



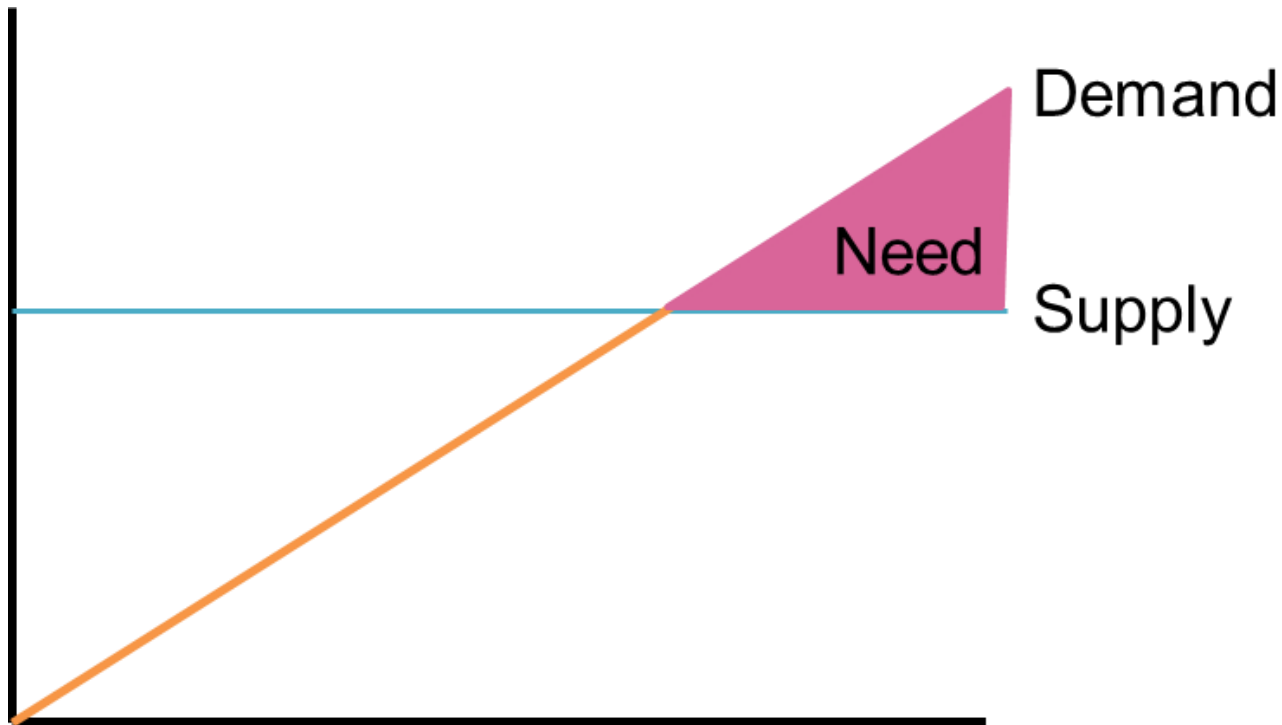
Water Forward – Austin's Integrated Water Resource Plan

February 7, 2017



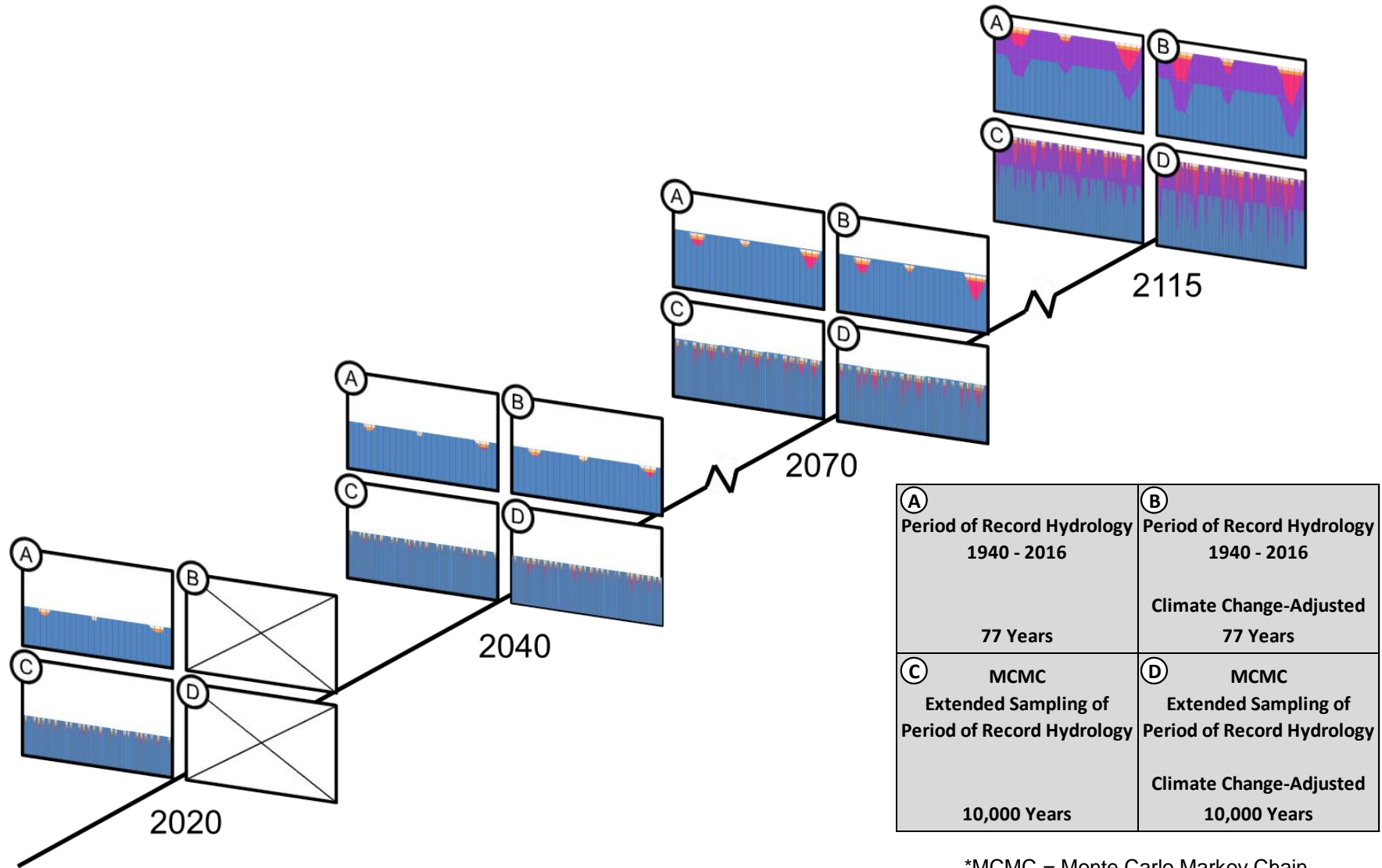
Preliminary water needs identification

Traditional Water Planning



- Unlike traditional water planning, the IWRP is a dynamic process
- Not just planning for one number, but for a range of possible future conditions

