Decision Framework for Infrastructure Sequencing (DFIS):

A holistic approach for regional water supply planning

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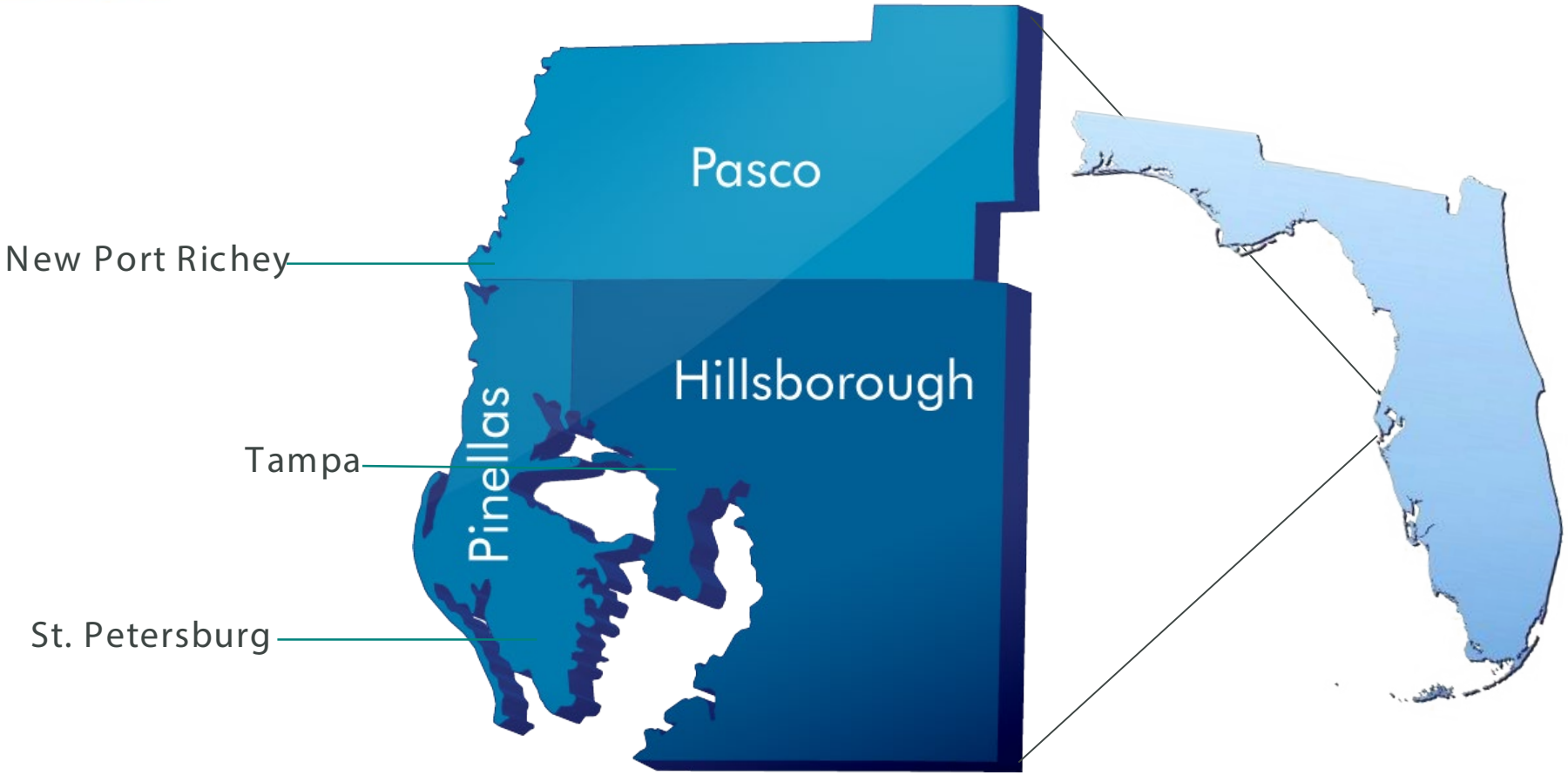
Tampa Bay Water's Member Governments



Tampa Bay Water's Supply System

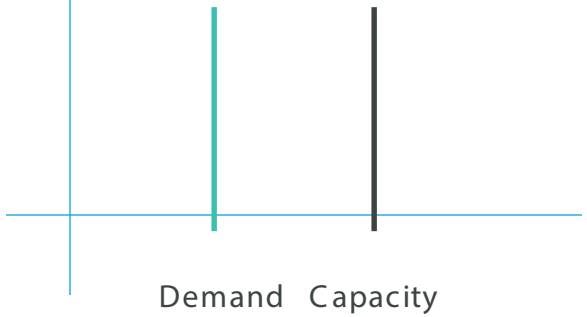
- Integrated drought-resistant supply system
  - 13 wellfields
  - 8 groundwater treatment facilities
  - Surface Water Treatment Plant
  - Desalination Treatment Plant
  - 9 pump stations
  - 270 miles of transmission mains

Overarching Question

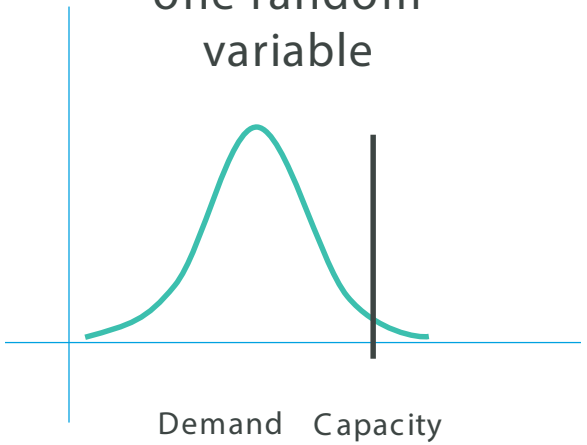
How much water the Tampa Bay region may need through the planning period of 2040?

