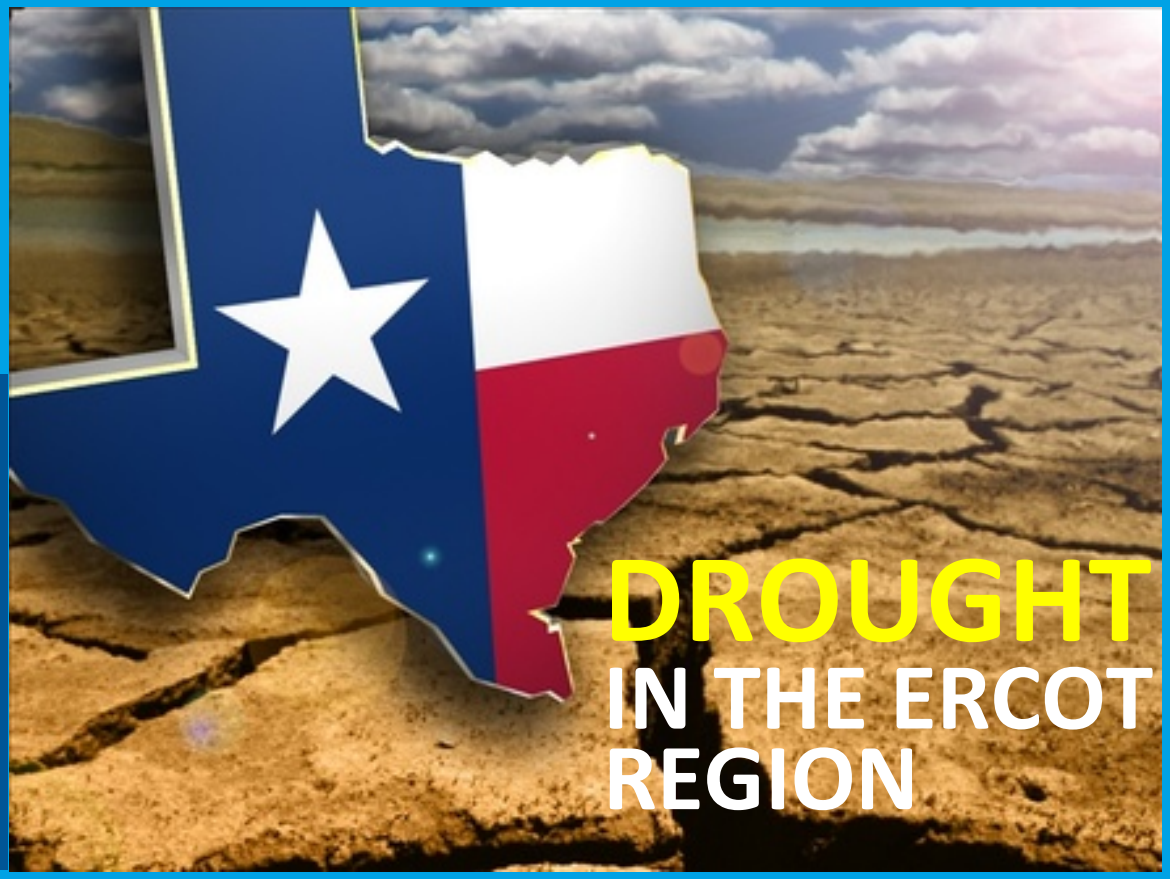
12 October 2012



BLACK & VEATCH
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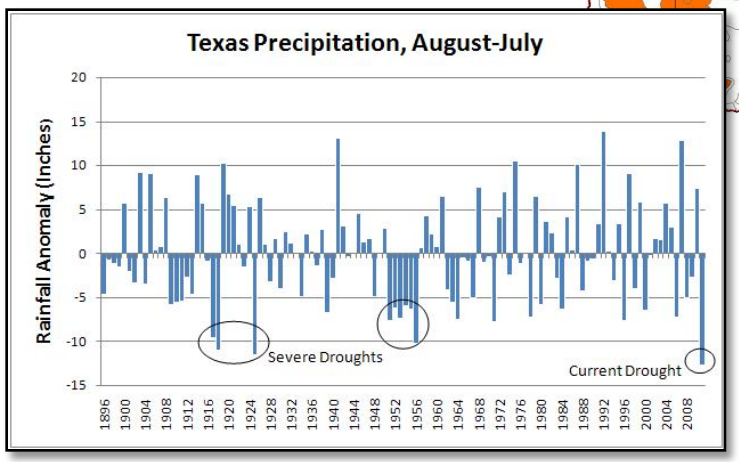