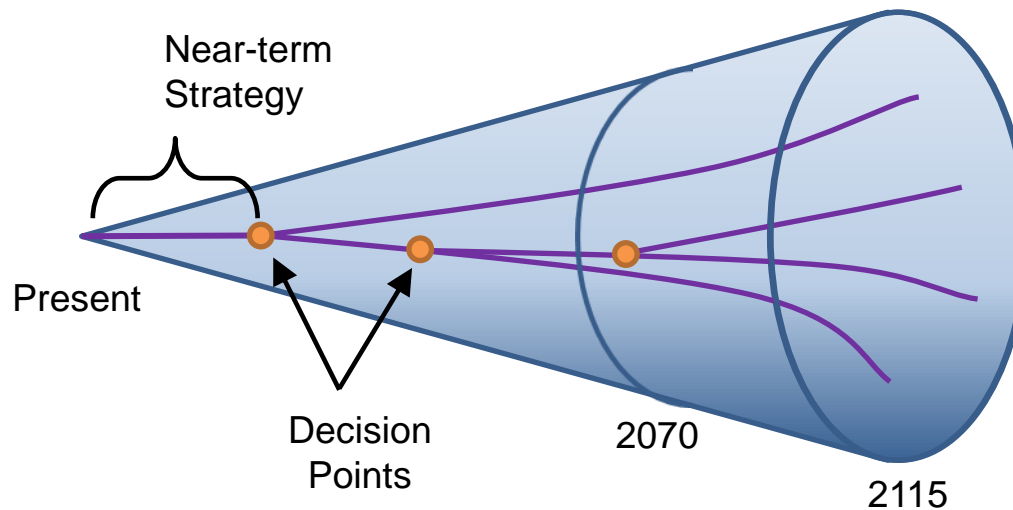
Water Forward Planning For Change and Uncertainties



*MCMC = Monte Carlo Markov Chain

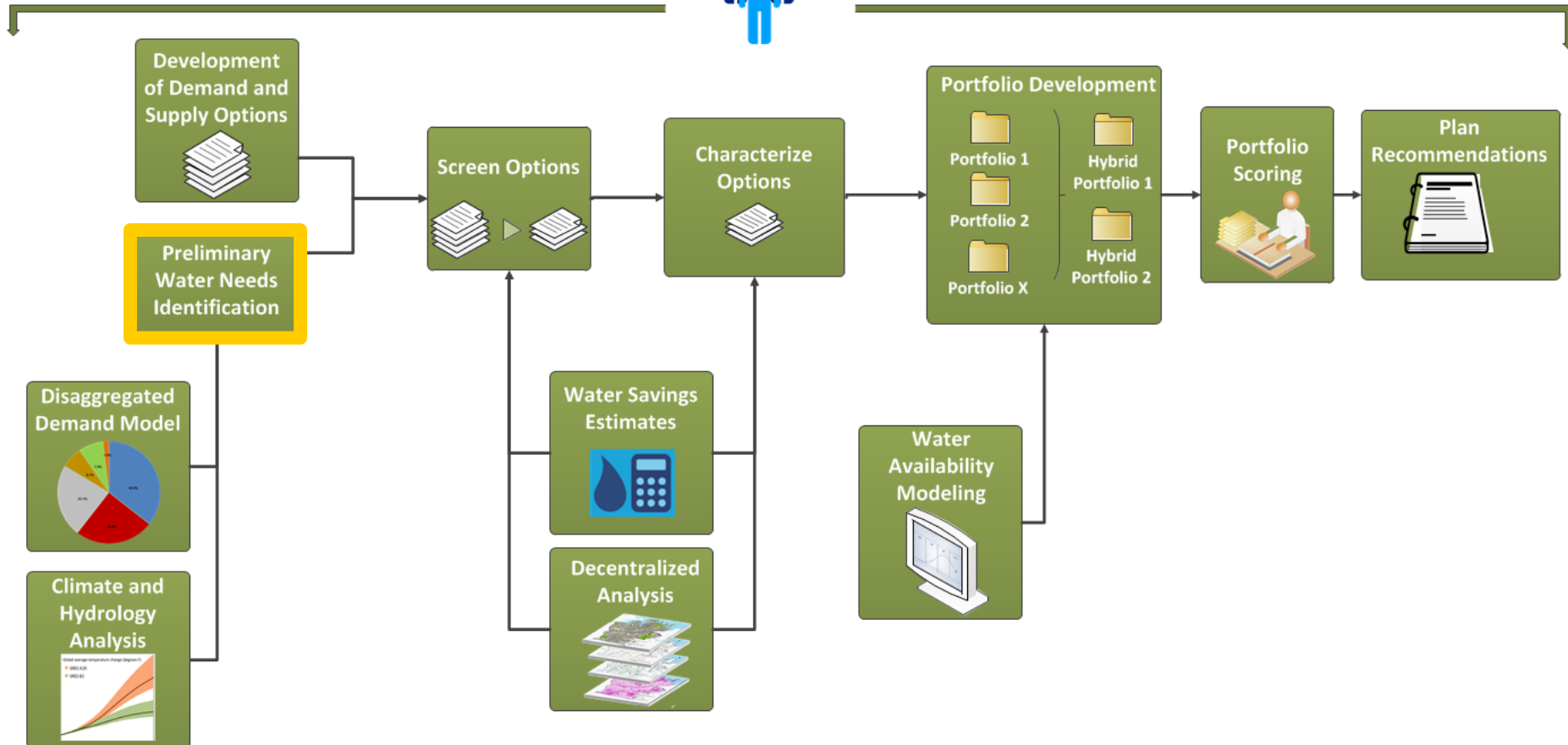
Some Key Points About Austin's Integrated Water Resource Plan

- We're implementing an adaptive management approach
- This process is about incremental changes we can make to get closer to our desired future
- The plan is anticipated to be updated on a five year cycle to allow new data to inform planning assumptions
- Future updates to the plan will allow us to build on the work we do today and learn from our actions



