Lake Granger ASR

Agenda Item 6.6.1A

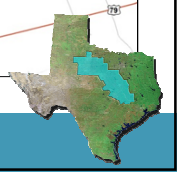
September 25, 2019

HDR

BRAZOS G WATER PLANNING GROUP

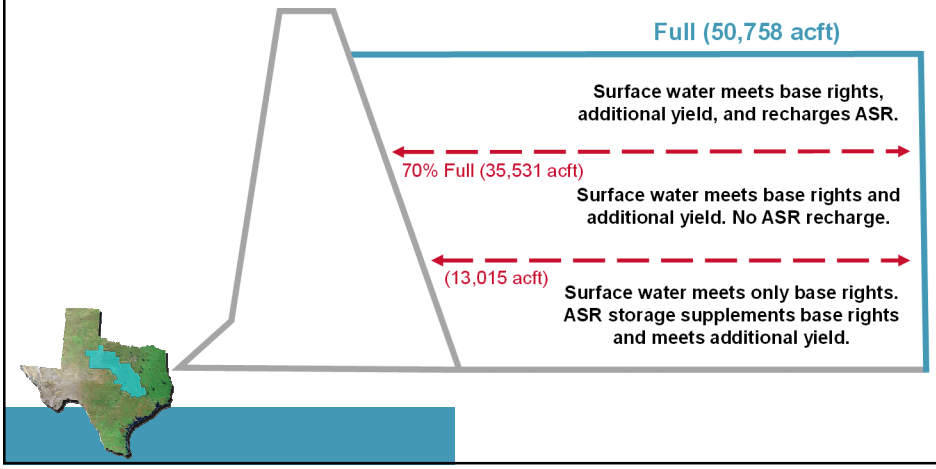
Lake Granger ASR Project

- Water Source: Lake Granger
- Storage Aquifer: Trinity Aquifer
  (Capped at 80,000 acft)
- Treatment: Expansion of EWCRWTP
- Annual Capacities:
  - Base Rights: 13,015 acft/yr firm yield
  - Additional Yield: 11,900 acft/yr
- Facilities:
  - 6 ASR Wells
  - 16 Additional Recovery Wells (Phases 2,3)
  - Connection Pipeline
  - 1.4 mile Transmission Pipeline
  - Treatment Plant Upgrade

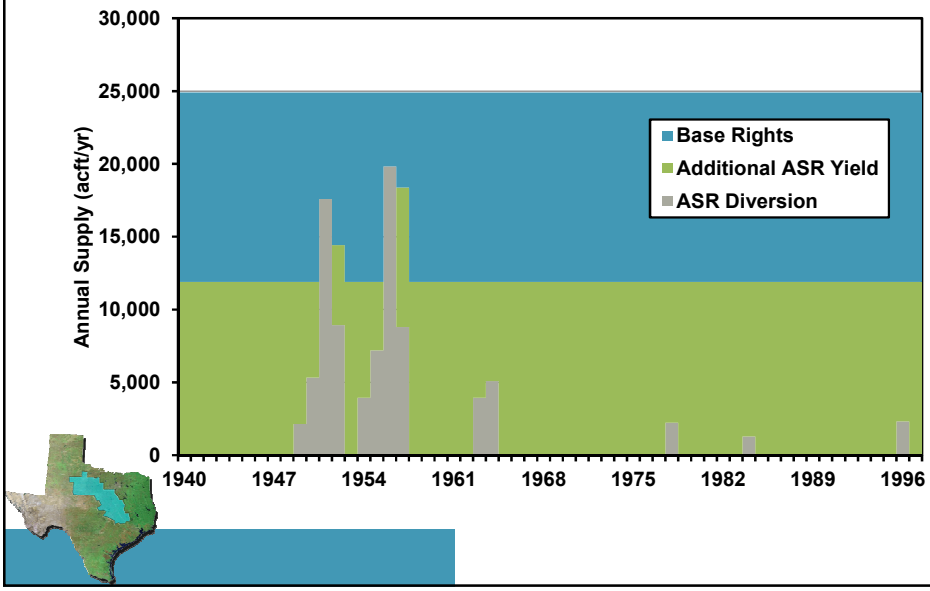


Operational Concept

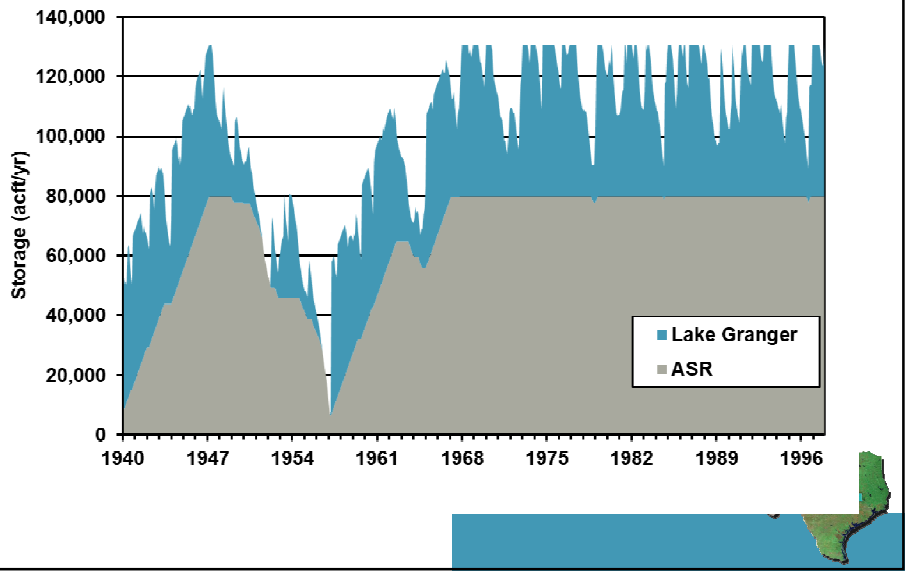
- Utilize existing base rights (13,015 acft/yr) in Lake Granger
- Provide additional firm supply of 11,900 acft/yr
- Install and operate ASR well field to support additional firm supply