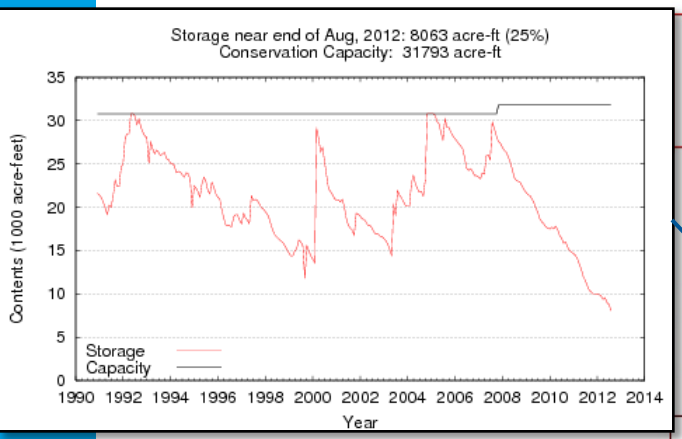
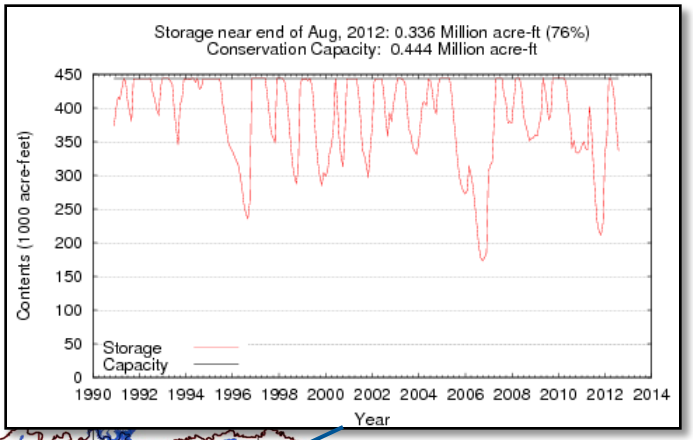
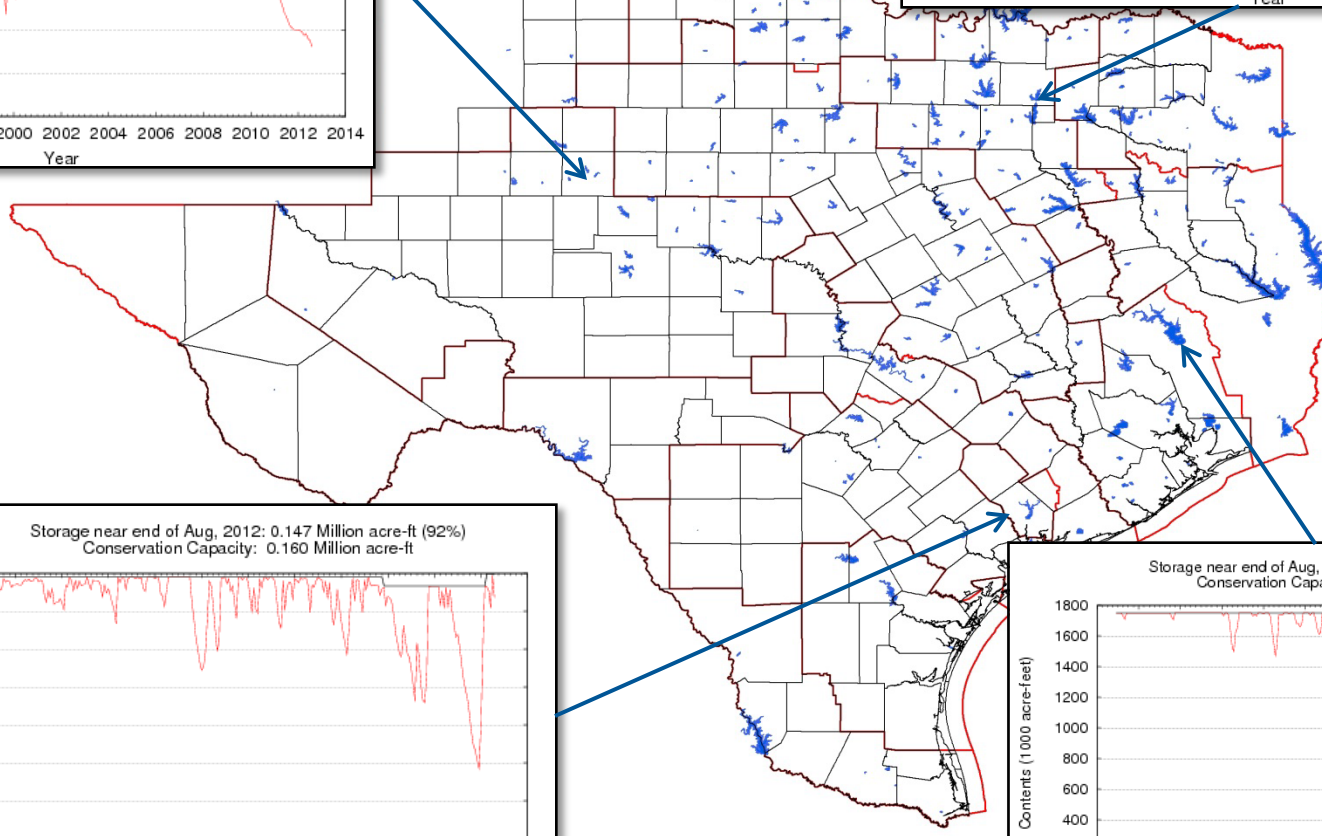
NORMAL RAINFALL PATTERNS