Planning for Multiple Futures: A Level of Service Approach‡

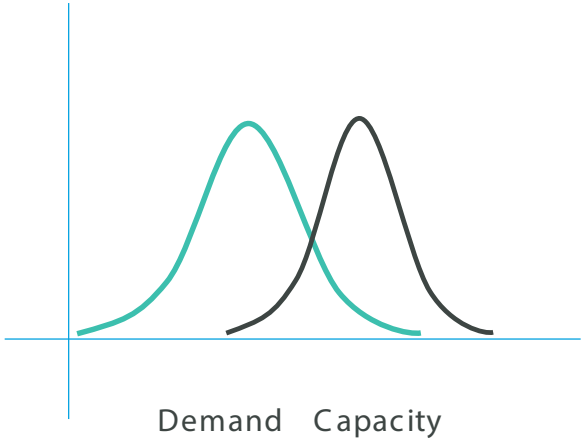
Deterministic



Stochastic one random variable



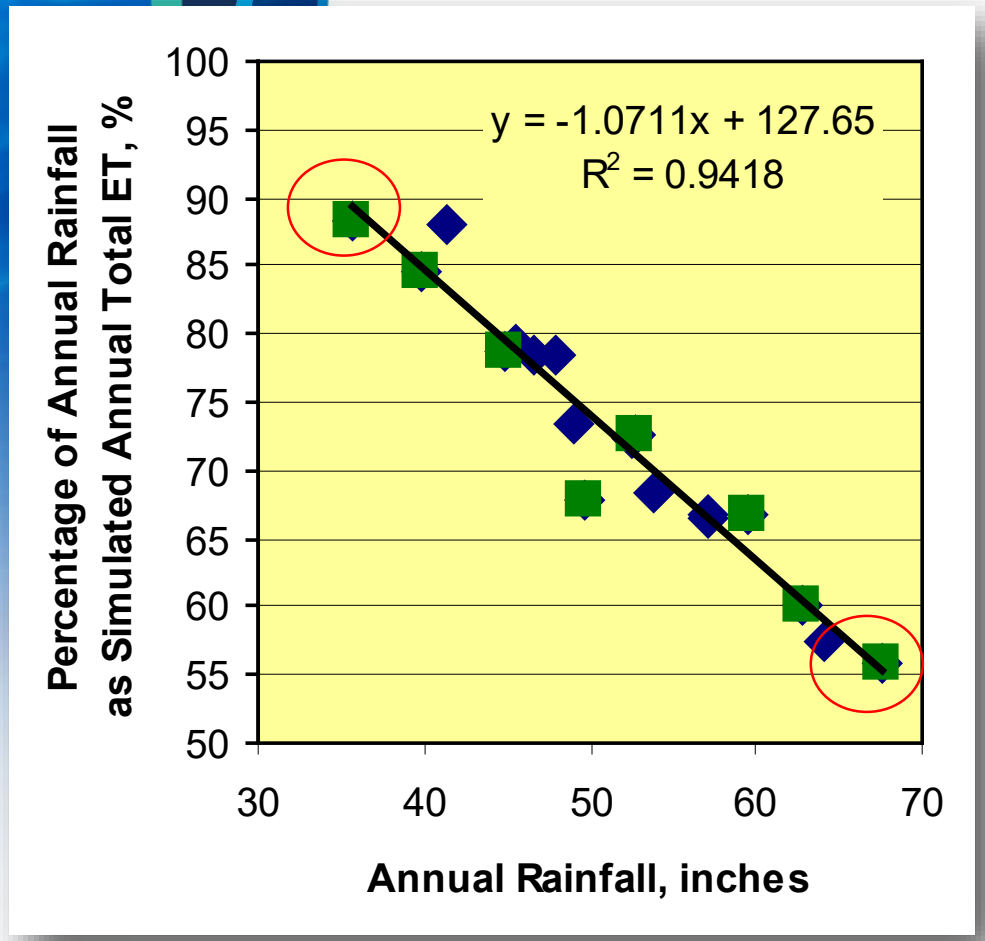
Stochastic two random variables

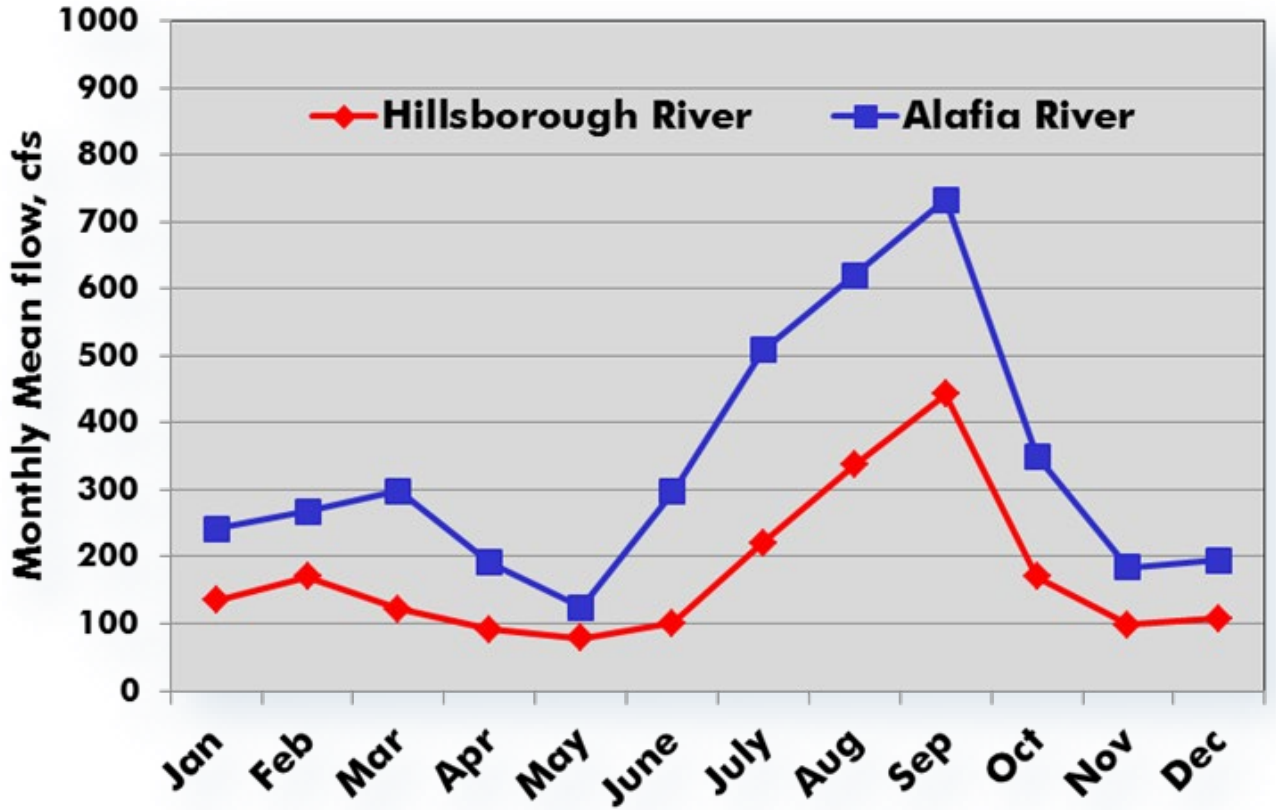


Characterize shortages to understand gap between supply and demand

‡ Asefa, T., A. Adams, and N. Wanakule, 2015, A level of service concept for planning future water supply projects under probabilistic demand and supply framework, Journal of American Water Resources Association, 51(5) pp: 1272-285, DOI: 10.1111/1752-1688.12309

Why we care about climate change impact





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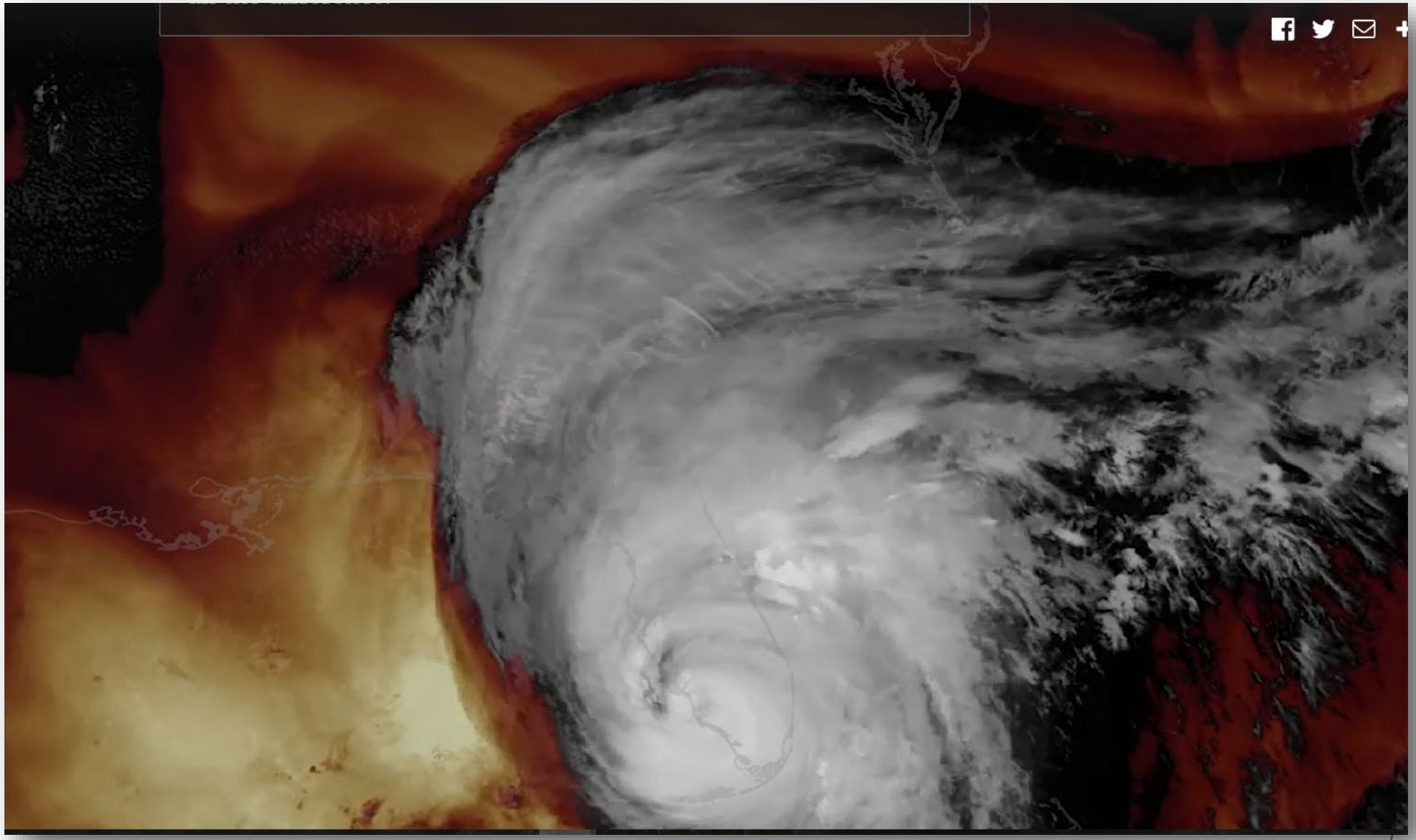
2017: From the driest dry season in a century to an active summer



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Key uncertainties in future needs and delivery

- Future needs
  - Socio-economic
    - Population growth
    - Income
    - Price, pph, etc.
  - Climate impacting demand
  - Demand management
    - Passive
    - Active
- Delivery
  - Climate impacting supply
  - Level-of-service
  - Regulatory
  - Finance
  - Sustainability

Long-term Demand Forecast

"Forecasting is the art of saying what will happen, and then explaining it

why it didn't"