Plan Development Process

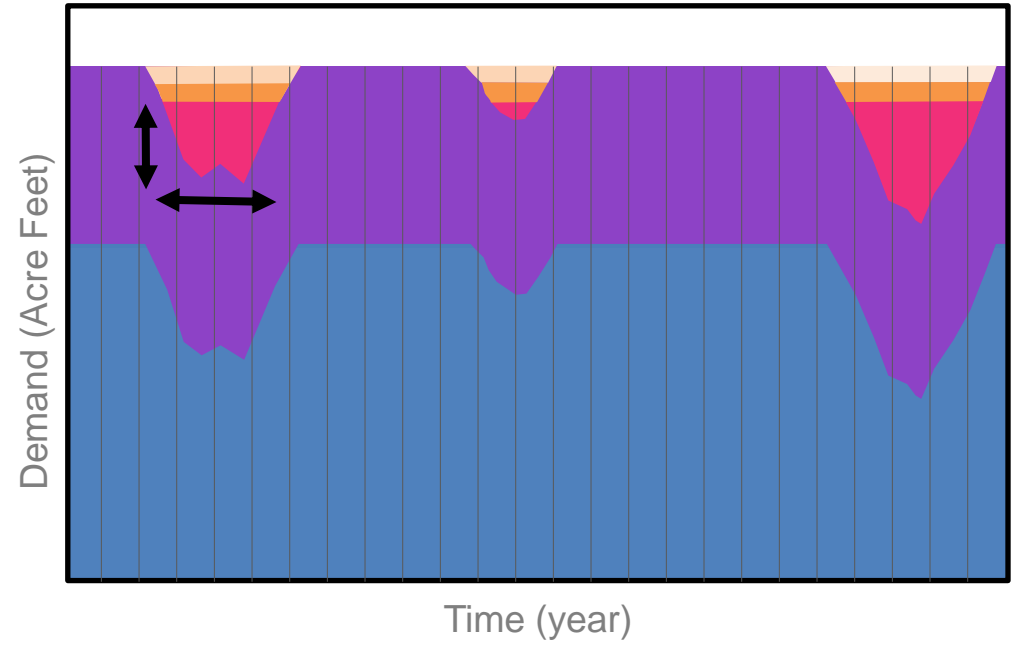
Public and Stakeholder Input



Preliminary Water Needs Identification

- **City of Austin Needs will include**
 - **Needs During Prolonged Drought** = Demand reductions from implementation of Stages 3&4
 - **Needs Above Current Contract** = Baseline demands above current 325,000 AF contract with LCRA

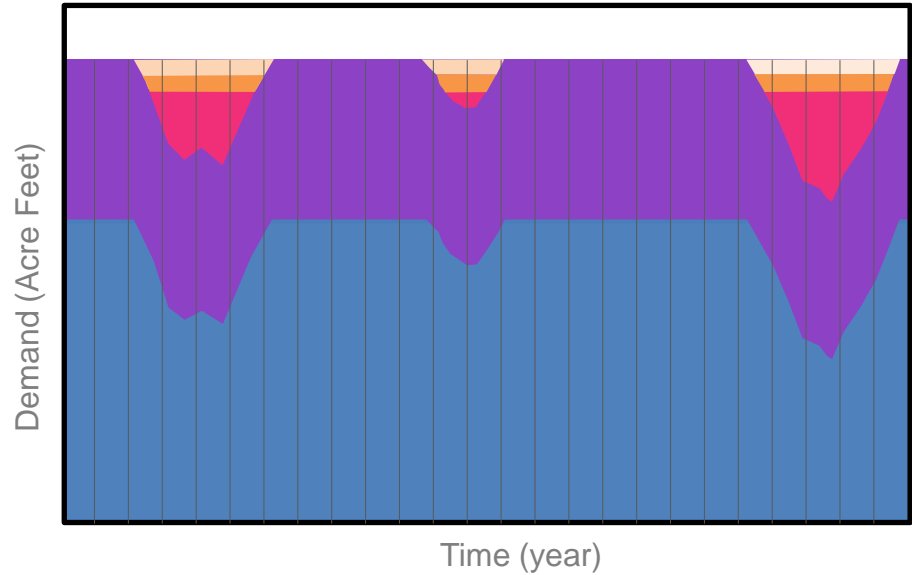
2115 Demands
Evaluated Against Period of Record Hydrology



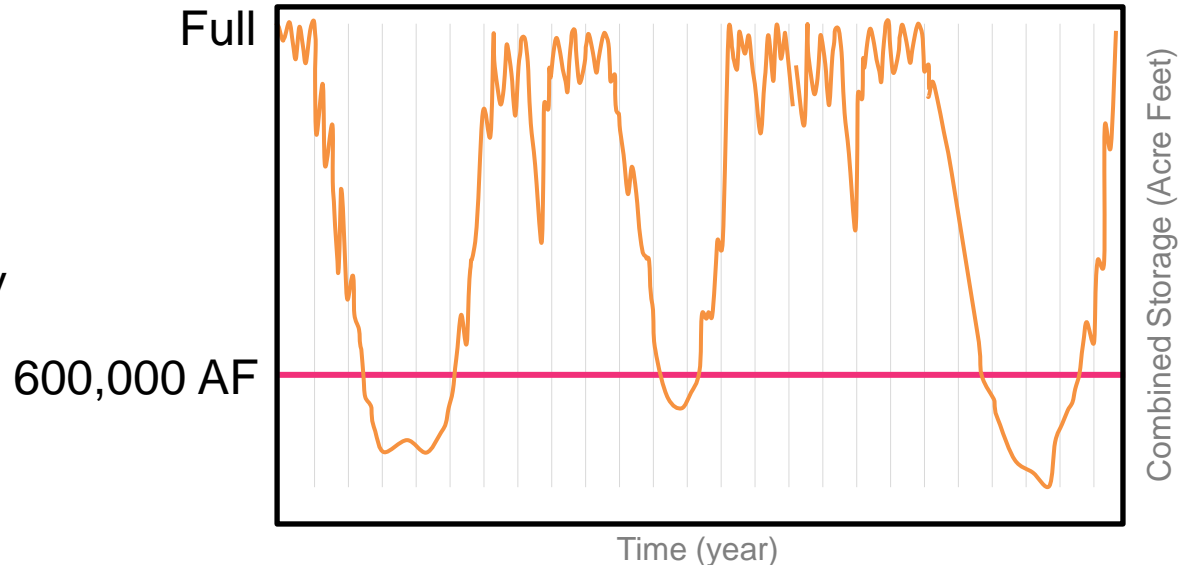


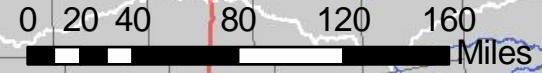
- **Regional Needs** = include periods when combined storage levels dip below emergency levels
- Future hydrologic scenarios may identify regional water needs
- Despite assumed cutbacks on the part of AW and others, reservoir levels may still go below emergency levels