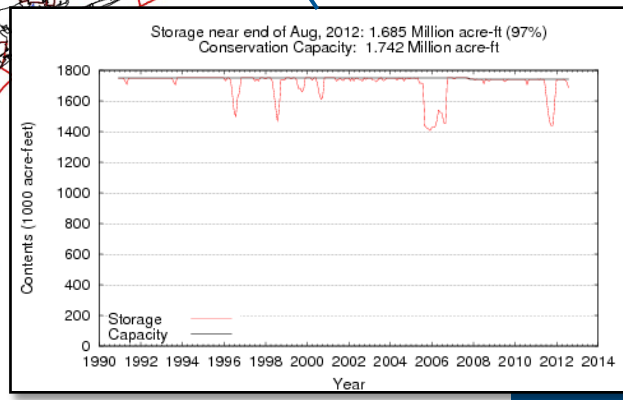


RESERVOIR LEVELS





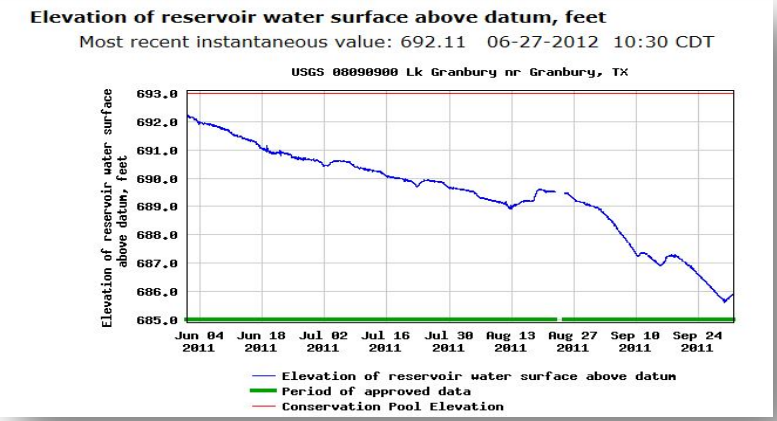




RESERVOIR LEVELS

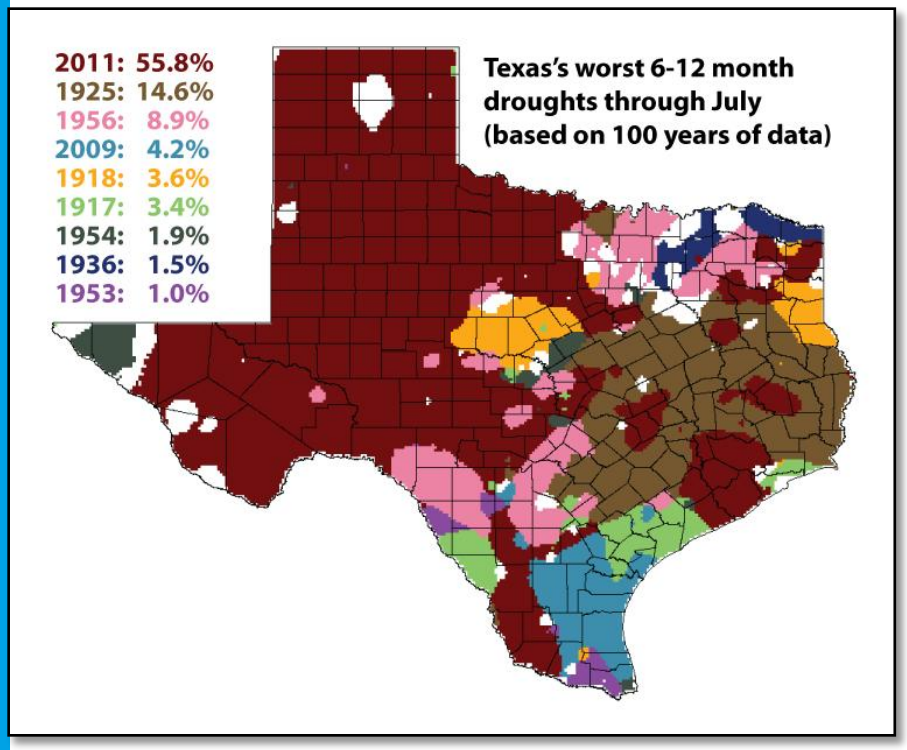
- **Summer Water Level Reductions for North Texas Lakes**

Lake	MW Impact	Conservation Level	Total Depth	Water Level Loss per Month
Arlington	1265	550	45	2.24
Bridgeport	1865	836	84	2.13
Lavon	406	492	39	1.86
Granbury	278	693	53	1.57
Others (not top 4)				
Ray Hubbard	916	435	47	0.84
Mountain Creek	800	457	55	0.78



POTENTIAL ISSUES

- **There is a potential for problems**
  - Reduced water availability
  - Increasing temperature in cooling lakes and once-through systems



- **Need to evaluate**
  - Water Use vs Water Consumption
  - Types of water sources
  - Generation Technology water use and consumption
  - Location of available water resources
  - Climatic variations

DROUGHT AND POWER GENERATION

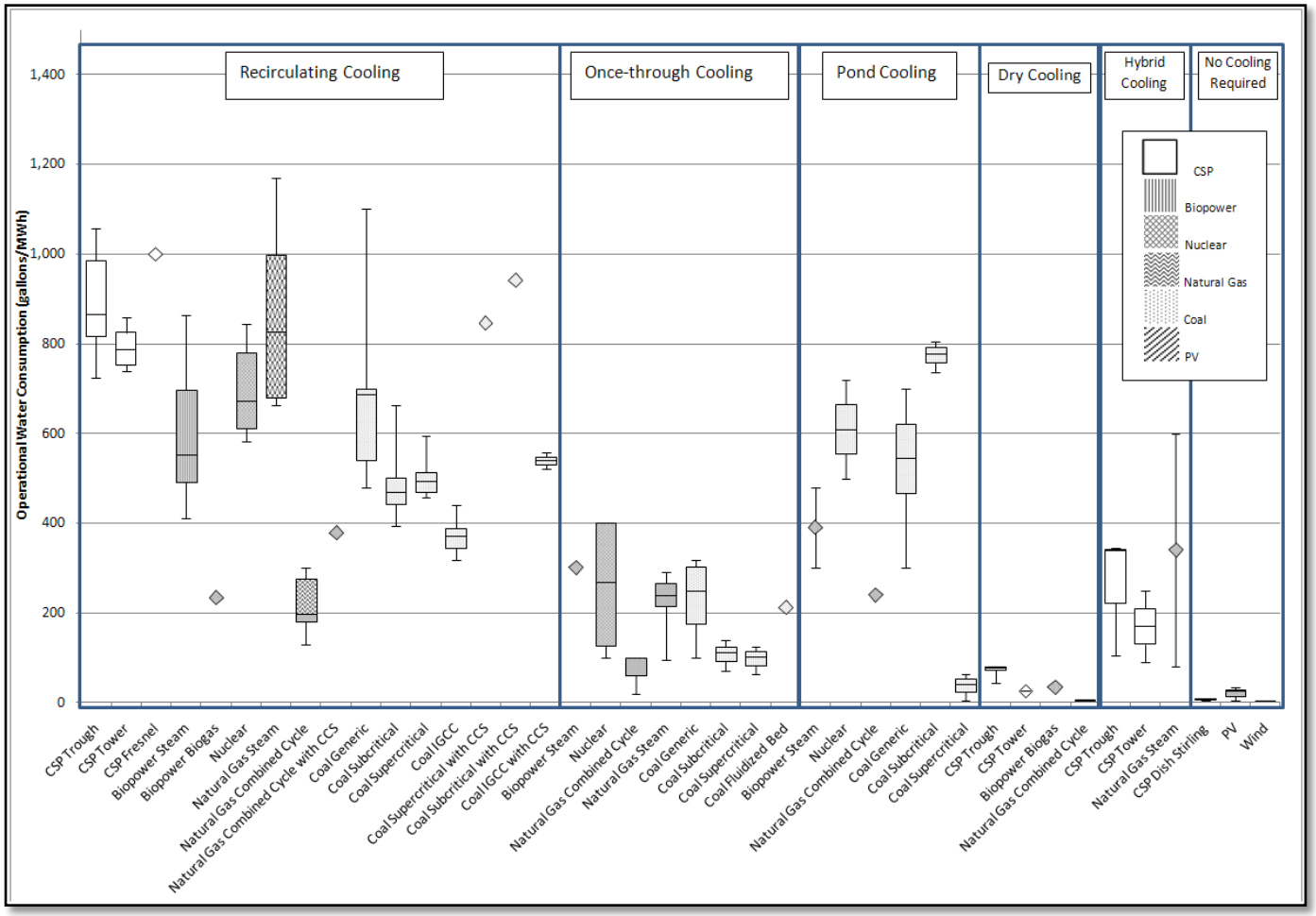
OVERVIEW

- Misunderstanding between water withdrawal and water use (49% versus 3%)
- Single-year droughts do not appear to significantly affect generation capacity due to storage improvements
- Multi-year droughts expected to affect capacity due to
  - Water supply availability
  - Temperature effects for cooling