- Anonymous

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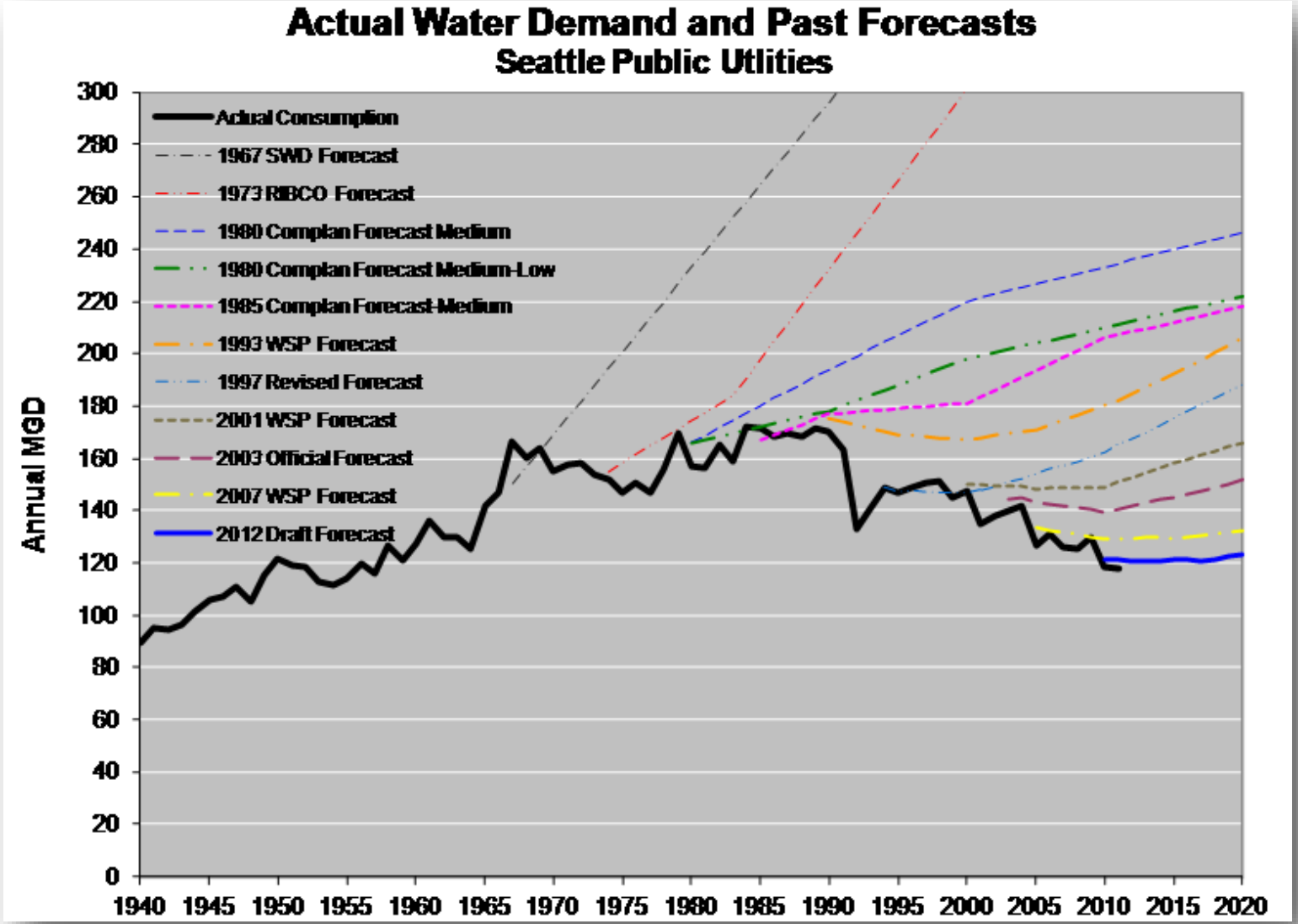

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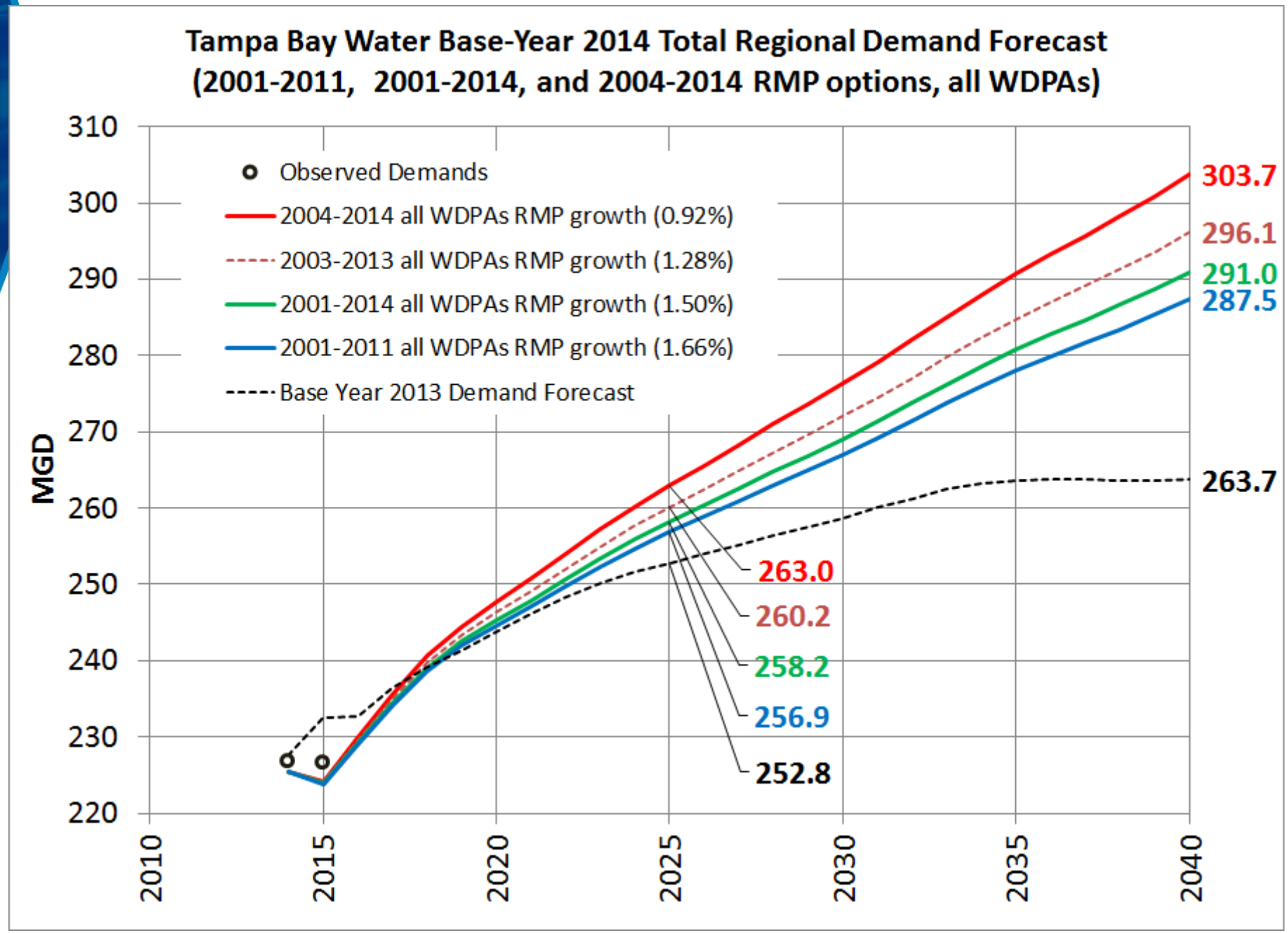

