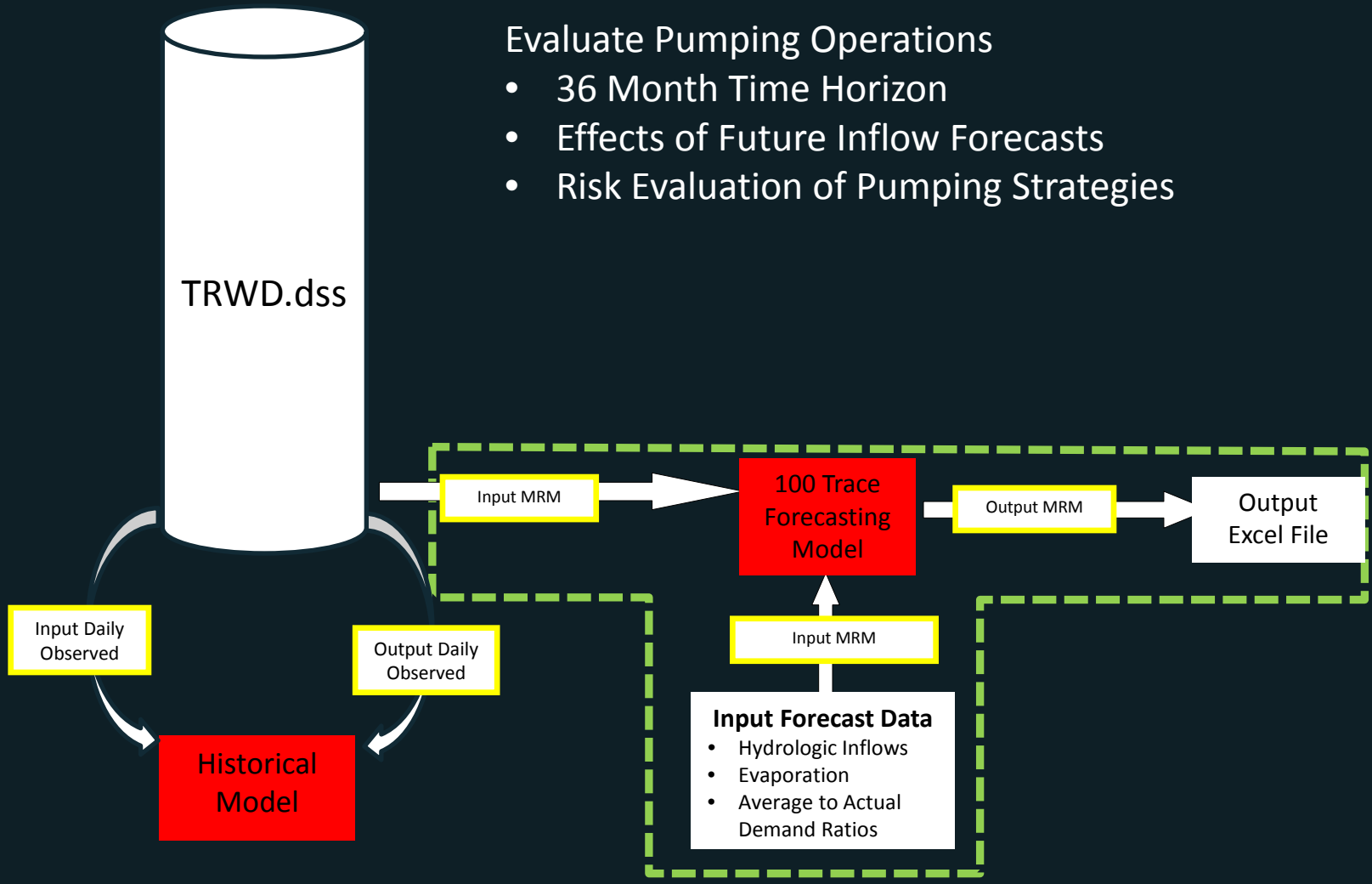
Resulting in Four Climate Based Policies
- Increase Wet Season Flexibility in 3 Terminal Storage Reservoirs
- Minimum Pumping During Dry Seasons