TECHNOLOGY

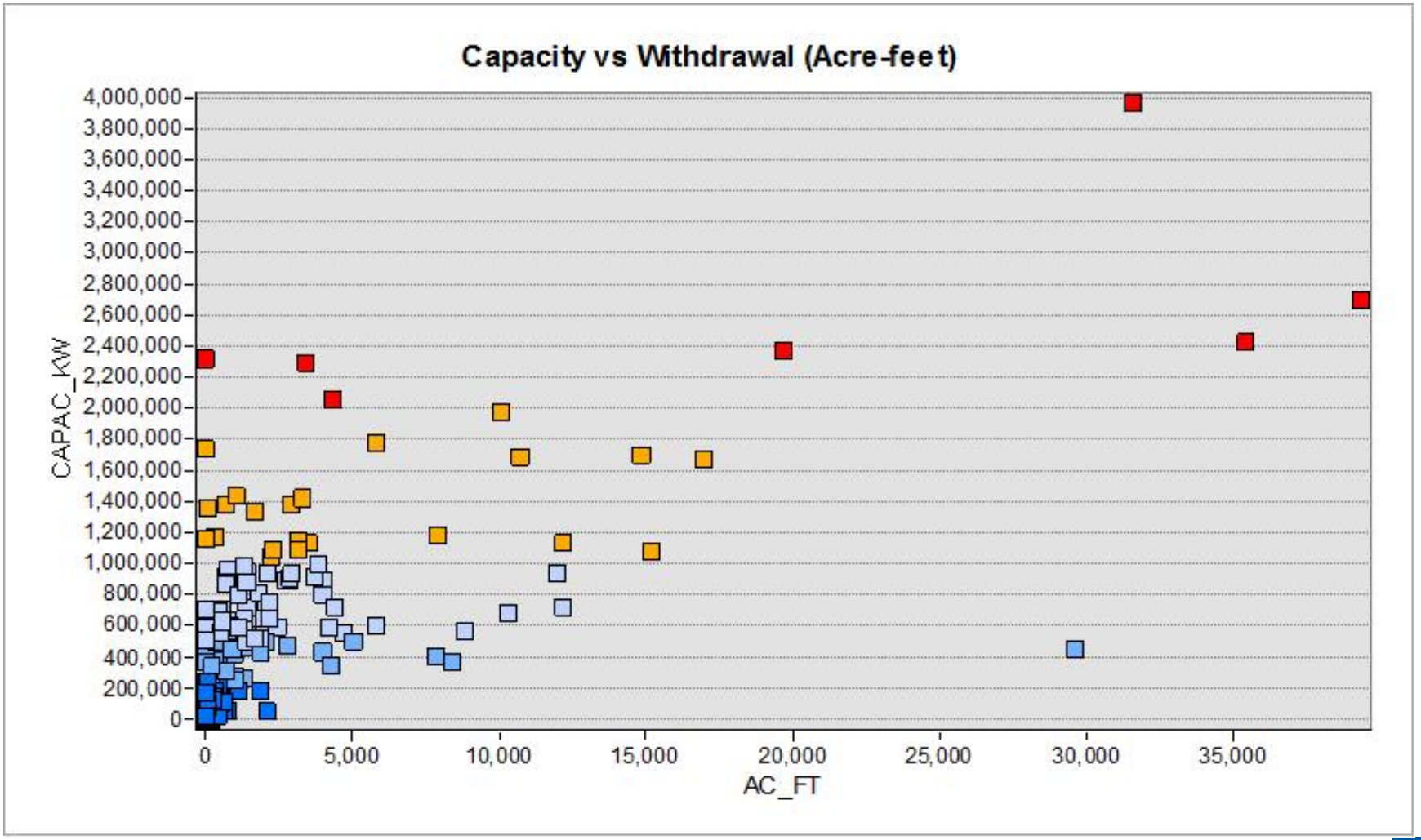
- Some technologies use less water than others
- Renewables (non-hydro) only use the water required to make the materials.
- Large thermal and nuclear units use the most water, but do not generally consume the most per MWh produced.
- Air cooled systems use much less water than water cooled systems, but they still have a small component of water use.