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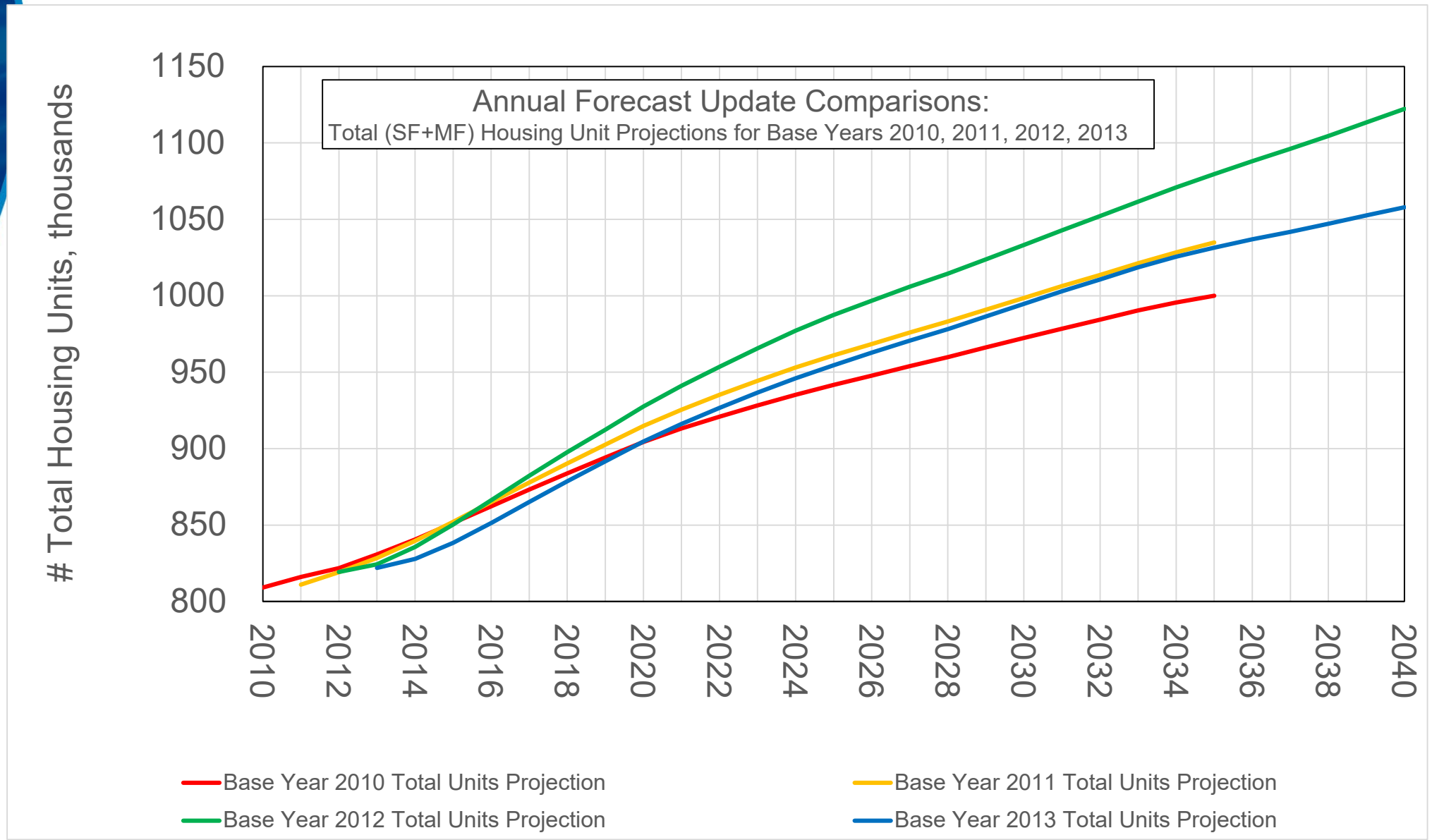

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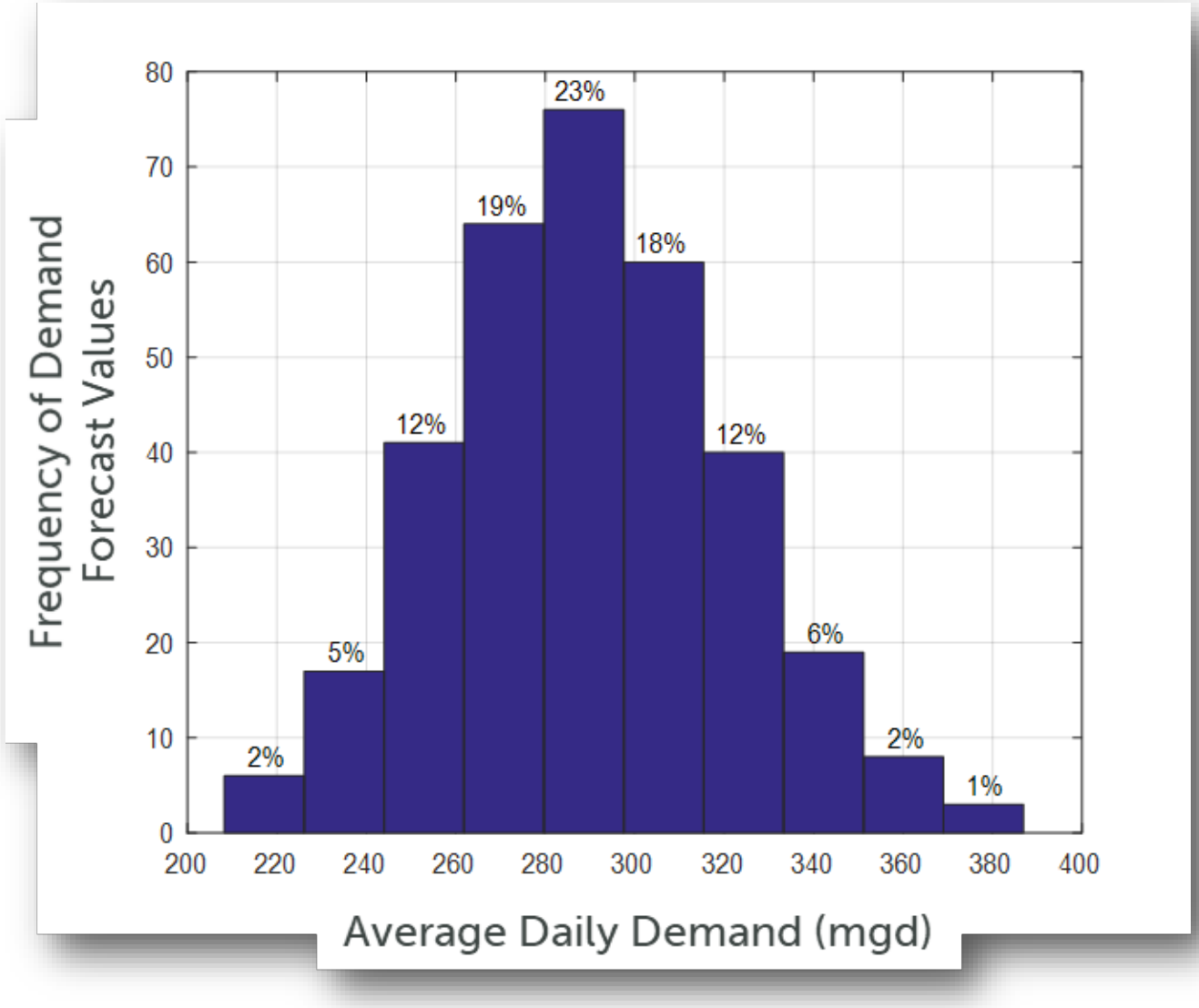
2040 Demand Forecast: Stochastic