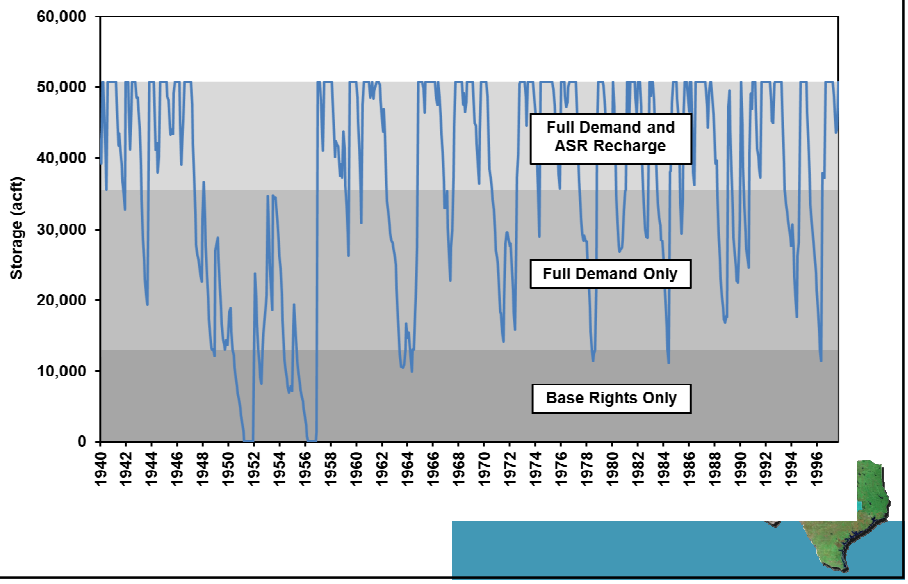
Sources of Supply



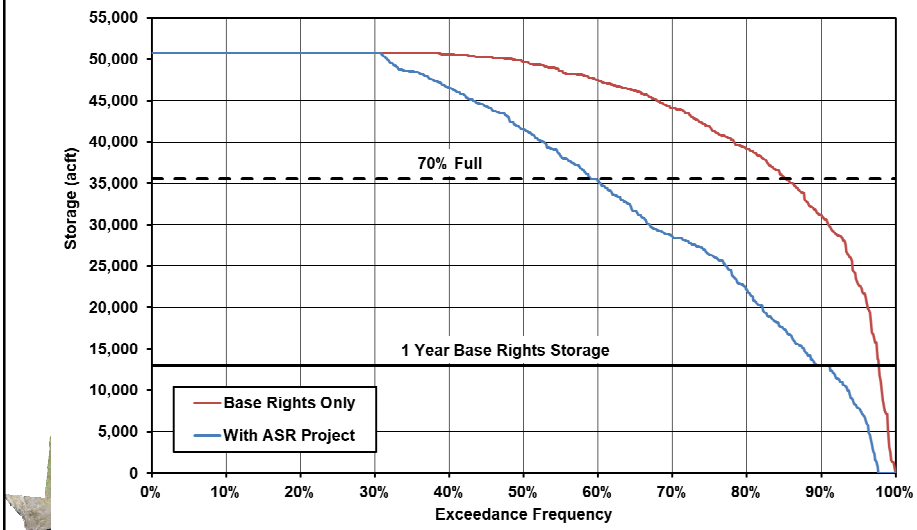
Combined System Storage under Proposed Operation



Lake Granger Storage



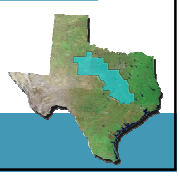
Lake Granger Storage



Costs

Cost	Phase 1	Phase 2*	Phase 3*
Wells and Collection Piping	$14,506,000	$15,360,000	$17,375,000
Other Costs (transmission pipeline, etc.)	$36,528,000	$0	$0
Total Capital	**$51,034,000**	**$15,360,000**	**$17,375,000**
Total Project	**$70,983,000**	**$21,307,000**	**$24,141,000**
Debt Service	$4,994,000	$6,493,000	$8,192,000
O&M	$2,522,000	$2,676,000	$2,850,000
Other (Power/wells)	$366,000	$952,000	$2,138,000
Total annual	**$7,882,000**	**$10,121,000**	**$13,180,000**
Total Project Yield (acft/yr)	3,200	7,600	11,900
Annual Unit Cost ($ per acft)	$2,429	$1,332	$1,108
Annual Unit Cost ($ per 1000 gal)	**$7.45**	**$4.09**	**$3.40**

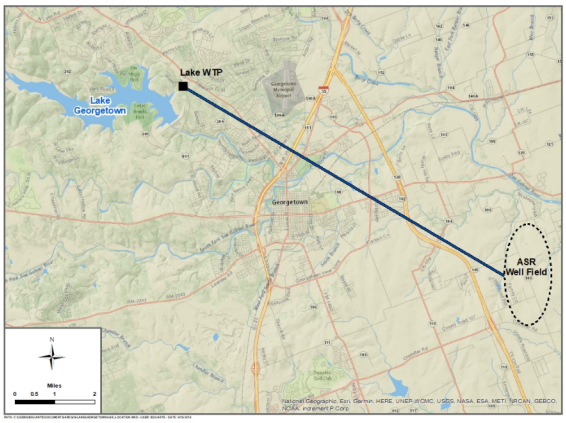
* Phase 2 assumed to be built within 10 years from Phase 1
**Phase 3 assumed to be built within 15 years of Phase 1



Questions?