WATER CONSUMPTION ESTIMATES BY COOLING TECHNOLOGY

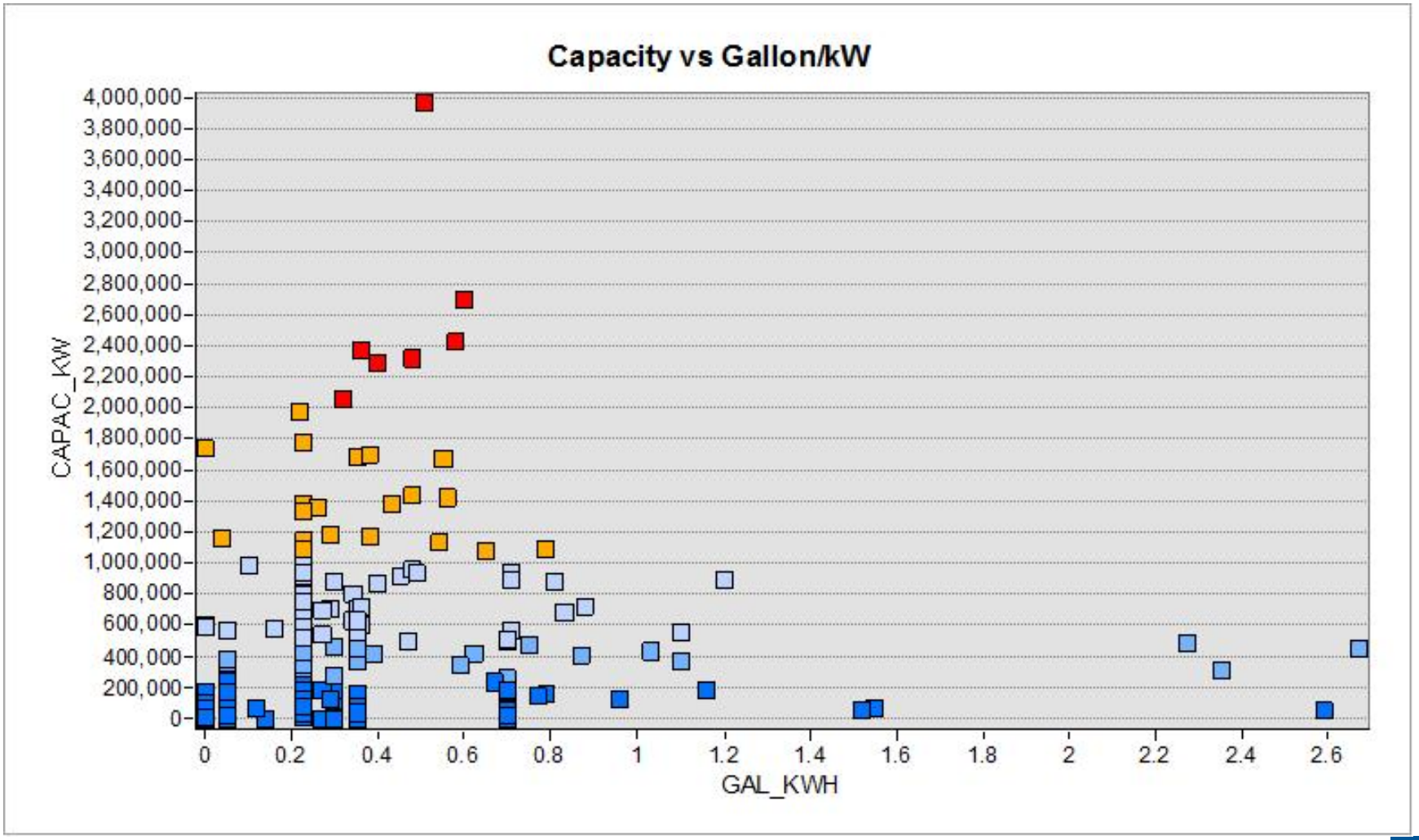


Source: NREL 2011

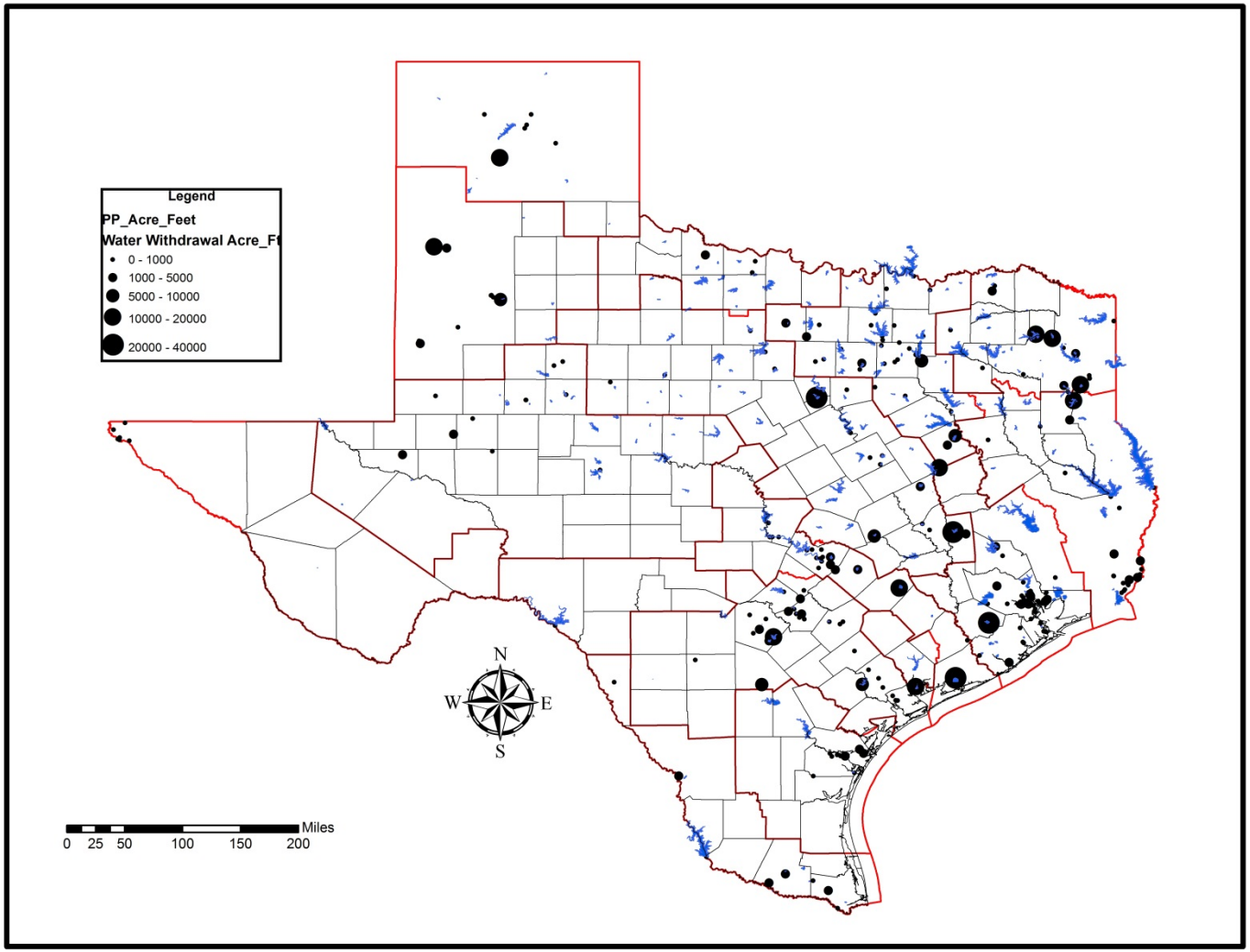
WITHDRAWAL OF WATER FROM TEXAS UNITS



GALLONS USED PER KWH PRODUCED

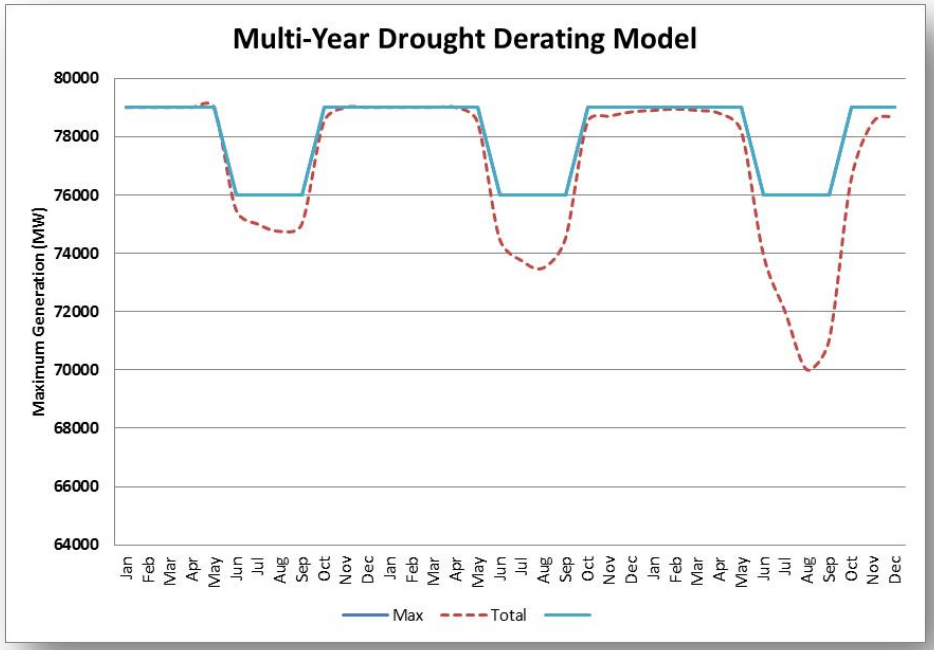


WATER WITHDRAWAL BY LOCATION



SINGLE-YEAR TO MULTI-YEAR DROUGHT IMPACTS

- **Single-year droughts**
  - Storage acts as buffer to mitigate short-term droughts in most parts of the state