2115 City of Austin Supplies versus Demand

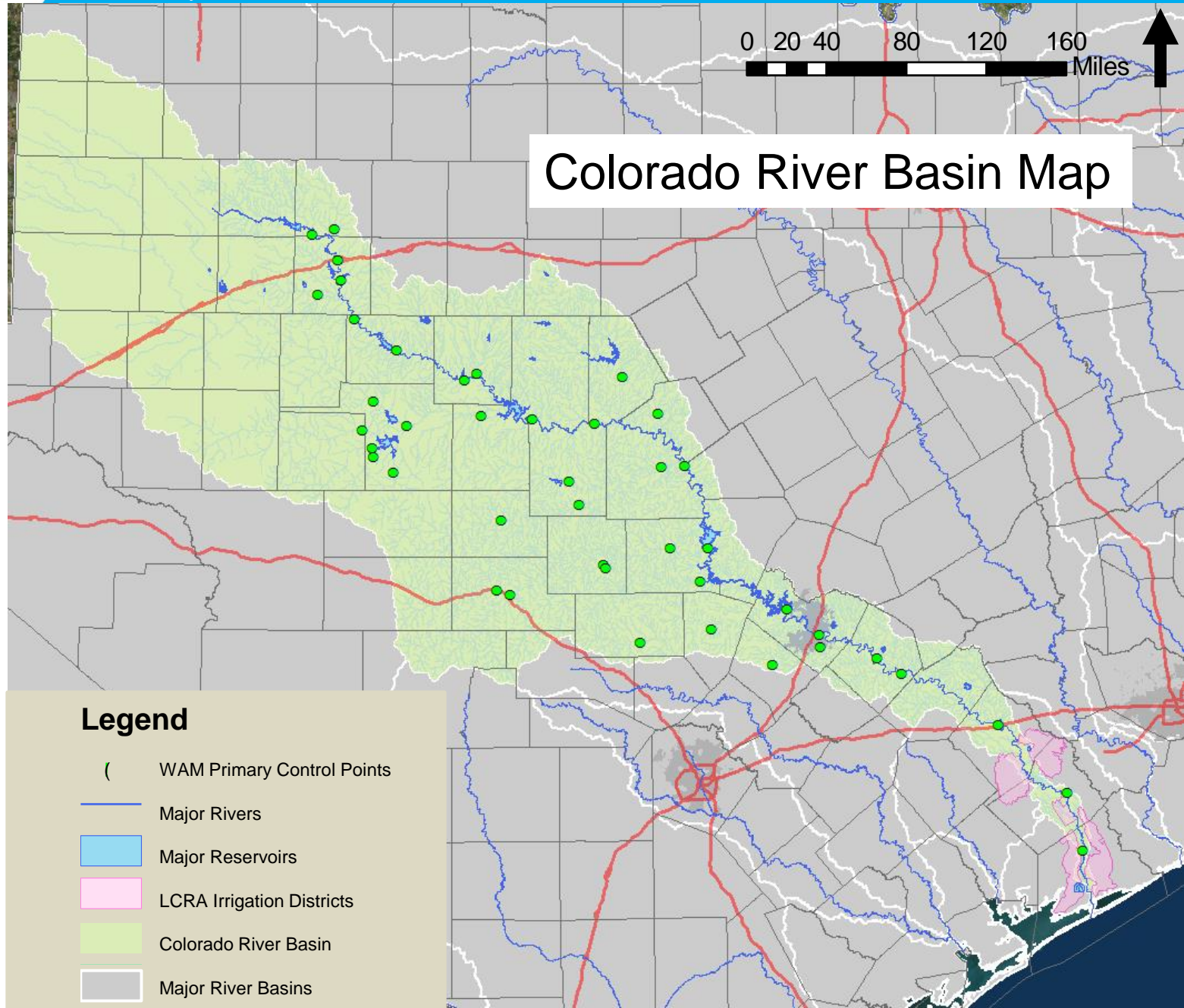


Highland Lakes Combined Storage Levels





Colorado River Basin Map



Legend

- () WAM Primary Control Points
- Major Rivers
- Major Reservoirs
- LCRA Irrigation Districts
- Colorado River Basin
- Major River Basins

Assumptions for “Water Forward WAM”

- Full basin simulation based on TCEQ WAM
- Monthly time step simulation
- Modifications made to better reflect lower basin water right operations
 - Water rights above OH Ivie and Brownwood simulated first (Region K cutoff assumption)
 - Assumption for reliable flows and stored water delivery losses below Highland Lakes
- Austin’s municipal return flows added
- Austin and regional demands are reduced according to combined storage amounts

Assumptions for “Water Forward WAM”, continued

- Demands for firm water customers set according to 2020, 2040, and 2070 estimates
 - Austin’s average-year demands according to Disaggregated Demand Model
 - Regional firm demands informed by Region K projections
 - Agricultural demands according to 2015 WMP projections
- Regional demands for 2115 estimated from 2070 demands and other information
- Demands adjusted for climate change scenarios
 - Firm customer demand increases of 2%, 4%, and 6% in 2040, 2070, and 2115
 - Agricultural demands adjusted using equation incorporating evaporation and precipitation
- LCRA’s Lane City off-channel reservoir in all simulations
- Agricultural irrigation demands allowed to access LCRA interruptible stored water in 2020 and 2040 in conjunction with other supplies. On-farm storage and other supplies used for agriculture in 2070 and 2115.

City of Austin Needs Summary

Needs During Prolonged Drought

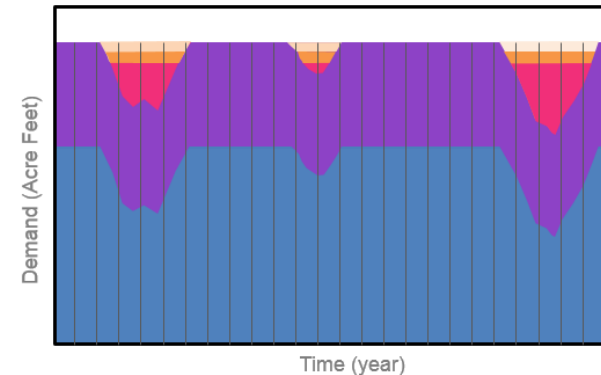
Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
-	-	-	-

Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
-	-	-	-

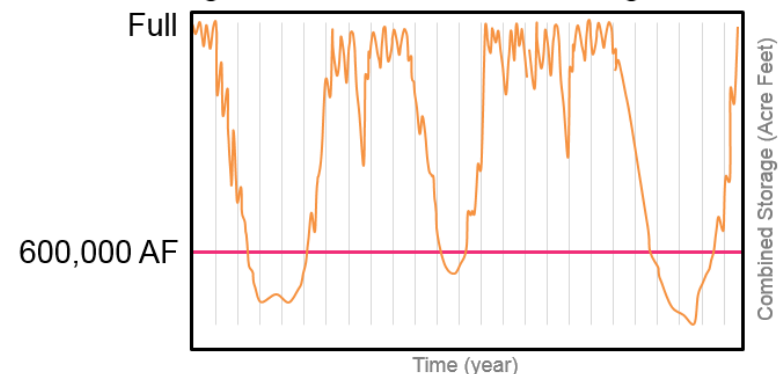
Planning Horizon Year	(C)	(D)
-	-	-

- Drought of 2007-2016 used for results reporting for POR simulations
- In a February 2015 press release LCRA announced that ...“the Highland Lakes are now in a new ‘critical period’ marking the driest conditions on record, eclipsing the 1947-57 drought that until now was the worst on record for this region.”

2115 City of Austin Supplies versus Demand



Highland Lakes Combined Storage Levels



2020 City of Austin Needs Summary

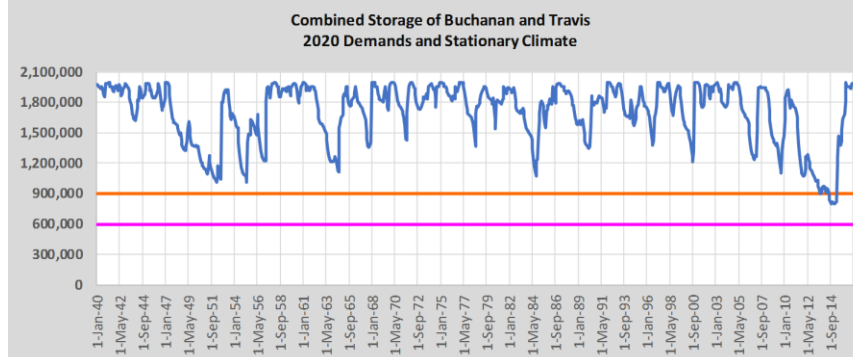
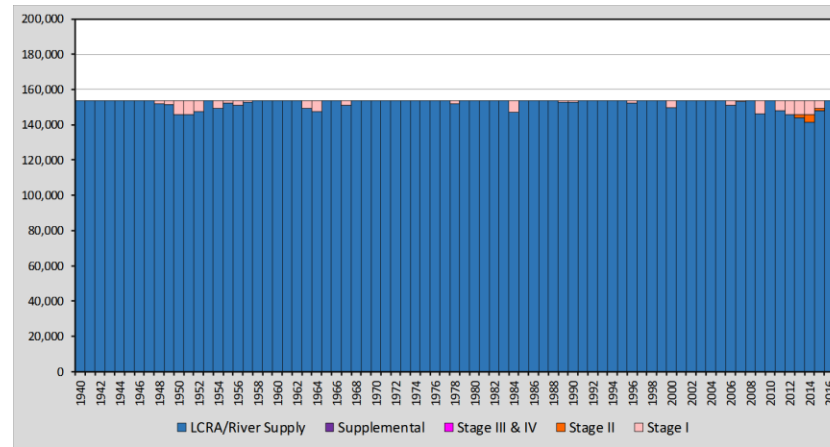
Needs During Prolonged Drought