Lake Georgetown ASR Project

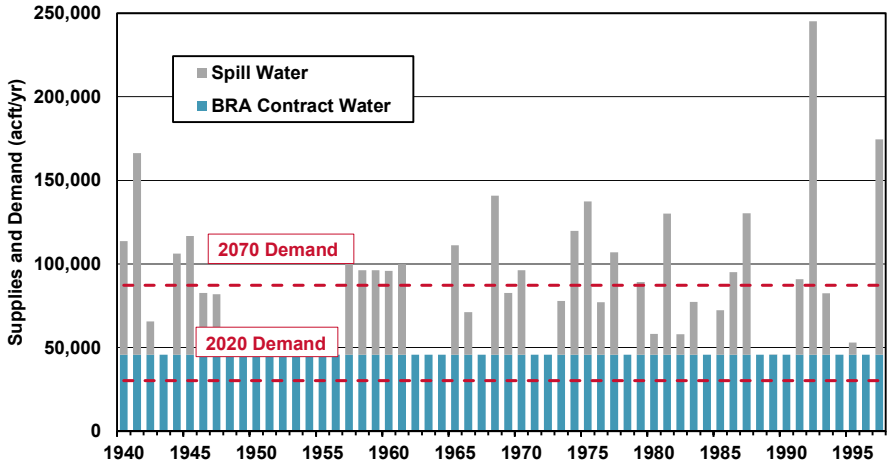
- Water Source: Lake Georgetown
- Storage Aquifer: Trinity Aquifer
- Treatment:
  - Expansion of LWTP
  - Chlorination at ASR well field
- Average Recharged: 10,170 acft/yr
- 85% Recoverable: 8,600 acft/yr
- Facilities:
  - 15 initial ASR Wells (Phase 1)
  - 10 Additional ASR Wells (Phases 2 & 3)
  - Connection Pipelines
  - 12 miles Transmission Pipeline
  - Treatment Plant Upgrade and Chlorination



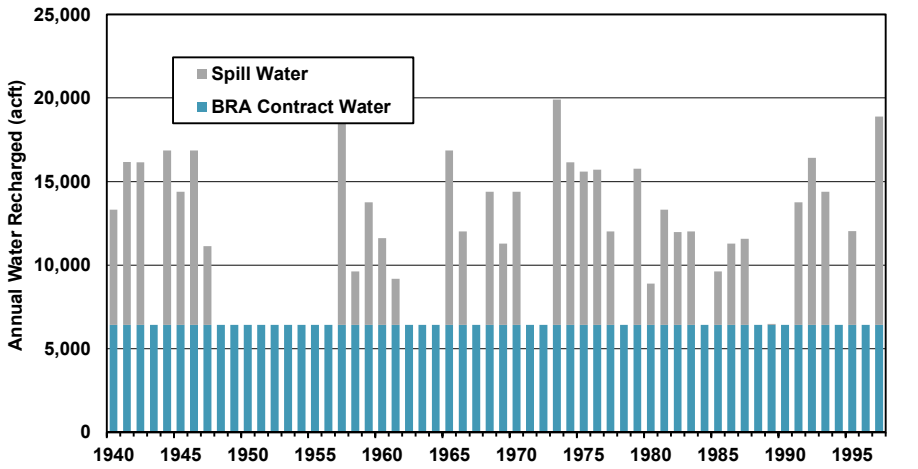
Operational Concept

- Sources of Supply from Lake Georgetown:
  - Unutilized existing BRA contractual supply (45,707 acft/yr)
  - Monthly spills from Brazos G WAM, 1940 – 1997
- Utilize Lake Georgetown spills with remaining BRA water available after City of Georgetown demands are satisfied
  - 2020, 2030, 2040, 2050, 2060 & 2070 demand conditions
  - Water available for recharge under each future demand condition
- After 2030, only spills are available, requiring large increases in WTP capacity
  - 2020: 35.5 MGD
  - 2070: 156 MGD
- Install and operate ASR well field
  - 15 ASR wells – initial Phase 1
  - 10 additional ASR wells – 2040
- Average Annual Recharge: 10,170 acft/yr
- Annual Recoverable Recharge (85%): 8,600 acft/yr

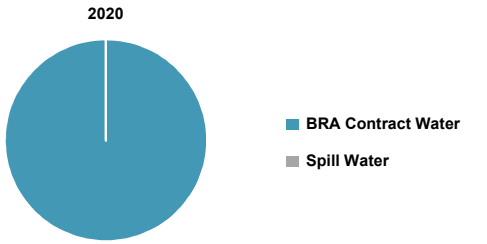
Annual Sources of Supply

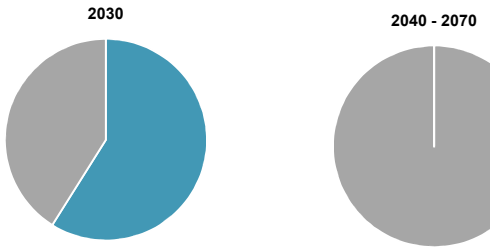


Annual Water Recharged, 2030 Demand Conditions



Proportion of Water Recharged Under Various Demand Conditions





Costs

Item	Cost
Wells and Collection Piping	$64,393,000
Two Water Treatment Plants (increase LWTP plus chlorinate ASR)	$200,549,000
Transmission Pipeline	$20,079,000
Total Capital	**$285,021,000**
Total Project	**$395,695,000**
Debt Service	$27,842,000
O&M	$15,119,000
Other (Power/wells)	$1,633,000
Total Annual	**$44,594,000**
Total Project Yield (acft/yr)	8,700
Annual Unit Cost ($ per acft)	$5,126
Annual Unit Cost ($ per 1000 gal)	$15.73

Questions?

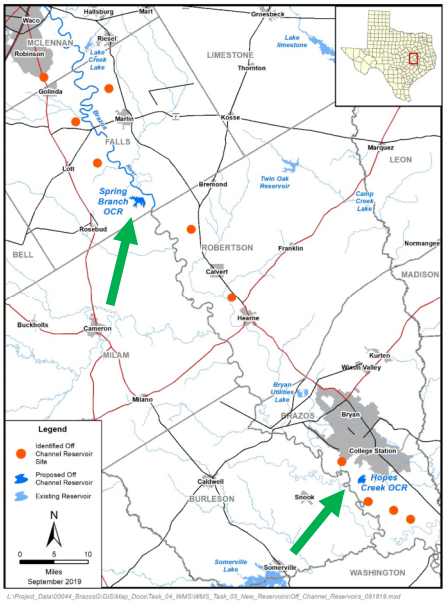
Evaluation of Brazos River Main Stem Off-Channel Reservoirs