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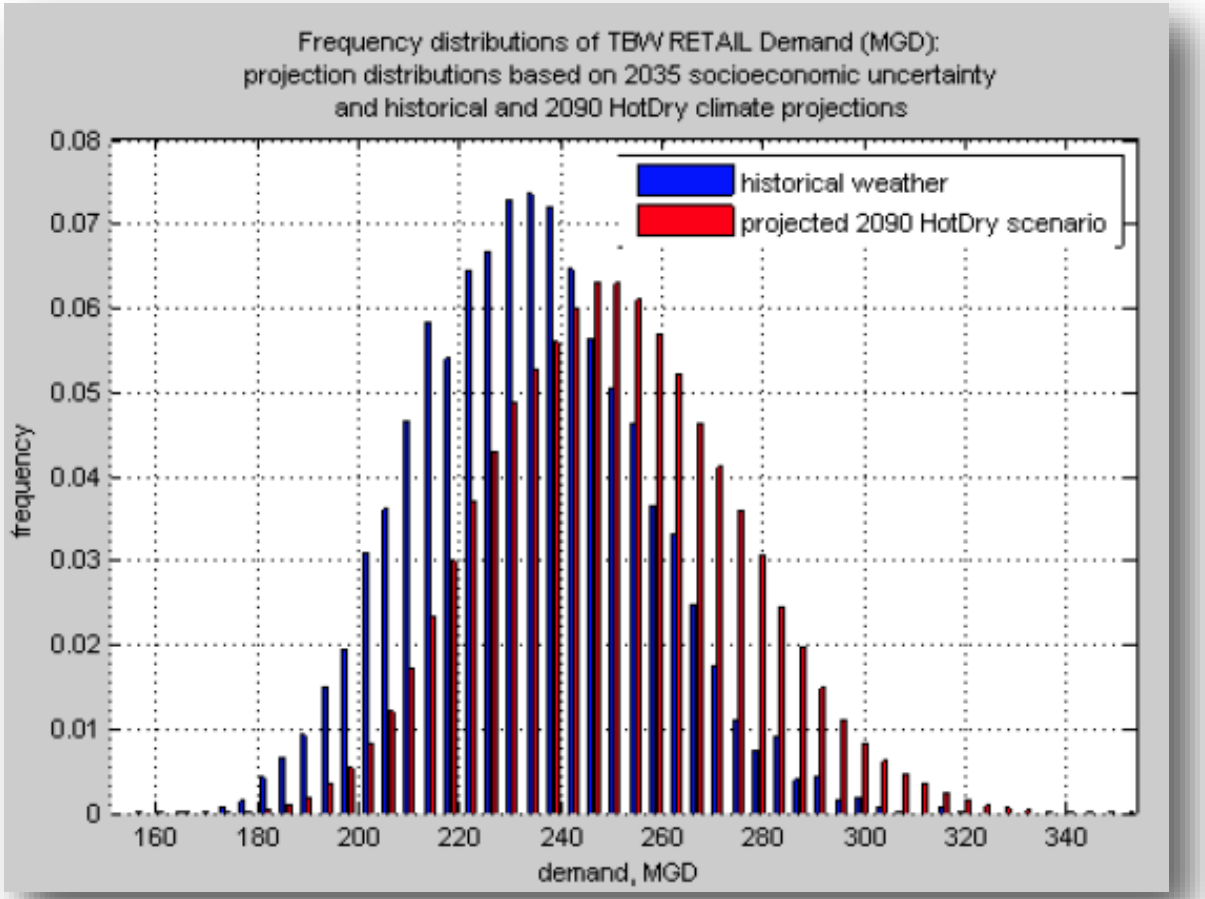
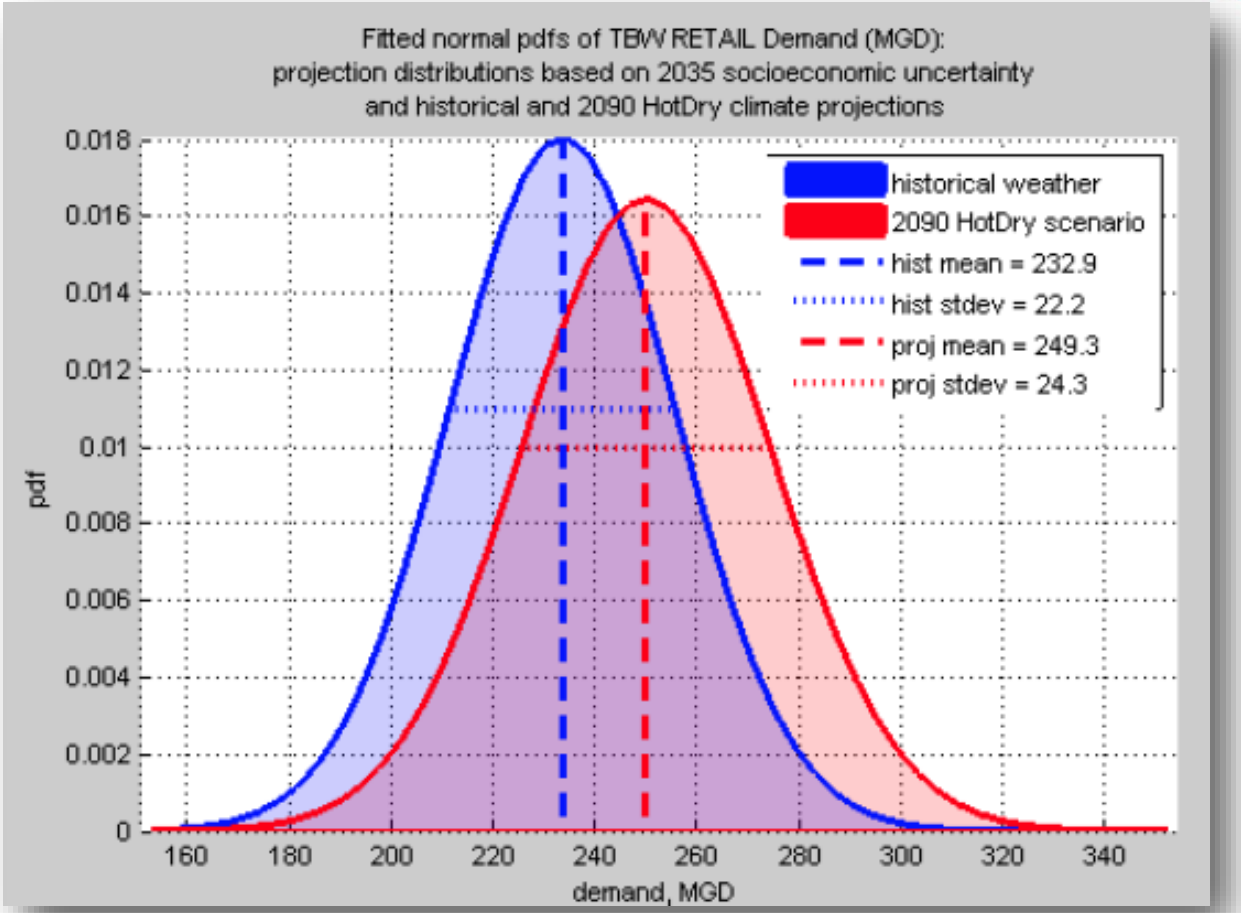
Climate change impacts water demand





Figuring out the next supply source

Approach

- Identify project concepts
  - E.g., SWTP and desal expansion, DPR, or IDPR
- Stress test if a given project concept is worth further investigating
- Full Monte-Carlo run (334 demand-supply pairs)
- Each full run took about 5 to 6 hours on cluster of computers
- Over 100-project concept evaluated using the level of service criteria to meet demand

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Each Configuration Increases Regional Supply by 20 Million Gallons Per Day

Config	SWTP Exp. w/ Existing	Desal WTP Exp. w/ Existing	GW via SHARP	Gulf Coast Desal	SWTP Exp. w/ Tampa	New AWT for Reclaimed Water	Aquifer R&R	Total Addt'l Supply	SHARP	SC Pipeline
1	10	10						20		✓
2A			7.5	12.5				20	✓	✓
2B				20				20		✓
3	12.5		7.5					20	✓	✓
4A		12.5	7.5					20	✓	
4B		12.5	7.5					20	✓	
5A			20					20	✓	
5B			20					20	✓	
6A			7.5		12.5			20	✓	✓
6B					20			20		✓
7A			7.5			12.5		20	✓	✓
7B	10					10		20		✓
8		10				10		20		✓
9A			7.5				12.5	20	✓	
9B			7.5				12.5	20	✓	

Also addresses hydraulic limitations in South-Hillsborough County

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Evaluation Evolution

Surface Water
- Existing supply

Seawater
- Existing supply

Groundwater
- Via recharge credits (SHARP/TAP)

Reclaimed Water
- Advanced treated and blended with other finished supplies
- Advanced treated, recharged and recovered

+

South County Supply Options

a) 7.5 mgd groundwater via SHARP credit

b) South County Pipeline

9 Shortlisted Configurations

Projects Recommended for Additional Study

Three New Water Supply Projects

- Surface Water Treatment Plant Expansion with existing source water
- Desalination Facility Expansion with existing source water
- New Groundwater Treatment Plant via Net Benefit from SHARP Program