Needs above Current Contract

Needs During Prolonged Drought				Needs above Current Contract					
Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft	Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft	Annual Need, ac-ft	Annual Need, ac-ft
(A) 0	0	0	0	(B) No Significant Change from Period of Record				(A) -	(B) -

(A)

Period of Record (77 years)



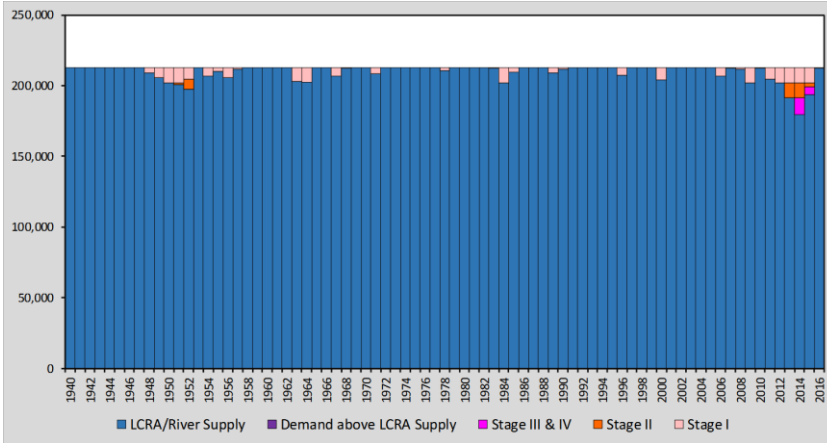
2040 City of Austin Needs Summary

Needs During Prolonged Drought

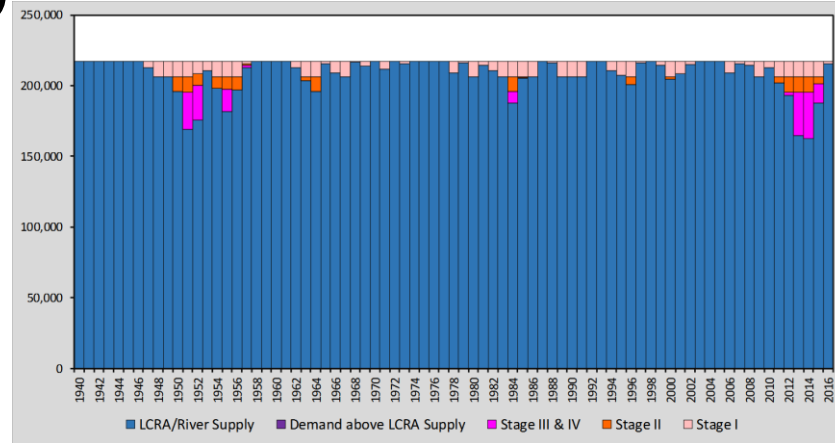
Needs above Current Contract

Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft	Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft	Needs above Current Contract	
								Annual Need, ac-ft	Annual Need, ac-ft
(A) 17,802	0.9	17,802	17,802	(B) 78,851	2.8	28,673	32,545	(A) -	(B) -

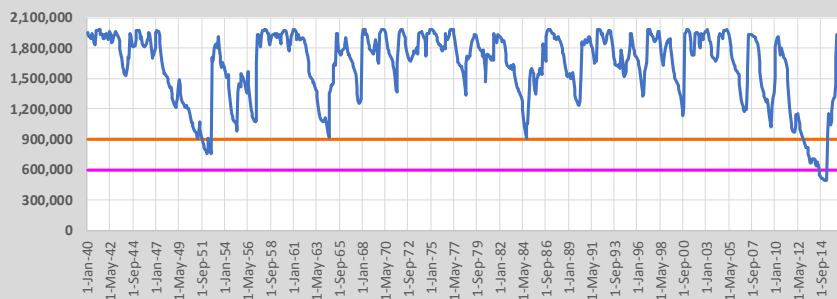
(A) Period of Record (77 years)



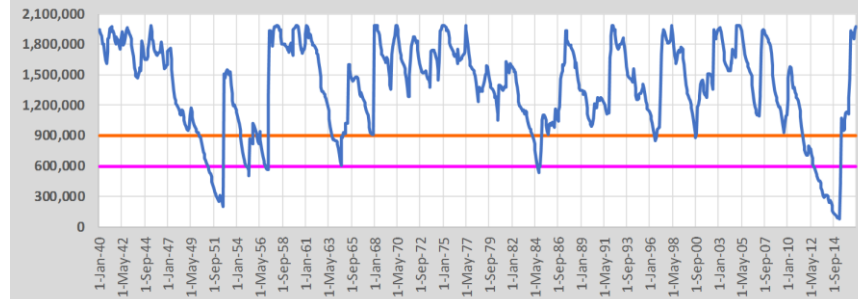
(B) Period of Record (77 years) Climate-Adjusted



**Combined Storage of Buchanan and Travis
2040 Demands and Stationary Climate**



**Combined Storage of Buchanan and Travis
2040 Climate Adjusted Demands and RCP 8.5 Hydrology**



2070 City of Austin Needs Summary

Needs During Prolonged Drought

Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft	Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
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(A) 117,563	2.8	42,750	48,304	(B) 240,100	5.2	46,471	50,236
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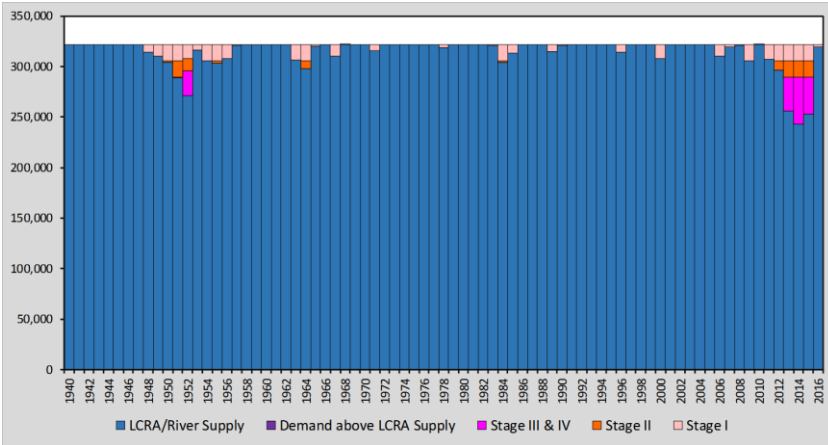
Needs above Current Contract