Agenda Item 6.6.1C

September 25, 2017

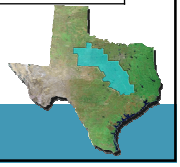
HDR | SUSAN ROTH water and wastewater consulting | BRAZOS G WATER PLANNING GROUP

Brazos River Main Stem OCR



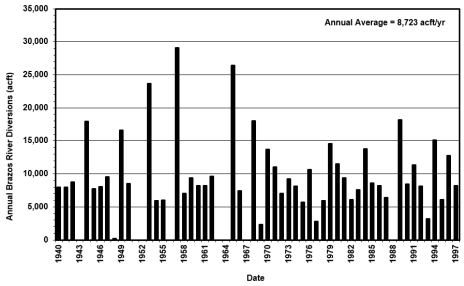
- 12 sites initially identified
- 2 sites selected for further evaluation:
  - Spring Branch OCR – Falls County
  - Hopes Creek OCR – Brazos County
- Potential WUGs to receive water:
  - BRA Customers

Reservoir Characteristics		
	Spring Branch OCR	Hopes Creek OCR
Capacity	23,715 acft	18,618 acft
Surface Area	1,268 acres	664 acres

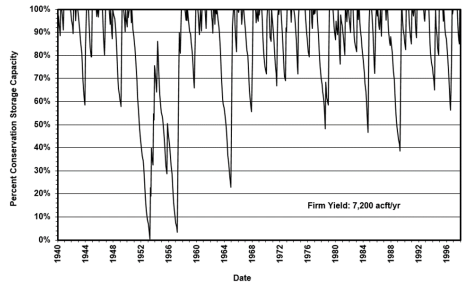


Brazos River Main Stem OCR

Spring Branch OCR Brazos River Diversions



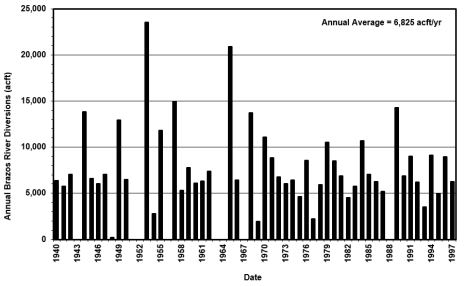
Spring Branch OCR Firm Yield Storage Trace



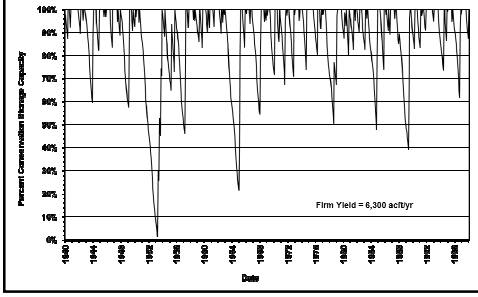
- Spring Branch OCR Water Availability
  - Diversions from Brazos River
    - Simulated at junior priority date
    - Optimal Diversion Capacity: 98 cfs
    - Avg Annual Diversion: 8,723 acft
  - OCR Firm Yield: 7,200 acft/yr

Brazos River Main Stem OCR

Hopes Creek OCR Brazos River Diversions



Hopes Creek OCR Firm Yield Storage Trace



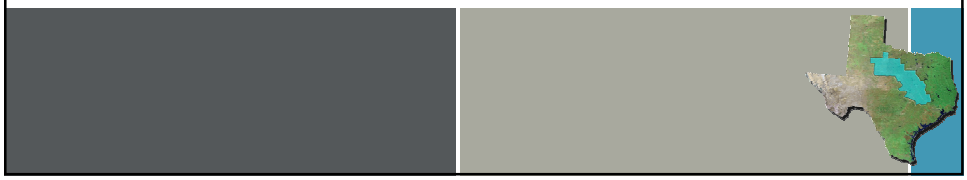
- Hopes Creek OCR Water Availability
  - Diversions from Brazos River
    - Simulated at junior priority date
    - Optimal Diversion Capacity: 98 cfs
    - Avg Annual Diversion: 6,825 acft
  - OCR Firm Yield: 6,300 acft/yr

Brazos River Main Stem OCR

Cost Estimate Summary (raw water at reservoir)		
	Spring Branch OCR	Hopes Creek OCR
Total Capital Costs[1]	$69,092,000	$72,819,000
Total Project Cost	$107,532,000	$112,413,000
Annual Cost	$7,854,000	$8,367,000
Available Project Yield	7,200 acft/yr	6,300 acft/yr
Annual Unit Cost of Water	$1,091 /acft	$1,328 /acft
Annual Unit Cost of Water	$3.35 /1,000 gal	$4.08 /1,000 gal

[1]Facilities include OCR, Brazos River intake pump station, and 60-inch pipeline to OCR.

- Spring Branch OCR would provide greater firm yield at lower project, annual, and unit cost.



Questions?

Evaluation of Steam-Electric Supplies to Supply Williamson County

Agenda Item 6.6.2

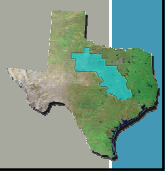
September 25, 2019

HDR

BRAZOS G WATER PLANNING GROUP

Background

- October 13, 2017: Luminant announces closure of power plant in Milam County
- November 1, 2017: Brazos G RWPG decided to maintain Steam-Electric demands in Milam County because future of the power plant was in doubt
- Alcoa property including groundwater and surface water rights are for sale
- Potential buyers have contacted Georgetown to supply water to Williamson County
- Brazos G can evaluate this as a potential water management strategy
  - SOW includes $22,000 to evaluate "Additional Strategies" for such a situation
  - Estimate $14,000 to evaluate



Alcoa/Williamson County Strategy

- Re-assign supplies from Milam County Steam-Electric use
  - 14,650 acft/yr surface water (Lake Alcoa and Little River diversion)
  - 4,019 – 4,156 acft/yr BRA contract (Little River system – 5,000 acft/yr contract)
  - 14,006 – 17,529 acft/yr Carrizo-Wilcox GW (varies with the MAG)
  - **32,757 – 36,335 acft/yr total supply** (32,757 in 2040)
- Williamson County needs in 2070:
  - 26,875 – 93,933 acft/yr depending on other strategies
- Strategy components:
  - Purchase price for water
  - Well field upgrades
  - Well water chlorination
  - Surface WTP
  - Pump station and transmission pipeline
- Leave Milam County Steam-Electric demands unmet
  - 32,254 acft/yr
  - Too late in planning process to remove the SE demands

Suggested Action

"The Brazos G Regional Water Planning Group directs HDR Engineering, Inc. to coordinate with the City of Georgetown to evaluate a water management strategy that would utilize existing steam-electric supplies in Milam County to meet water needs in Williamson County.