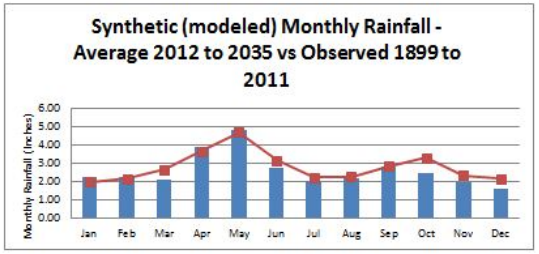
- **Multi-year droughts**
  - Reduction in storage
  - Increases lake and river temperatures
  - More susceptibility to capacity reduction

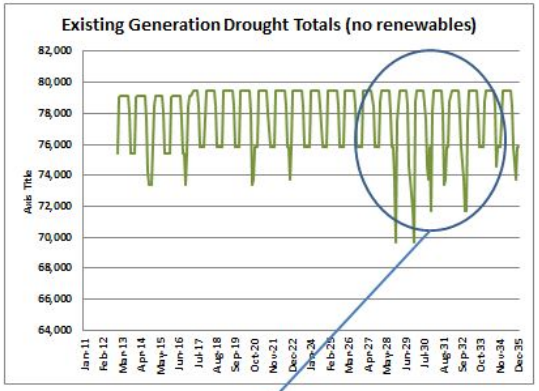
EVALUATION

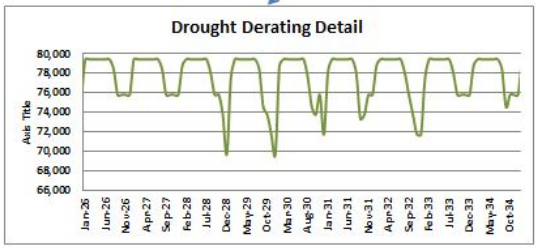
METHODOLOGY

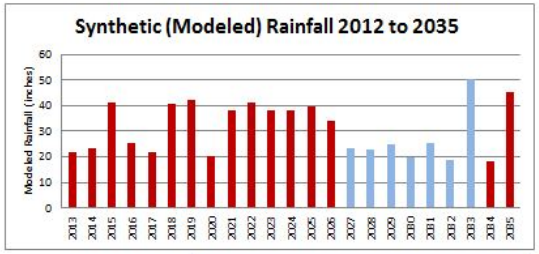
- Evaluated the historical climatic variations between 1900 and 2011 and previous studies
- Developed a model which predicts climatic variations between 2012 and 2035
- Modeled 1950's drought also
- Developed estimates of capacity reductions for drought years by month

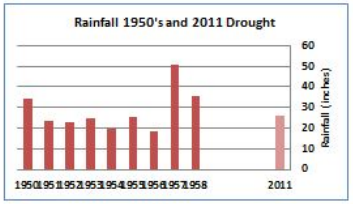
DEVELOPMENT OF SYNTHETIC CLIMATE PROFILES 2012 TO 2035











New Prediction

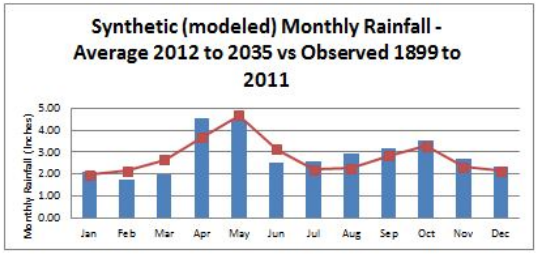
New

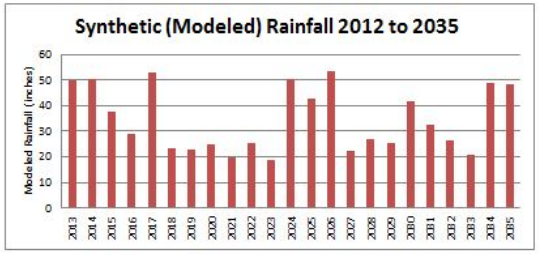
Year	DFW	SAT	
2013	21.82		
2014	23.33		
2015	41.20		
2016	25.37		
2017	21.86		
2018	40.71		
2019	42.22		
2020	20.33		
2021	38.08		
2022	41.29		
2023	38.35		
2024	38.04		
2025	39.51		
2026	34.22	1950	
2027	23.37	1951	
2028	22.69	1952	
2029	24.74	1953	
2030	19.55	1954	
2031	25.16	1955	
2032	18.55	1956	
2033	50.49	1957	
2034	18.48		
2035	45.15		