Forecasting Application

Data Flow Diagram

Evaluate Pumping Operations

- 36 Month Time Horizon
- Effects of Future Inflow Forecasts
- Risk Evaluation of Pumping Strategies



Forecasting Application

Projecting the Future

Project Future Hydrologic Conditions Generating "Traces"

- 100 Hydrologic Traces
- Conditioned on Recent Knowledge
- Sample from Historical Data
- Use Monthly Transition Probabilities
- "Dry", "Average", "Wet"
- In 36 Fixed Excel Files
  (12 months x 3 climate states)

Project Operational Responses

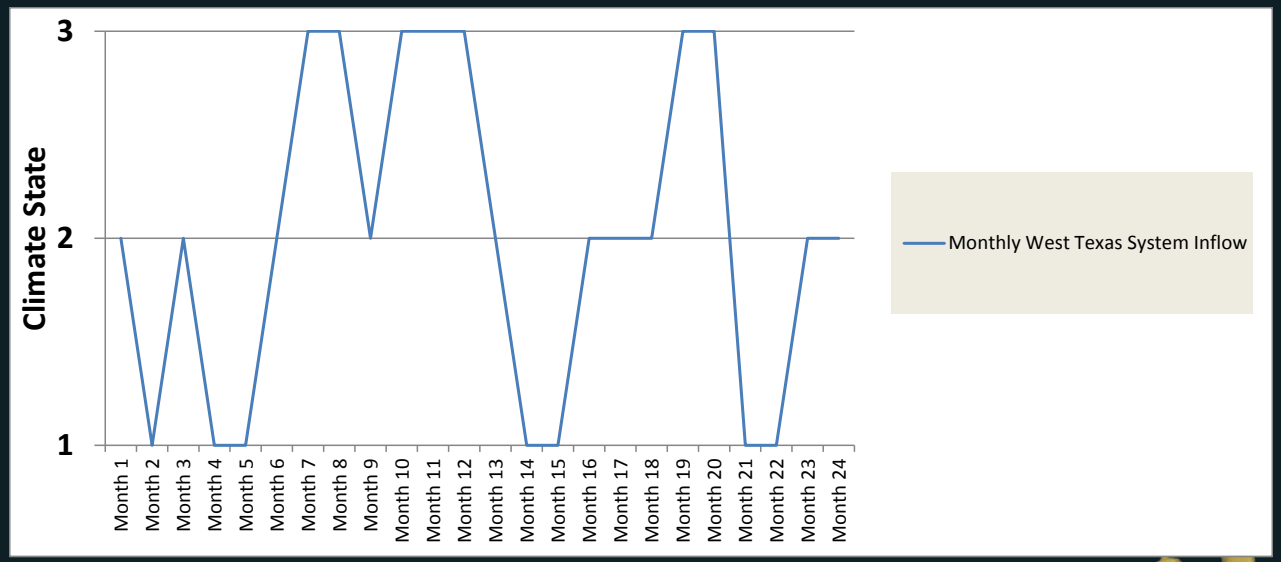
- Operators "Best Guess" of Future Hydrologic Conditions
- Simulate Operator Decisions
- Minimize Pumping Variations
- Written into Rule Set
- Use Quarterly Transition Probabilities
- 50% Threshold for Maintaining Dry or Wet Conditions
- Default to Average Conditions