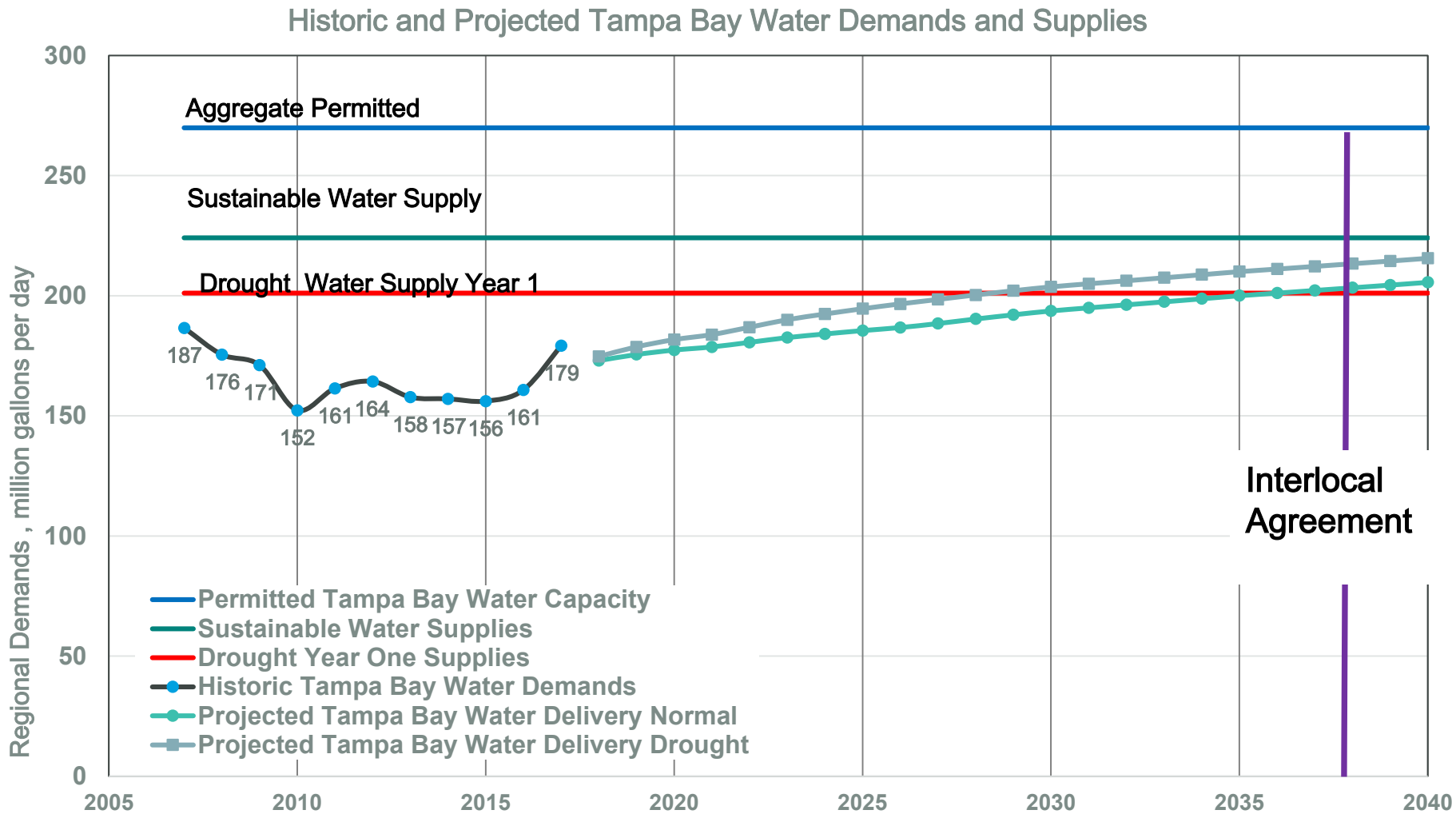
South County Projects

New Groundwater Treatment Plant via Net Benefit from SHARP Program
Pipeline from Regional SWTP to South Hillsborough County

Decision Framework for Infrastructure Sequencing (DFIS)

Master Water Plan Update Cycle 2019-2023

Current timing of new supply source



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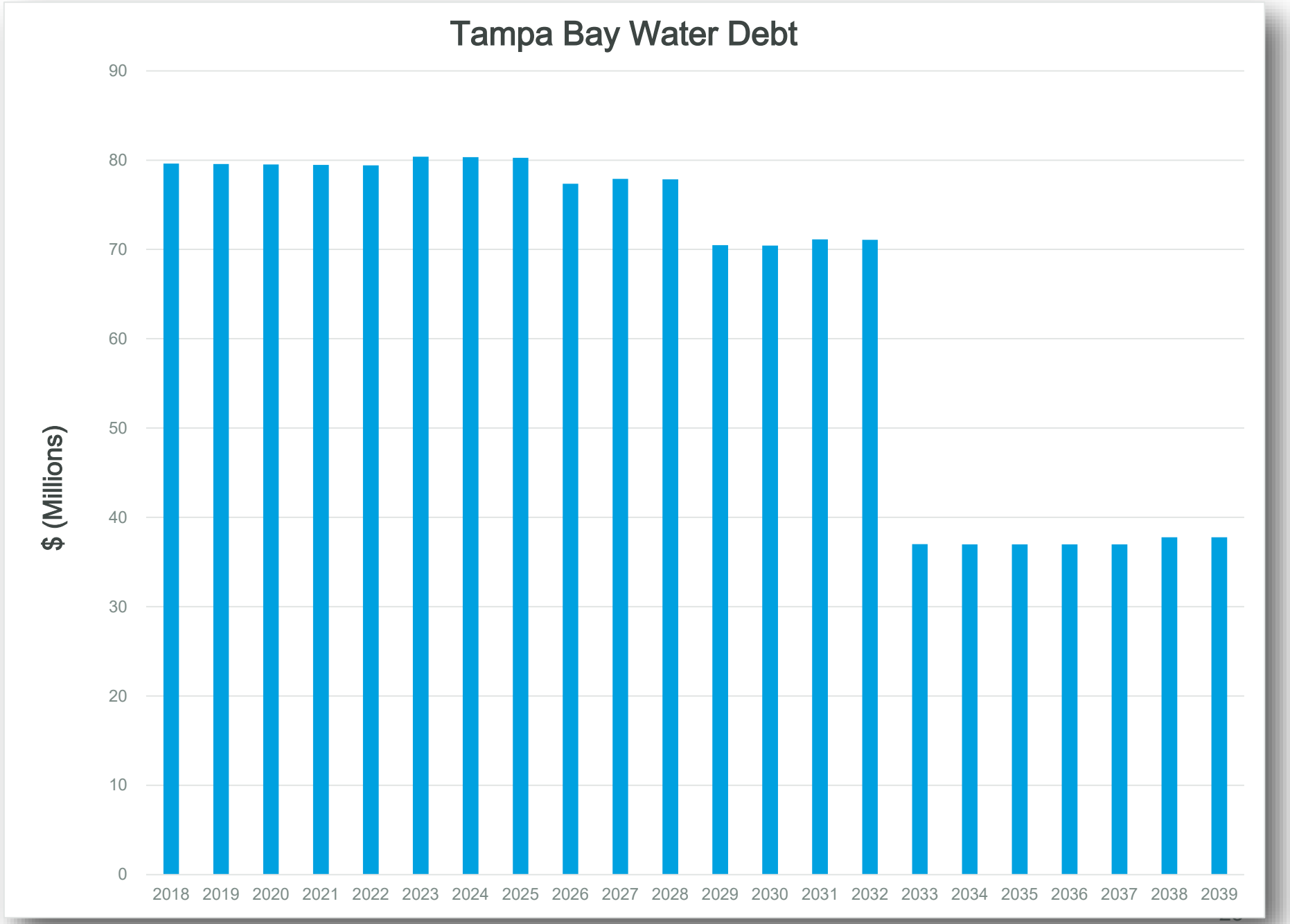

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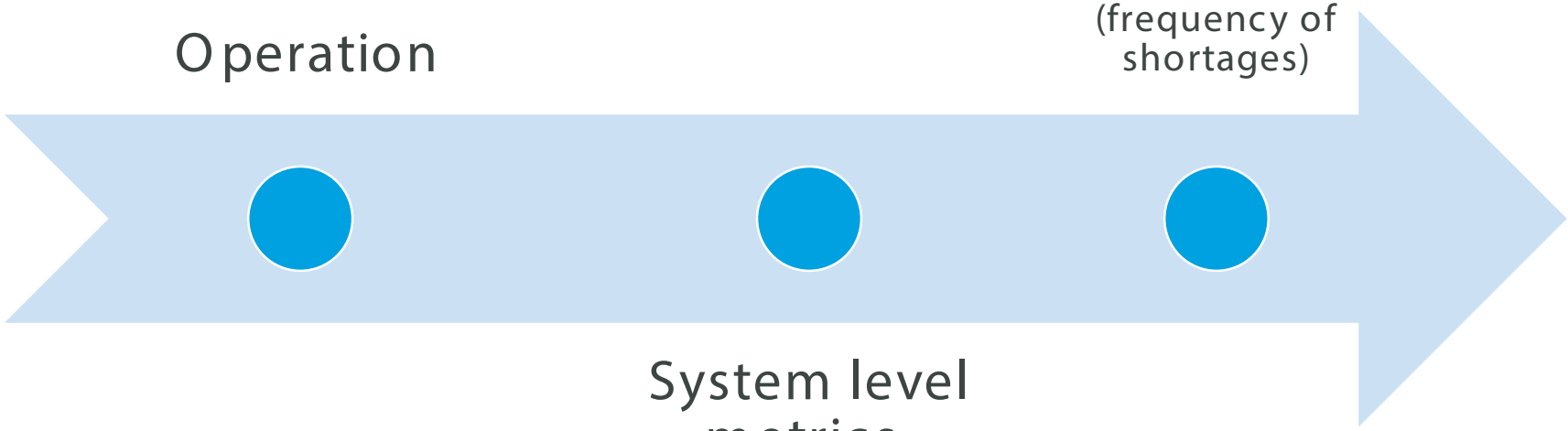
DFIS: Systems monitoring and triggers

Demand
(annual update. DMP Imp.)