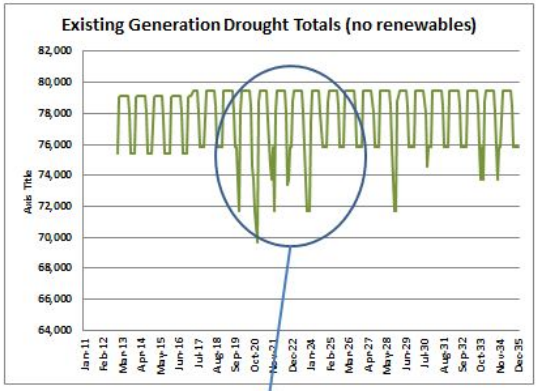
Monthly to Match Predicted

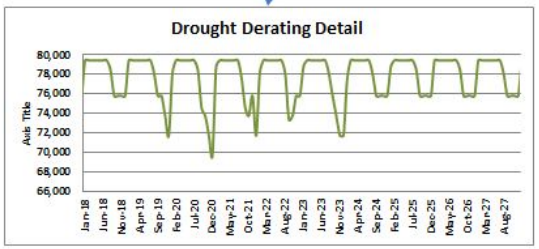
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2013	1.62	1.47	1.21	2.88	4.22	2.87	0.99	2.51	0.08	0.28	1.59	2.10	21.82
2014	1.13	1.83	1.13	1.23	5.93	1.40	2.55	0.85	3.27	1.37	0.48	2.15	23.33
2015	2.03	4.47	3.15	4.60	6.58	6.36	0.41	5.19	4.32	1.34	0.43	2.31	41.20
2016	2.99	1.04	0.34	1.98	0.27	1.74	2.35	2.79	4.20	2.44	2.64	2.58	25.37
2017	1.79	0.21	1.89	3.31	3.23	2.59	1.10	0.81	1.46	3.29	1.10	1.08	21.86
2018	1.70	3.97	4.01	1.38	4.35	6.43	0.51	2.14	8.34	3.69	0.96	3.25	40.71
2019	0.83	7.76	5.58	7.98	4.92	0.35	1.80	1.38	4.33	2.25	3.03	2.02	42.22
2020	0.53	0.06	0.69	0.61	6.21	1.28	2.56	1.30	2.22	2.95	1.14	0.78	20.33
2021	1.75	1.43	1.75	2.97	7.69	2.97	1.37	6.78	2.02	2.97	5.20	1.18	38.08
2022	5.54	1.91	0.65	8.35	0.82	0.66	6.85	5.73	5.32	4.12	0.57	0.78	41.29
2023	2.07	1.36	2.25	3.28	4.12	0.48	5.58	2.63	4.97	7.06	2.68	1.87	38.35
2024	3.48	3.32	3.32	4.33	8.15	3.63	0.78	2.73	1.10	2.34	1.87	2.98	38.04
2025	3.73	2.98	3.14	5.67	5.36	3.56	2.78	3.96	3.85	2.12	2.22	0.13	39.51
2026	5.01	2.47	1.58	4.73	6.16	3.16	4.53	3.05	3.21	0.30	0.02	0.00	34.22
2027	1.39	2.42	1.33	2.27	4.60	4.12	2.22	0.47	1.84	1.62	1.00	0.09	23.37
2028	0.58	1.12	1.39	6.51	3.21	0.00	0.56	0.44	0.54	0.01	5.84	2.49	22.69
2029	0.54	1.34	2.52	4.82	3.55	0.55	0.97	1.09	1.68	4.27	2.09	1.32	24.74
2030	2.08	0.73	0.66	3.62	4.38	1.20	0.24	0.81	1.46	2.35	1.24	0.78	19.55
2031	1.17	2.01	2.15	1.94	6.58	4.99	0.64	1.00	3.68	0.20	0.59	0.21	25.16
2032	1.34	2.54	0.11	3.12	3.83	0.88	0.38	0.23	0.23	1.20	2.61	2.08	18.55
2033	1.72	1.77	4.18	12.19	12.64	3.96	0.65	0.12	3.23	3.53	4.72	1.78	50.49
2034	2.32	1.65	0.84	0.83	3.75	1.90	0.95	1.66	1.19	1.24	1.44	0.71	18.48
2035	6.04	3.87	4.73	1.17	0.40	7.40	6.11	2.51	2.20	5.76	1.80	3.17	45.15

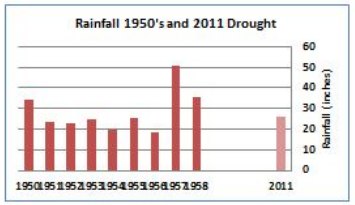
DEVELOPMENT OF A SYNTHETIC MULTI-YEAR DROUGHT PROFILE 2018 TO 2023









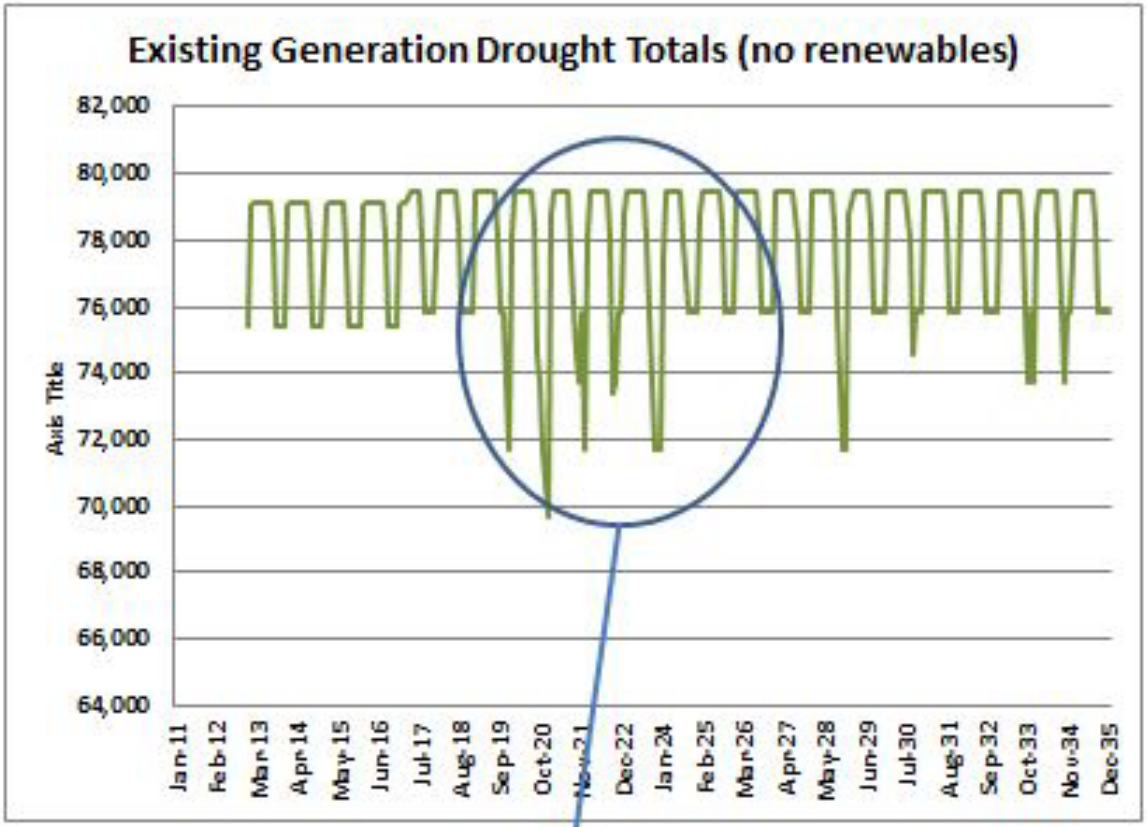


New Prediction

Year	DFW	SAT
2013	50.05	
2014	50.32	
2015	37.55	
2016	29.13	
2017	52.95	
2018	23.37	1951
2019	22.69	1952
2020	24.74	1953
2021	19.55	1954
2022	25.16	1955
2023	18.55	1956
2024	50.49	1957
2025	42.66	
2026	53.43	
2027	22.26	
2028	27.18	
2029	25.63	
2030	41.65	
2031	32.41	
2032	26.24	
2033	20.90	
2034	48.79	
2035	48.25	