This work effort will utilize funds budgeted as "Other Water Management Strategies" in the Task 5A Scope of Work.

Furthermore, Brazos G recognizes that recommendation of this strategy would necessitate leaving steam-electric demands in Milam County unmet."

Update on Non-Municipal Water Conservation Evaluations

Agenda Item 6.6.3

September 25, 2019

HDR

BRAZOS G WATER PLANNING GROUP

Background

- March 20, 2019 – Brazos G considered methodology for determining recommended non-municipal water conservation savings
  - Irrigation, Mining and Manufacturing
    - Adopted reduction in water use of 3% in 2020, 5% in 2030, and 7% 2040-2070
    - All WUGs with Needs
  - Steam-electric
    - Tabled for later
- September 25, 2019 (Today)
  - (Information only) Present summary of results of conservation savings for irrigation, mining, and manufacturing
  - (Planning group action requested) Options for Steam-Electric conservation based on additional analysis

Irrigation WUGs with Needs- Calculated Conservation Savings

20 counties in Brazos G with reported irrigation needs during the 2020-2070 planning period

WUG	Water Savings with Voluntary Reduction in Demand of 3% by 2020; 5% by 2030; and 7% 2040-2070					
	2020	2030	2040	2050	2060	2070
BELL COUNTY-IRRIGATION	85	142	199	199	199	199
BOSQUE COUNTY-IRRIGATION	107	179	250	250	250	250
BURLESON COUNTY-IRRIGATION	804	1,340	1,876	1,876	1,876	1,876
COMANCHE COUNTY-IRRIGATION	964	1,606	2,248	2,248	2,248	2,248
GRIMES COUNTY-IRRIGATION	20	33	47	47	47	47
HASKELL COUNTY-IRRIGATION	1,747	2,912	3,922	3,933	4,010	4,010
HILL COUNTY-IRRIGATION	53	88	123	123	123	123
JOHNSON COUNTY-IRRIGATION	17	28	40	40	40	40
JONES COUNTY-IRRIGATION	85	141	198	198	198	198
KNOX COUNTY-IRRIGATION	1,319	2,199	2,791	2,665	2,829	2,829
LAMPASAS COUNTY-IRRIGATION	16	27	38	38	38	38
MILAM COUNTY-IRRIGATION	195	325	455	455	455	455
NOLAN COUNTY-IRRIGATION	347	578	809	809	809	809
PALO PINTO COUNTY-IRRIGATION	90	151	211	211	211	211
ROBERTSON COUNTY-IRRIGATION	2,375	3,959	5,579	5,612	5,612	5,612
STEPHENS COUNTY-IRRIGATION	5	8	11	11	11	11
TAYLOR COUNTY-IRRIGATION	49	82	114	114	114	114
THROCKMORTON COUNTY-IRRIGATION	5	8	11	11	11	11
WILLIAMSON COUNTY-IRRIGATION	10	17	23	23	23	23
YOUNG COUNTY-IRRIGATION	15	25	35	35	35	35
Total Brazos G water savings for Irrigation WUGs with needs (acft/yr)	**8,308**	**13,847**	**18,980**	**18,898**	**19,138**	**19,138**

Irrigation Best Management Strategies that Can be Implemented to Achieve Conservation Savings Goals

	Best Management Practices	Water Savings Estimates				Cost Estimates				Assumptions/Notes
		Min	Max	Avg	Savings Metric	Min	Max	Avg	Cost Metric	
1	Irrigation Scheduling	0.3	0.5	0.40	acft/ac/yr	-	-	-	-	Verification of estimated savings attempted by Pacific Northwest Laboratory (1994), study not able to confirm or disprove water savings estmates.
2	Volumetric Measurement of Irrigation Water Use	0	0	0	-	-	-	-	-	Helps inform conservation efforts, but does not directly lead to conservation savings. Cost varies widely.
3	Crop Residue Management and Conservation Tillage	0.25	1	0.63	acft/ac/yr	-	-	-	-	Cost varies, some conservation tillage programs are less expensive than conventional tillage.
4	On-farm Irrigation audit	-	-	-	-	-	-	-	-	No quantifiable savings or costs. Site and crop use specific.
5	Furrow Dikes	-	-	0.25	acft/ac/yr	$5	$30	$18	per acre/yr	
6	Land Leveling	-	-	0.3	acft/ac/yr	$150	$500	$325	per acre	Savings based on leveled rice fields near the Texas Gulf Coast. Costs reflect initial costs (touch-up costs are much less)
7	Contour Farming	-	-	-	-	$5	$10	$8	per acre	
8	Conservation of Supplemental Irrigated Farmland to Dry-Land Farmland	-	-	-	-	-	-	-	-	
9	Brush Control/Management	0.34	0.55	0.45	acft/ac/yr	$36	$203	$119	acre/10 yrs	Cost estimates are per a Texas A&M study; county average costs range from $150 to $200
10	Lining of On-Farm Irrigation ditches	-	-	-	-	$2.50	$3.50	$3	per sq ft	Concrete lining saves about 80% (conservative estimate) of original seepage. Cost is for concrete lining.