Annual Need, ac-ft	Annual Need, ac-ft
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(A) -	(B) 7,562
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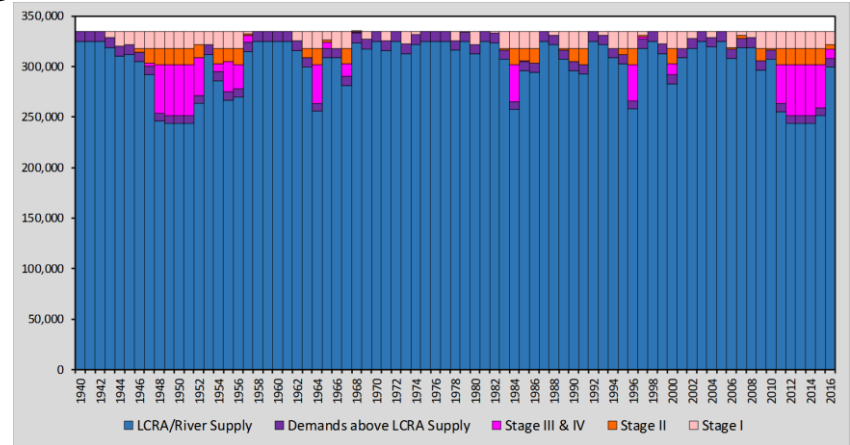
(A)

Period of Record (77 years)

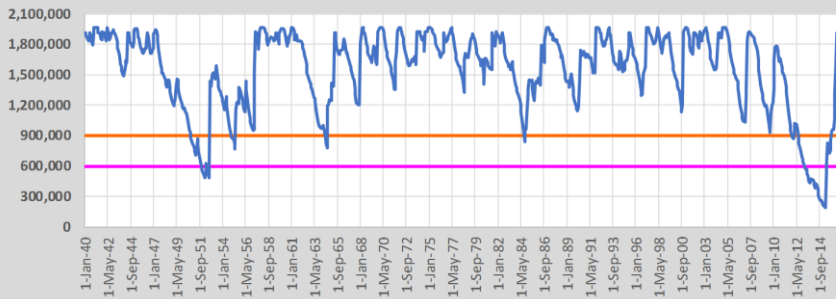


(B)

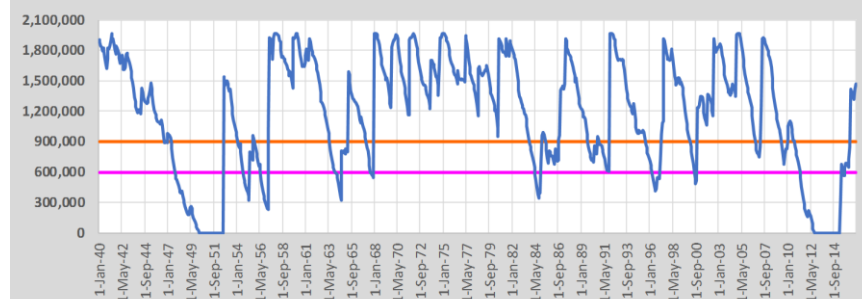
Period of Record (77 years) Climate-Adjusted



Combined Storage of Buchanan and Travis
2070 Demands and Stationary Climate



Combined Storage of Buchanan and Travis
2070 Climate Adjusted Demands and RCP 8.5 Hydrology



2115 City of Austin Needs Summary

Needs During Prolonged Drought

Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
(A) 212,395	3.1	68,885	82,234

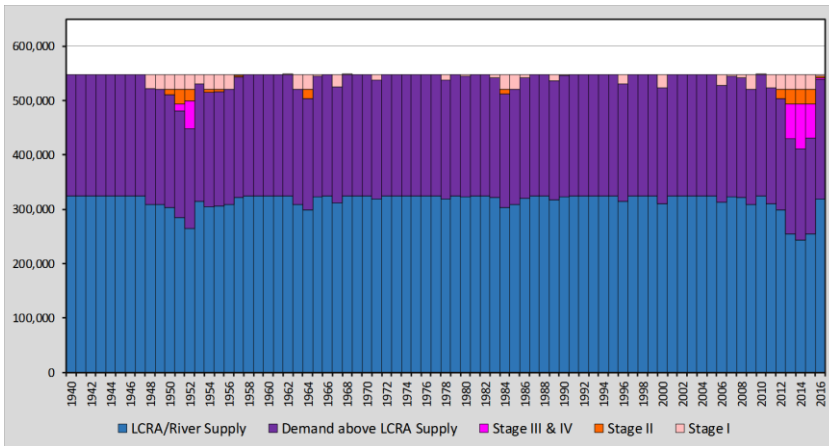
Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
(B) 503,241	6.7	75,486	87,168

Needs above Current Contract

Annual Need, ac-ft	Annual Need, ac-ft
(A) 220,823	(B) 253,801

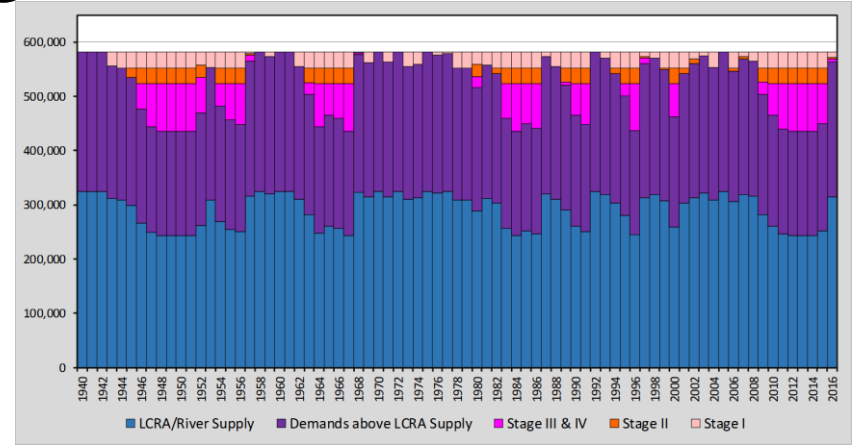
(A)

Period of Record (77 years)

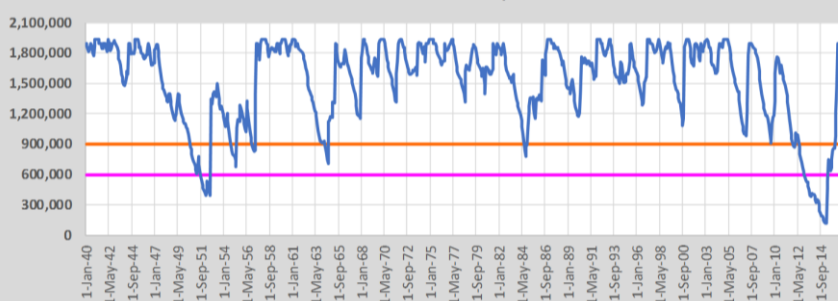


(B)