Monthly to Match Predicted

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2013	2.39	0.41	2.75	7.39	6.40	6.37	5.18	0.52	1.36	7.13	4.39	5.71	50.05
2014	1.82	2.63	4.46	1.47	0.61	2.62	8.18	7.93	6.77	7.84	2.86	3.05	50.32
2015	1.61	0.68	0.52	5.18	4.50	1.25	1.17	5.37	3.85	6.98	2.75	3.70	37.55
2016	3.31	3.20	2.15	3.40	2.10	2.07	3.95	1.56	0.85	3.73	2.76	0.05	29.13
2017	2.40	0.40	0.89	10.13	8.98	3.75	3.38	5.95	7.78	5.66	2.70	0.94	52.95
2018	1.39	2.42	1.33	2.27	4.60	4.12	2.22	0.47	1.84	1.62	1.00	0.09	23.37
2019	0.58	1.12	1.39	6.51	3.21	0.00	0.56	0.44	0.54	0.01	5.84	2.49	22.69
2020	0.54	1.34	2.52	4.82	3.55	0.55	0.97	1.09	1.68	4.27	2.09	1.32	24.74
2021	2.08	0.73	0.66	3.62	4.38	1.20	0.24	0.81	1.46	2.35	1.24	0.78	19.55
2022	1.17	2.01	2.15	1.94	6.58	4.99	0.64	1.00	3.68	0.20	0.59	0.21	25.16
2023	1.34	2.54	0.11	3.12	3.83	0.88	0.38	0.23	0.23	1.20	2.61	2.08	18.55
2024	1.72	1.77	4.18	12.19	12.64	3.96	0.65	0.12	3.23	3.53	4.72	1.78	50.49
2025	6.67	0.37	3.41	1.30	6.12	1.40	6.97	5.46	7.22	0.35	2.18	1.20	42.66
2026	2.83	4.90	5.70	7.52	2.41	0.81	6.34	2.51	4.71	8.43	4.96	2.31	53.43
2027	1.59	0.04	0.67	1.92	4.33	2.50	1.88	2.97	2.12	2.93	0.17	1.14	22.26
2028	2.48	0.69	3.04	2.19	1.40	0.13	1.40	3.64	2.98	3.68	3.87	1.67	27.18
2029	2.37	3.17	0.02	7.77	0.82	2.07	0.87	2.27	0.33	3.06	1.34	1.53	25.63
2030	0.21	1.10	0.61	6.26	9.74	6.67	1.87	4.57	1.94	0.20	3.51	4.95	41.65
2031	2.07	2.43	3.75	2.92	3.49	2.22	1.74	2.32	4.14	1.05	1.89	4.39	32.41
2032	0.86	0.99	1.17	3.33	4.46	1.21	3.22	2.85	2.73	2.52	1.81	1.08	26.24
2033	0.73	1.57	1.87	1.50	2.73	1.98	1.21	1.95	2.06	1.62	1.46	2.21	20.90
2034	3.66	2.34	0.02	3.21	1.91	7.64	3.70	6.34	5.86	3.83	5.05	5.23	48.79
2035	3.84	3.27	2.42	3.88	3.06	0.03	1.92	6.86	5.72	8.46	2.67	6.11	48.25


Existing Generation Drought Totals (no renewables)
Axis Title
82,000
80,000
78,000
76,000
74,000
72,000
70,000
68,000
66,000
64,000
Jan-11
Feb-12
Mar-13
Apr-14
May-15
Jun-16
Jul-17
Aug-18
Sep-19
Oct-20
Nov-21
Dec-22
Jan-24
Feb-25
Mar-26
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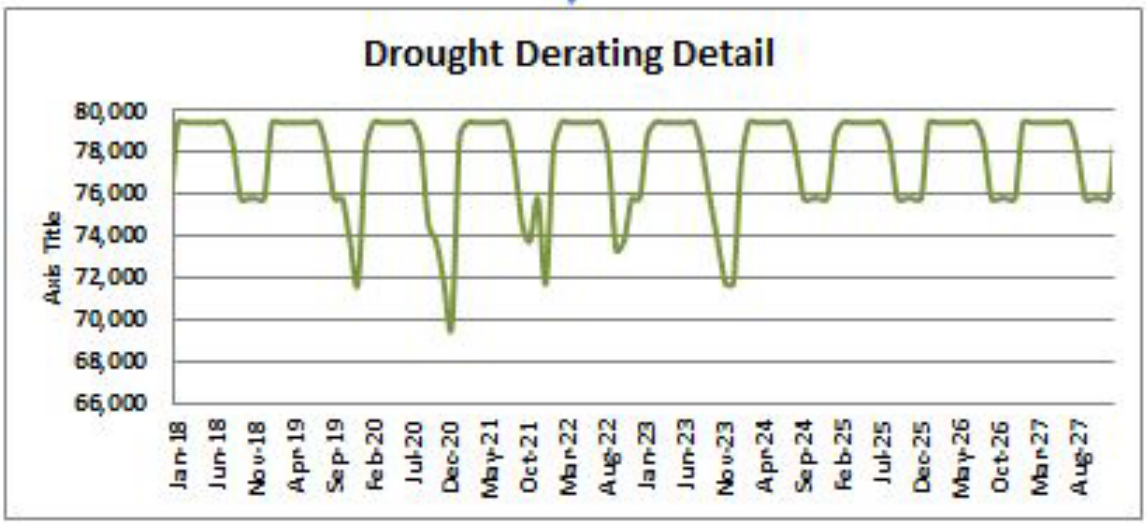
May-28
Jun-29
Jul-30
Aug-31
Sep-32
Oct-33
Nov-34
Dec-35


Drought Derating Detail
Axis Title
80,000
78,000
76,000
74,000
72,000
70,000
68,000
66,000
Jan-18
Jun-18
Nov-18
Apr-19
Sep-19
Feb-20
Jul-20
Dec-20
May-21
Oct-21
Mar-22
Aug-22
Jan-23
Jun-23
Nov-23
Apr-24
Sep-24
Feb-25
Jul-25
Dec-25
May-26
Oct-26
Mar-27
Aug-27

QUESTIONS