- WUGs encouraged to voluntarily select BMPs that suit their situation/needs best.
- Source: TWDB Best Management Practices for Agricultural Water Users, November 2013 (https://www.twdb.texas.gov/conservation/BMPs/Ag/index.asp)

Irrigation Best Management Strategies that Can be Implemented to Achieve Conservation Savings Goals, *continued*

	Best Management Practices	Water Savings Estimates				Cost Estimates				Assumptions/Notes
		Min	Max	Avg	Savings Metric	Min	Max	Avg	Cost Metric	
11	Replacement of On-/farm Irrigation Ditches with Pipelines	-	-	-	-	-	-	-	-	
12	Low Pressure Center Pivot Sprinkler Irrigation Systems	0.29	0.68	0.49	acft/yr	$300	$500	$400	per acre	Savings based on fraction. "Min" water savings estimate based on fair conditions.
13	Drip/Micro-Irrigation System	-	-	-	-	$800	$1,200	$1,000	per acre	Costs reflect installation costs only (no O&M)
14	Gated and Flexible Pipe for Field Water Distribution Systems	-	-	-	-	$20	$25	$23	per acft/yr	•Assuming that 0.25 acft/ac/yr of water is saved
15	Surge Flow Irrigation for Field Water Distribution Systems	0.1	0.4	0.25	acft/yr	$20	$25	$23	per acft/yr	Savings based on a percentage. Cost estimates assume that 0.25 acft/ac/yr of water is saved by using a surge valve
16	Linear Move Sprinkler Irrigation Systems	0.29	0.68	0.49	acft/yr	$300	$700	$500	per acre	Savings based on fraction. "Min" water savings estimate based on fair conditions.
17	Lining of District Irrigation Canals	-	-	-	-	$2.50	$3.50	$3	per sq ft	Cost of concrete lining
18	Replacement of District Irrigation canals and Lateral canals with Pipelines	-	-	-	-	-	-	-	-	
19	Tailwater Recovery and Use System	0.5	1.5	1.00	acft/ac/yr	-	-	-	-	Cost Varies widely
20	Nursery Production Systems	-	-	-	-	-	-	-	-	

- WUGs encouraged to voluntarily select BMPs that suit their situation/needs best.
- Source: TWDB Best Management Practices for Agricultural Water Users, November 2013 (https://www.twdb.texas.gov/conservation/BMPs/Ag/index.asp)

Manufacturing WUGs with Needs-Calculated Conservation Savings

10 counties in Brazos G with reported manufacturing needs during the 2020-2070 planning period

WUG	Water Savings with Voluntary Reduction in Demand of 3% by 2020; 5% by 2030; and 7% 2040-2070					
	2020	2030	2040	2050	2060	2070
BELL COUNTY-MANUFACTURING	19	34	48	48	48	48
BURLESON COUNTY-MANUFACTURING	4	6	8	8	8	8
ERATH COUNTY-MANUFACTURING	2	4	6	6	6	6
KNOX COUNTY-MANUFACTURING	0	0	0	0	0	0
LAMPASAS COUNTY-MANUFACTURING	6	11	15	15	15	15
LIMESTONE COUNTY-MANUFACTURING	10	19	26	26	26	26
MCLENNAN COUNTY-MANUFACTURING	144	373	522	522	522	522
NOLAN COUNTY-MANUFACTURING	13	26	37	37	37	37
STONEWALL COUNTY-MANUFACTURING	2	3	4	4	4	4
WASHINGTON COUNTY-MANUFACTURING	17	29	41	41	41	41
Total Brazos G water savings for Manufacturing WUGs with needs (acft/yr)	**217**	**506**	**708**	**708**	**708**	**708**

Mining WUGs with Needs- Calculated Conservation Savings

30 counties in Brazos G with reported mining needs during the 2020-2070 planning period

WUG	Water Savings with Voluntary Reduction in Demand of 3% by 2020; 5% by 2030; and 7% 2040-2070					
	2020	2030	2040	2050	2060	2070
BELL COUNTY-MINING	97	199	322	374	427	488
BOSQUE COUNTY-MINING	59	104	132	131	128	127
CALLAHAN COUNTY-MINING	7	11	15	14	13	13
COMANCHE COUNTY-MINING	13	26	25	19	13	9
CORYELL COUNTY-MINING	45	54	34	25	28	31
EASTLAND COUNTY-MINING	35	59	65	50	36	30
FALLS COUNTY-MINING	7	12	18	20	21	23
FISHER COUNTY-MINING	12	20	25	22	19	17
GRIMES COUNTY-MINING	10	30	33	24	15	9
HAMILTON COUNTY-MINING	12	12	7	0	0	0
HASKELL COUNTY-MINING	3	5	6	5	5	4
HILL COUNTY-MINING	49	60	54	28	31	33
HOOD COUNTY-MINING	62	122	156	149	143	144
JOHNSON COUNTY-MINING	124	139	106	71	81	94
JONES COUNTY-MINING	7	12	15	14	13	12

Table continued on next slide…

Mining WUGs with Needs- Calculated Conservation Savings *continued*

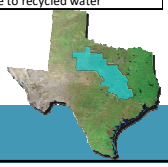
30 counties in Brazos G with reported mining needs during the 2020-2070 planning period

WUG	Water Savings with Voluntary Reduction in Demand of 3% by 2020; 5% by 2030; and 7% 2040-2070					
	2020	2030	2040	2050	2060	2070
KNOX COUNTY-MINING	0	1	1	1	1	1
LAMPASAS COUNTY-MINING	6	11	17	18	20	22
LEE COUNTY-MINING	95	159	0	0	0	0
LIMESTONE COUNTY-MINING	310	496	691	724	756	800
MCLENNAN COUNTY-MINING	76	150	214	246	268	295
NOLAN COUNTY-MINING	7	11	14	12	11	10
SHACKELFORD COUNTY-MINING	17	37	39	31	23	17
SOMERVELL COUNTY-MINING	33	64	80	74	70	68
STEPHENS COUNTY-MINING	152	257	312	268	228	194
STONEWALL COUNTY-MINING	18	29	36	31	27	24
TAYLOR COUNTY-MINING	12	20	26	24	23	22
THROCKMORTON COUNTY-MINING	6	10	12	11	9	8
WASHINGTON COUNTY-MINING	17	43	49	38	26	18
WILLIAMSON COUNTY-MINING	155	313	516	599	685	783
YOUNG COUNTY-MINING	6	14	14	11	7	5
Total Brazos G water savings for Mining WUGs with needs (acft/yr)	**1,451**	**2,478**	**3,034**	**3,035**	**3,129**	**3,300**