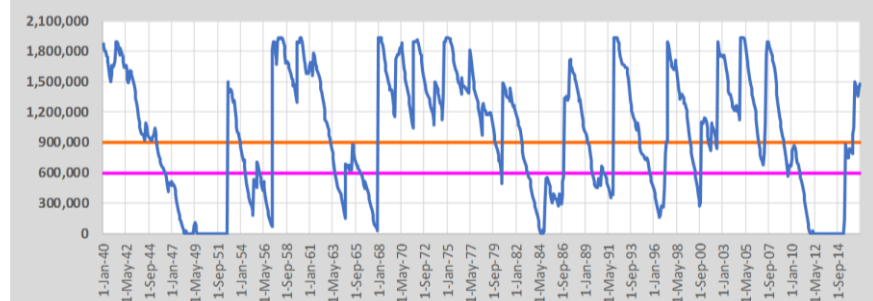
Period of Record (77 years) Climate-Adjusted



Combined Storage of Buchanan and Travis 2115 Demands and Stationary Climate



Combined Storage of Buchanan and Travis 2115 Climate Adjusted Demands and RCP 8.5 Hydrology



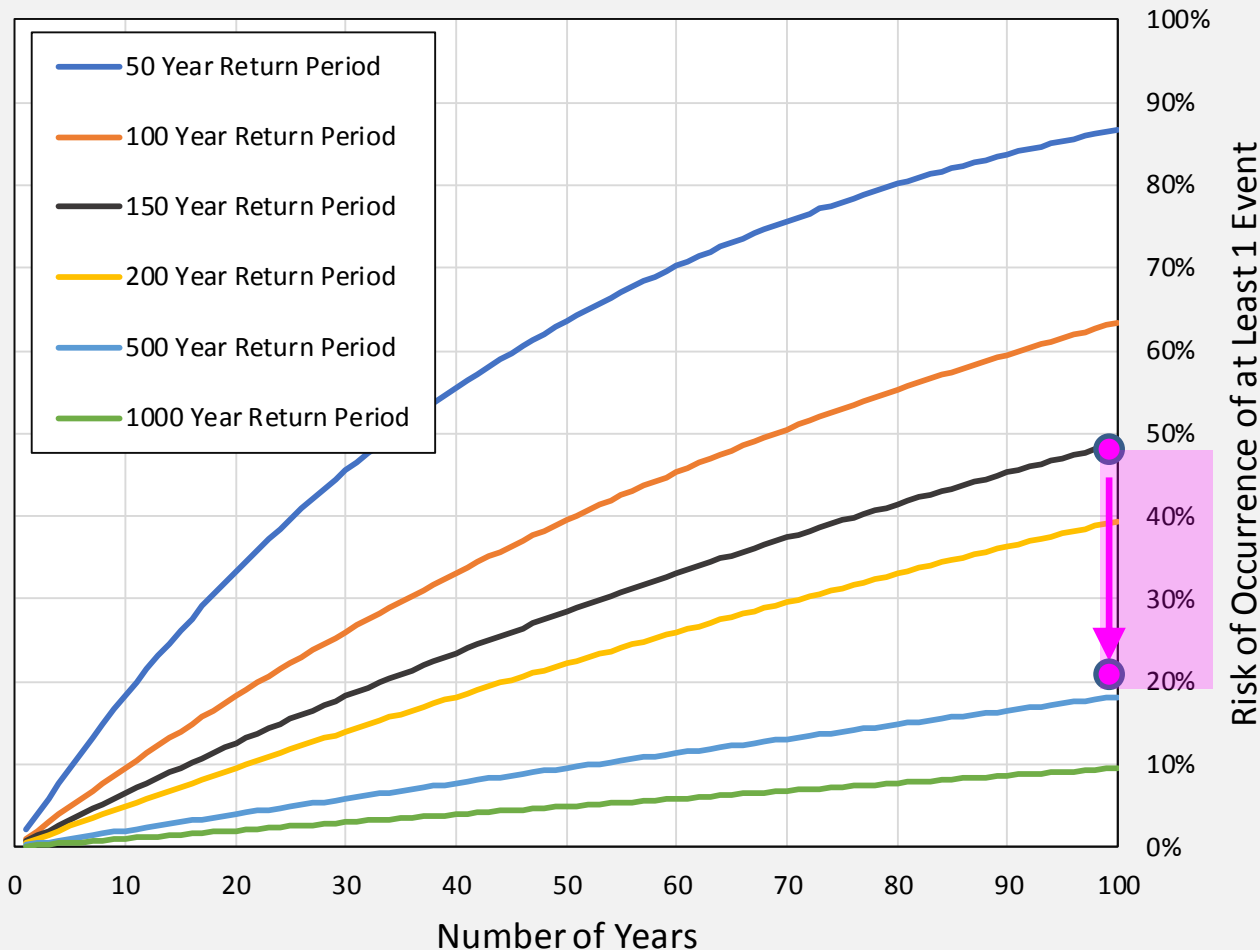
Monte Carlo Markov Chain – 10,000 year Simulations

Droughts Worse than the Drought of 2007-2016

- Evaluating portfolios for conditions worse than the recent drought is a key piece of the Water Forward analyses.
- The extended 10,000 year simulation is a tool for developing a range of conditions worse than the drought of 2007-2016
- 1,365 drought events identified between 12 and 224 months in the 10k year simulation.
- 74 of those droughts are worse than the 2007-2016 drought according to a calculation of drought return period based on inflow severity and duration.

Return Period and Risk of Occurrence

$$\text{Risk of at Least 1 Occurrence} = 1 - \left(1 - \frac{1}{\text{Return Period}}\right)^{\text{Number of Years}}$$



Drought of 2010's has a return period of 156 years relative to the other droughts in the 10,000 year simulation.

This equates to **47.3%** risk of at least 1 occurrence in 100 years.

Drought events with a lower risk of occurrence, down to 20%, were selected for analysis.