Supply
(seasonal variations)

Operation



Trigger
(frequency of shortages)

System level metrics,
Pr(getting into level IV shortage)

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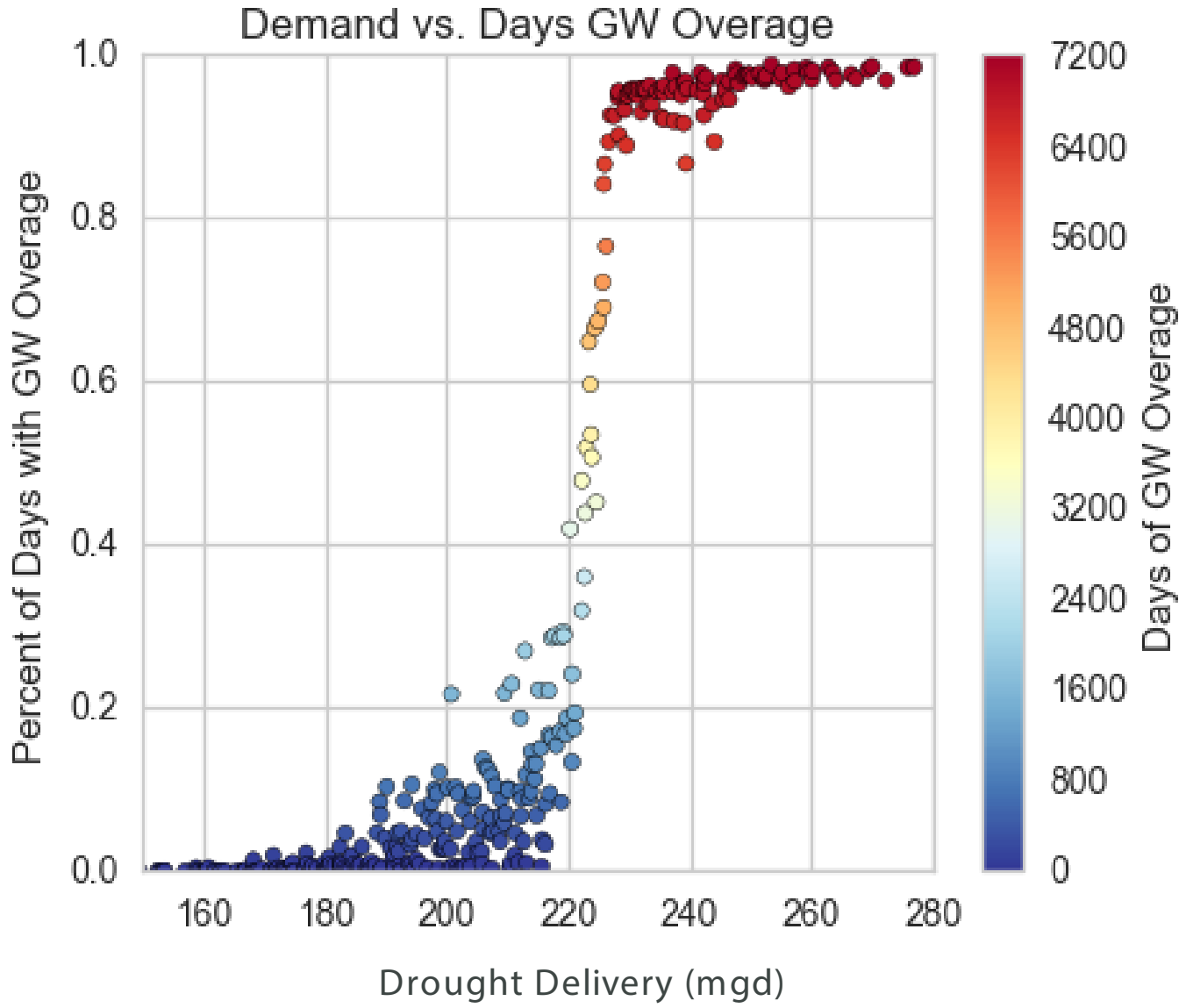
Scenario Discovery: discovering vulnerabilities



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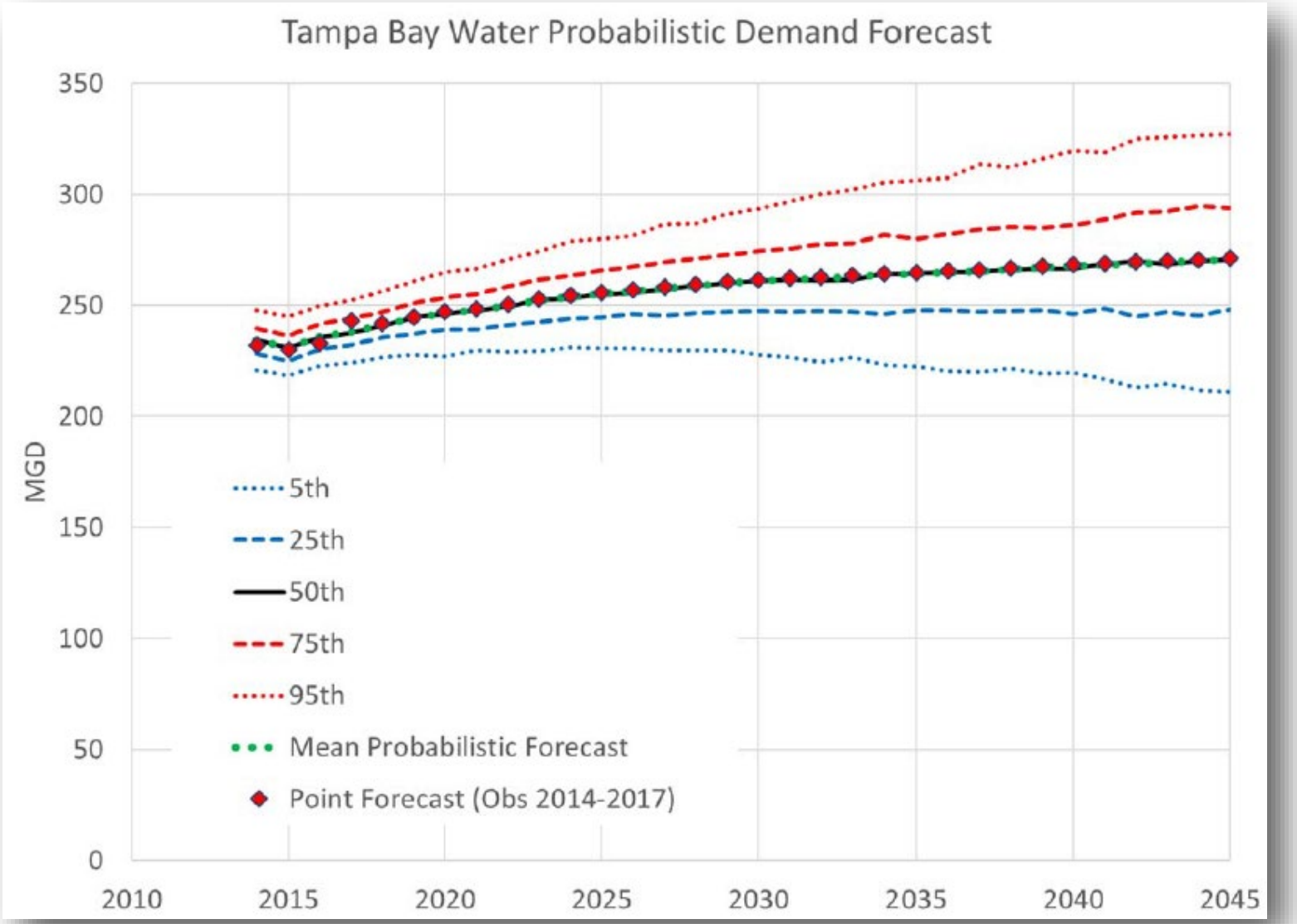
Mapping back to projections



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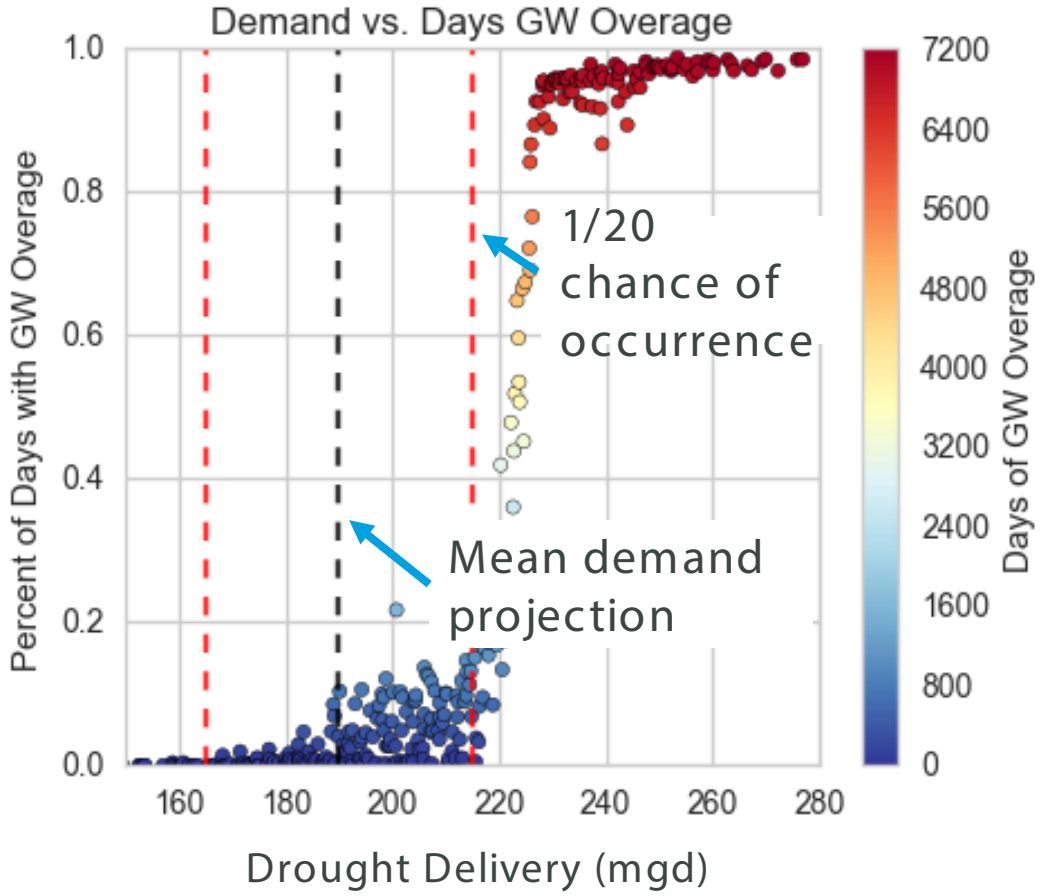
Mapping back to projections