Industrial (Manufacturing, Mining) Best Management Strategies that can be Implemented to Achieve Savings Goals

	Best Management Practices	Water Savings Estimates				Cost Estimates				Assumptions/Notes
		Min	Max	Avg	Savings Metric	Min	Max	Avg	Cost Metric	
1	Industrial Water Audit	10	35	22.5	%	-	-	-	-	
2	Industrial Water Waste Reduction	-	-	-	-	-	-	-	-	
3	Industrial Submetering	-	-	-	-	-	-	-	-	
4	Cooling Towers	-	-	-	-	-	-	-	-	Highly variable. Savings due to increased concentration ratio and implemented changes in operating procedures. TWDB guidance available for calculating water savings.
5	Cooling Systems (other than Cooling Towers)	-	90	-	%	-	-	-	-	Estimated that retrofitting of single-pass cooling equipment such as x-rays to recirculating water systems can cut water use by up to 90%.
6	Industrial Alternative Sources and Reuse and Recirculation of Process Water	-	-	-	-	-	-	-	-	
7	Rinsing/Cleaning	-	-	-	-	-	-	-	-	
8	Water Treatment	10	85	47.5	%	-	-	-	-	Water savings range widely based on specific updates - from process adjustments to reclaim systems
9	Boiler and Steam Systems	-	-	-	-	-	-	-	-	Highly variable. Savings due to increased condensate return and increased concentration ratios. TWDB guidance available for calculating water savings.
10	Refrigeration (including Chilled Water)	-	-	-	-	-	-	-	-	
11	Once-Through Cooling	-	-	-	-	-	-	-	-	
12	Management and Employee Programs	-	-	-	-	-	-	-	-	
13	Industrial Facility Landscaping	-	-	15	%	-	-	-	-	
14	Industrial Site Specific Conservation	10	95	52.5	%	-	-	-	-	Savings vary widely based on specific measure - from water audits to changing from potable to recycled water

- WUGs encouraged to voluntarily select BMPs that suit their situation/needs best.
- Source: TWDB Best Management Practices for Industrial Water Users, February 2013 (https://www.twdb.texas.gov/conservation/BMPs/Ind/index.asp



Steam-Electric Water Conservation- Background

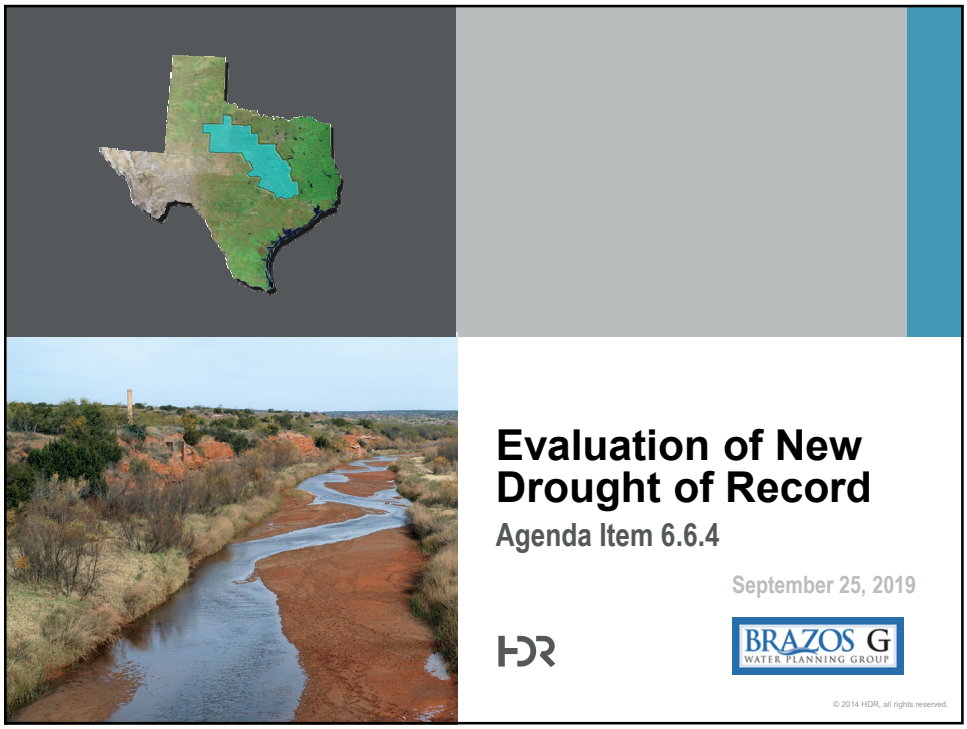
7 counties in Brazos G with reported steam-electric needs during the 2020-2070 planning period: Brazos (2020 only), Hill, Hood, Johnson, Limestone, Robertson, and Somervell

- March 20, 2019 – Brazos G considered 3-5-7% demand reduction methodology for steam-electric WUGs with needs. Tabled for future discussion
- April to August, 2019 –
  - Coordinated with Gary Spicer (Brazos G Steam-Electric representative).
  - Obtained from the TWDB historical steam-electric information (i.e. facilities in Brazos G, power generation records, fuel source, water use) and water use factors by fuel type that TWDB uses for future water demand projections
  - Performed analysis to evaluate S-E water use. Results inconclusive, due to high variability of plant-specific practices including fuel types and water use and variability in cooling practices.
  - Gary Spicer recommendation: do not recommend water conservation targets for Steam-Electric WUGs, with or without needs.