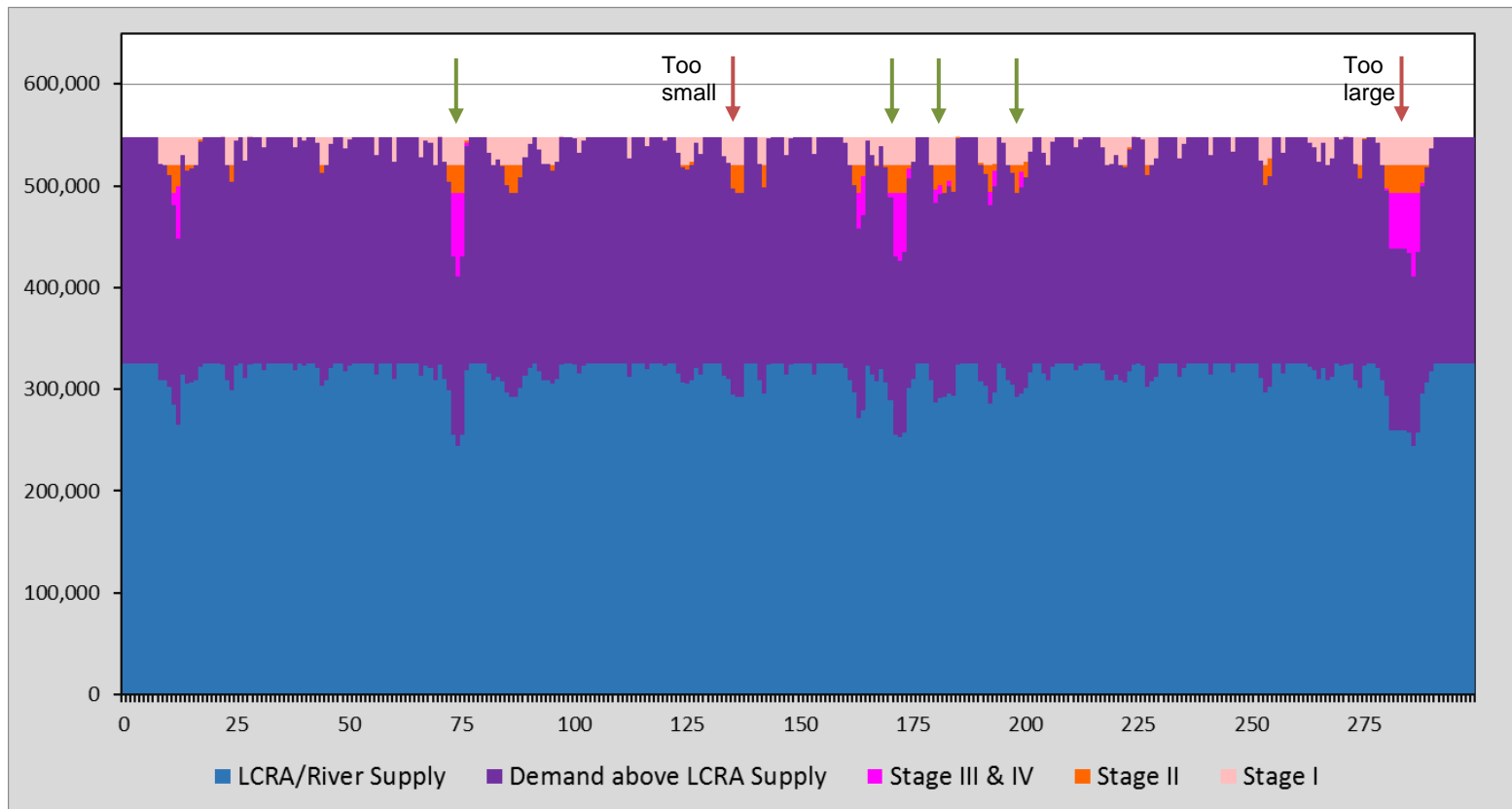
City of Austin Needs Summary

Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
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Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
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Planning Horizon Year	(C)	(D)
	- - - -	- - - -

2115 Demands, Stationary Climate



City of Austin Needs Summary Droughts Worse than the Drought of 2007-2016

Needs During Prolonged Drought

Needs above Current Contract

MCMC (10,000 years)

MCMC (10,000 years)
Climate Change-Adjusted

MCMC (10,000 years)

Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
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Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
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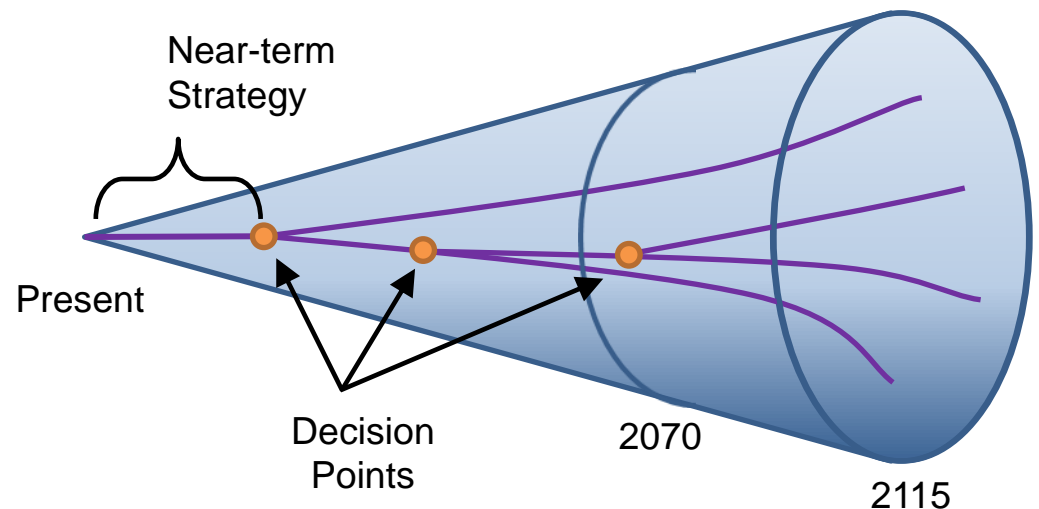
Annual Need, ac-ft

Annual Need, ac-ft

2020	(C) 18,997	1.2	16,283	18,997	(D)	No Significant Change from Period of Record	(C) -	(D) -			
2040	(C) 40,543	1.8	22,326	31,907	(D)	139,046	5.0	27,838	32,545	(C) -	(D) -
2070	(C) 159,230	4.0	39,563	48,304	(D)	442,702	9.4	47,270	50,236	(C) -	(D) 7,562
2115	(C) 312,638	4.5	69,609	82,234	(D)	967,538	11.5	83,882	87,168	(C) 220,823	(D) 253,801

Recap/Summary

- **City of Austin Needs**
 - **Needs During Prolonged Drought** = Demand reductions from implementation of Stages 3&4
 - **Needs Above Current Contract** = Baseline demands above current 325,000 AF contract with LCRA
- **Regional Needs** = include periods when combined storage levels dip below emergency levels



City of Austin and Regional Needs Summary

Needs During Prolonged Drought

Needs above Current Contract

Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
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Cumulative Need, ac-ft	Consecutive Number of years in Stage III or IV	Average Need per year, ac-ft	Max Need per year, ac-ft
------------------------	--	------------------------------	--------------------------

Annual Need, ac-ft

Annual Need, ac-ft

2020	(A)	0	0	na	na	(B)	No Significant Change from Period of Record				(A)	-	(B)	-
	(C)	18,997	1.2	16,283	18,997	(D)	No Significant Change from Period of Record				(C)	-	(D)	-
2040	(A)	17,802	0.9	17,802	17,802	(B)	78,851	2.8	28,673	32,545	(A)	-	(B)	-
	(C)	40,543	1.8	22,326	31,907	(D)	139,046	5.0	27,838	32,545	(C)	-	(D)	-
2070	(A)	117,563	2.8	42,750	48,304	(B)	240,100	5.2	46,471	50,236	(A)	-	(B)	7,562
	(C)	159,230	4.0	39,563	48,304	(D)	442,702	9.4	47,270	50,236	(C)	-	(D)	7,562
2115	(A)	212,395	3.1	68,885	82,234	(B)	503,241	6.7	75,486	87,168	(A)	220,823	(B)	253,801
	(C)	312,638	4.5	69,609	82,234	(D)	967,538	11.5	83,882	87,168	(C)	220,823	(D)	253,801