GOD

HUMAN

Forecasting Application

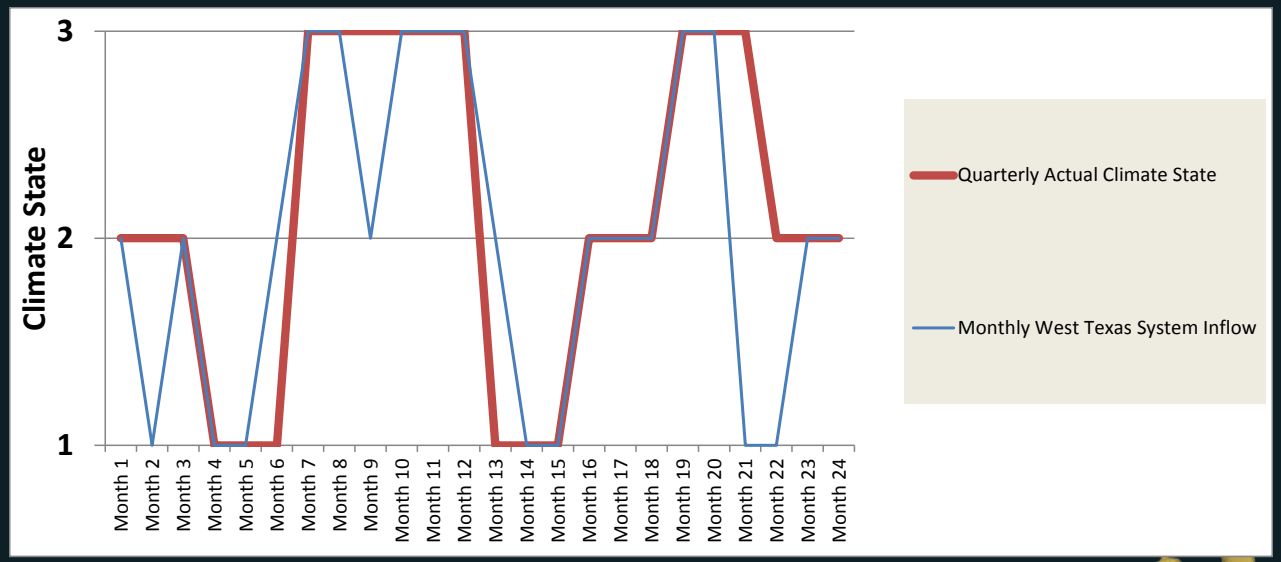
Generate Monthly Conditions



Transistion Type		Monthly Probabilities											
		1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 1
Dry to Dry	11	70%	70%	61%	70%	48%	39%	39%	48%	45%	57%	61%	59%
Dry to Avg	12	22%	17%	17%	17%	26%	48%	35%	22%	36%	35%	30%	23%
Dry to Wet	13	9%	13%	22%	13%	26%	13%	26%	30%	18%	9%	9%	18%
Avg to Dry	21	23%	23%	36%	27%	41%	41%	45%	32%	43%	32%	32%	27%
Avg to Avg	22	41%	36%	45%	41%	41%	36%	36%	41%	35%	27%	32%	45%
Avg to Wet	23	36%	41%	18%	32%	18%	23%	18%	27%	22%	41%	36%	27%
Wet to Dry	31	9%	9%	4%	4%	13%	22%	17%	17%	13%	13%	9%	17%
Wet to Avg	32	35%	43%	36%	41%	30%	13%	26%	39%	26%	35%	35%	26%
Wet to Wet	33	57%	48%	59%	59%	57%	65%	57%	43%	61%	52%	57%	57%