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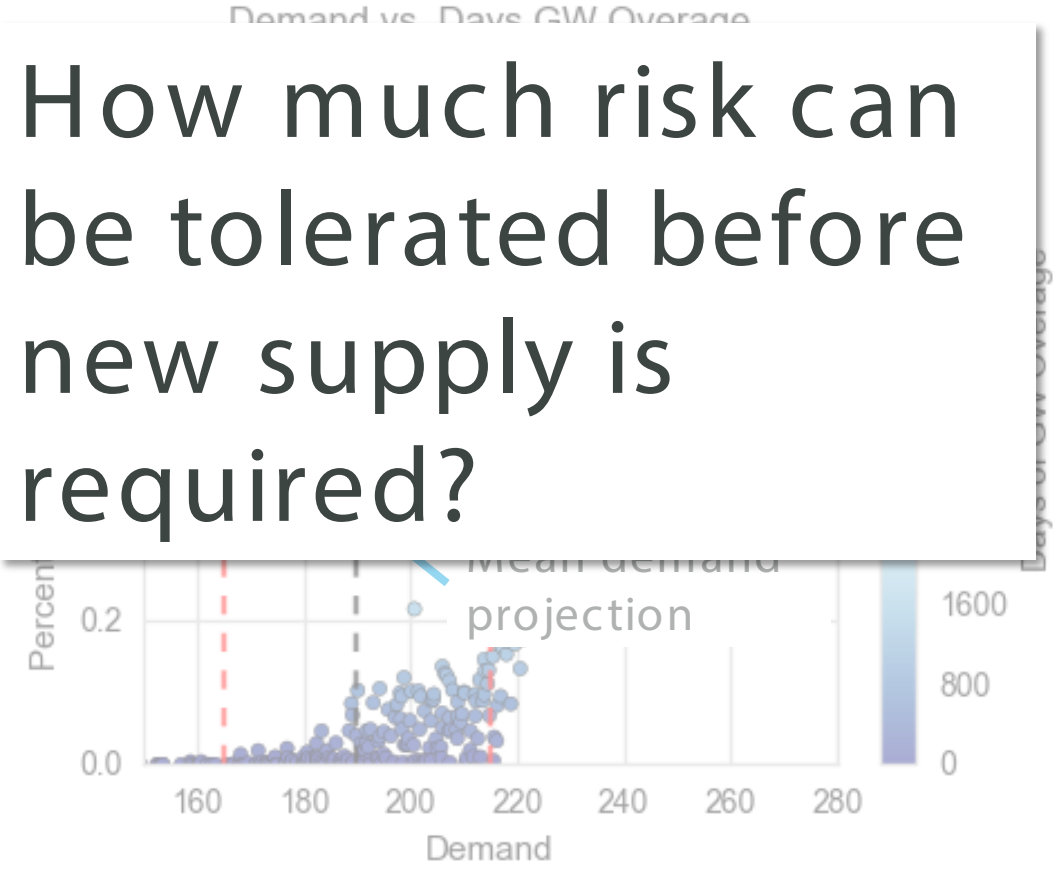
Mapping back to projections

How much risk can be tolerated before new supply is required?



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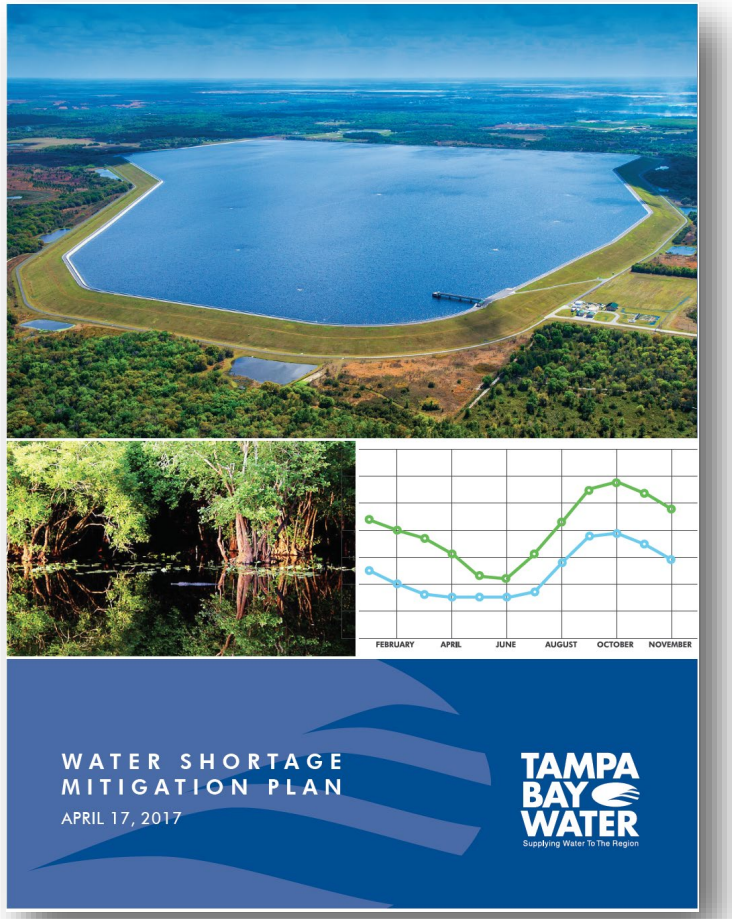
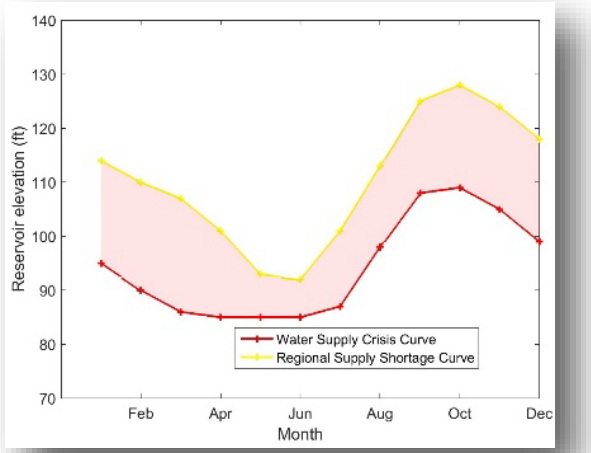
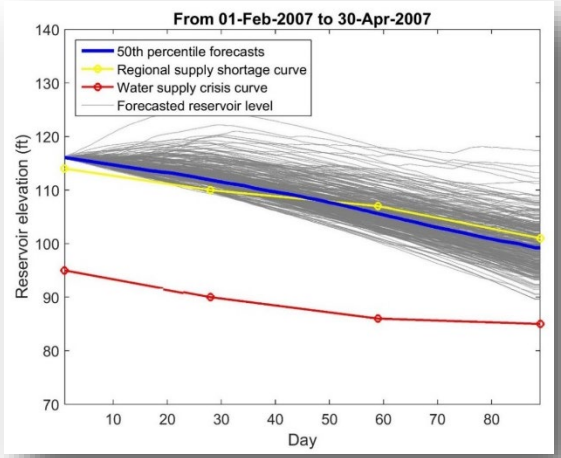
Residual Risk Management

(Water Shortage Mitigation Plan)

Innovative Residual Risk Management‡







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‡Wang, H., Asefa, T., Bracciano, B., Adams, A., and Wanakule, N. Proactive water shortage mitigation integrating system optimization and input uncertainty, Journal of Hydrology, https://doi.org/10.1016/j.jhydrol.2019.01.071, 2019

Key takeaways

- Meeting future water needs is more than just planning to bring a new supply sources online
- Prudent water supply planning should follow an “all of the above” approach
- Understanding key uncertainties and monitoring those uncertainties is a big part of it
- Plan for multiple future

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