Forecasting Application

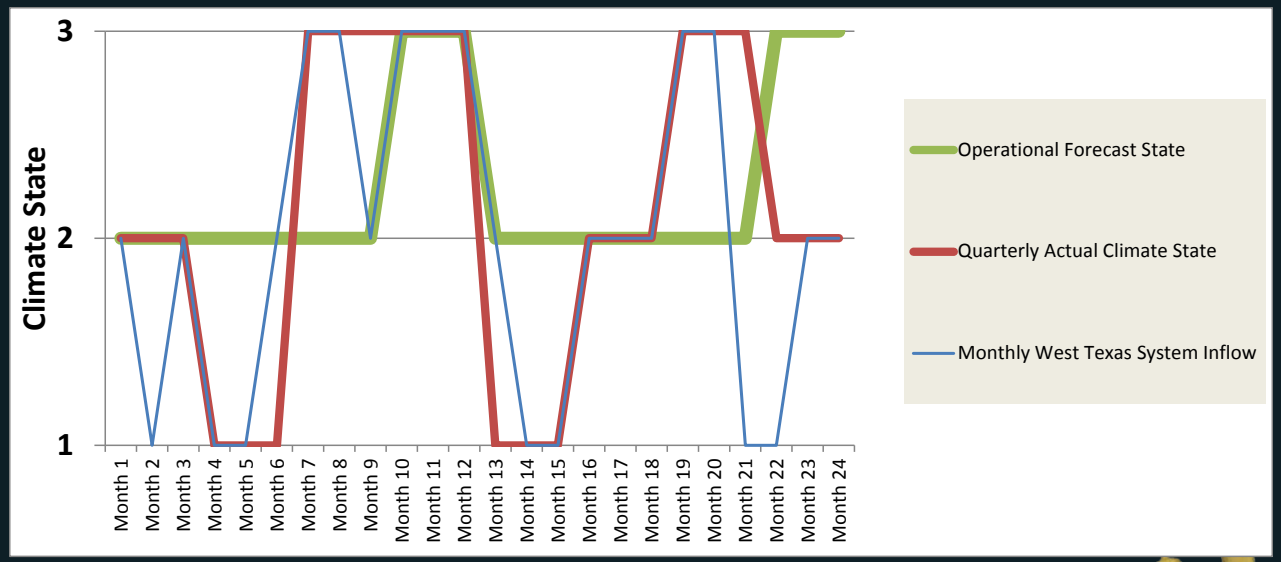
Evaluate "Actual" Quarters



Transition Type		Monthly Probabilities											
		1 to 2	2 to 3	3 to 4	4 to 5	5 to 6	6 to 7	7 to 8	8 to 9	9 to 10	10 to 11	11 to 12	12 to 1
Dry to Dry	11	70%	70%	61%	70%	48%	39%	39%	48%	45%	57%	61%	59%
Dry to Avg	12	22%	17%	17%	17%	26%	48%	35%	22%	36%	35%	30%	23%
Dry to Wet	13	9%	13%	22%	13%	26%	13%	26%	30%	18%	9%	9%	18%
Avg to Dry	21	23%	23%	36%	27%	41%	41%	45%	32%	43%	32%	32%	27%
Avg to Avg	22	41%	36%	45%	41%	41%	36%	36%	41%	35%	27%	32%	45%
Avg to Wet	23	36%	41%	18%	32%	18%	23%	18%	27%	22%	41%	36%	27%
Wet to Dry	31	9%	9%	4%	4%	13%	22%	17%	17%	13%	13%	9%	17%
Wet to Avg	32	35%	43%	36%	41%	30%	13%	26%	39%	26%	35%	35%	26%
Wet to Wet	33	57%	48%	59%	59%	57%	65%	57%	43%	61%	52%	57%	57%

Forecasting Application

Generate Quarterly Operational Forecast



Transition Type		Seasonal Probabilities			
		1 to 2	2 to 3	3 to 4	4 to 1
Dry to Dry	11	54.5%	55%	43%	55%
Dry to Avg	12	40.9%	32%	35%	23%
Dry to Wet	13	4.5%	14%	22%	23%
Avg to Dry	21	22%	42%	26%	22%
Avg to Avg	22	35%	25%	43%	35%
Avg to Wet	23	43%	33%	30%	43%
Wet to Dry	31	22%	5%	32%	23%
Wet to Avg	32	30%	45%	23%	45%
Wet to Wet	33	48%	50%	45%	32%

Forecasting Model Has Launched!

- Quarterly Pumping Operations and Decision Support
- Ongoing Evaluation of Climate-Based Policies

Next Steps

- Update Historical Hydrology Dataset
- Incorporate 2011 Texas Drought
- Increase Flexibility to Run Mid-Month Forecasting