Steam-Electric Water Conservation- Options for Consideration

- September 25, 2019, two options for Brazos G consideration:
  - Go with 3-5-7% approach similar to method approved by Brazos G for irrigation, manufacturing, and mining users with needs. This results in a projected water savings of 4,900 acft/yr in 2020 increasing to 11,433 acft/yr from 2040-2070 in counties with steam-electric needs.
  - Brazos G considered water conservation for Brazos G but due to variability in processes and water use practices, does not recommend water conservation as a water management strategy.
- Recommended Action:

"*The Brazos G Regional Water Planning Group has considered water conservation as a water management strategy to meet projected needs for Steam-Electric Water User Groups and does not recommend water conservation as a recommended strategy for Steam-Electric Water User Groups in the 2021 Brazos G Regional Water Plan.*"



Evaluation of New Drought of Record

Agenda Item 6.6.4

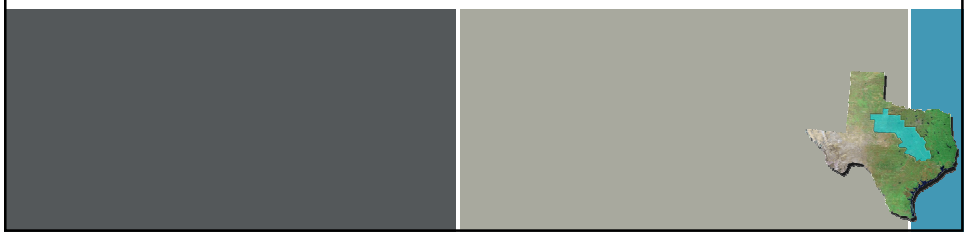
September 25, 2019

HDR

BRAZOS G WATER PLANNING GROUP

Chapter 7. Drought Response Information, Activities and Recommendations

- 7.1 Droughts of Record in the Brazos G Area – today
- 7.2 Current Drought Preparations and Response – today
- 7.3 Existing and Potential Emergency Interconnects – today
- 7.4 Emergency Responses to Local Drought Conditions or Loss of Municipal Supply – November
- 7.5 Region-Specific Drought Response Recommendations and Model Drought Contingency Plans – November
- 7.6 Drought Management Water Management Strategies – May 22, 2019
- 7.7 Other Drought-Related Considerations and Recommendations – November



Droughts in the Brazos G Area

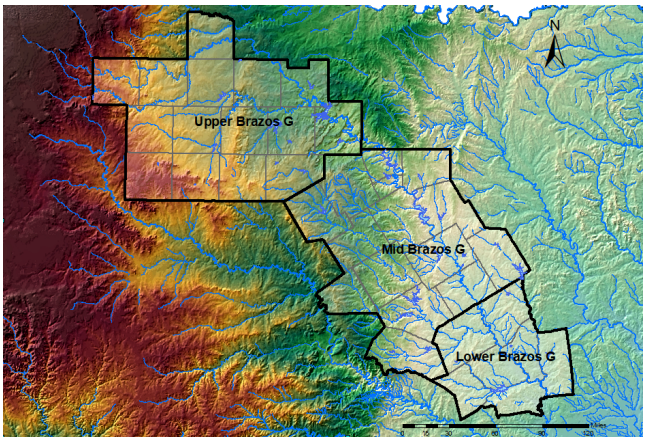
- In Texas, the next drought begins after the last drop of rainfall hits the ground.
- The "start" of a drought is difficult to pinpoint
- 1950's drought (1943 – 1957) is the generally-accepted Drought of Record (DOR) in Brazos G and throughout most of Texas
  - The impetus for the TWDB and most of the water supply development in the 1960's and 1970's
  - "The Time it Never Rained," Elmer Kelton, 1974
  - Further east, a drought in the 1960's is more severe in some watersheds
- Recent droughts have appeared to be equivalent or worse than the 1950's drought
  - 1993 – 2006
  - 2008 – 2015 (2011 worst one-year drought on record)

Evaluated Three Indicators of Drought

- Palmer Drought Severity Index
  - Droughts impacting terrestrial activities, i.e., agriculture, wildlife
  - Indirect indicator of streamflow and hydrology
- Water Availability Modeling of Reservoir Yields
  - Droughts impacting water supplies from reservoirs – longer term drought conditions
  - The period simulated under firm yield demands at which the reservoir drops below full conservation until it refills completely. We often mark the critical year/month – it's lowest level during the drought period.
- Naturalized Streamflows
  - Droughts impacting run-of-river supplies – shorter term drought conditions
  - Often one-year or even month-long periods can be critical

Droughts of Record in the Brazos G Area

- Divided Brazos G into three sub-areas
  - Upper – Palo Pinto, Stephens, Eastland Counties and all to the northwest
  - Mid – south of upper to north of Milam and Robertson Counties
  - Lower – Milam, Robertson, Lee, Burleson, Brazos, Washington & Grimes Counties

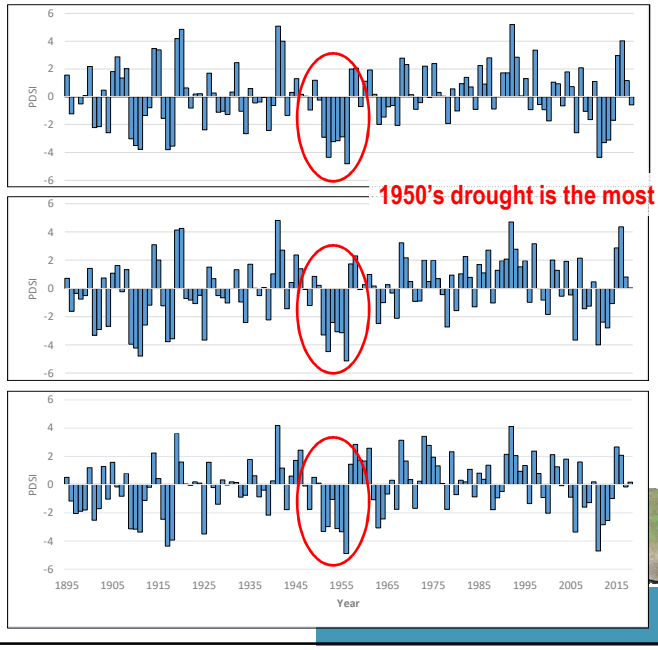


Palmer Drought Severity Index

Upper Brazos G

Mid Brazos G

Lower Brazos G



1950's drought is the most severe

Reservoir Firm Yields

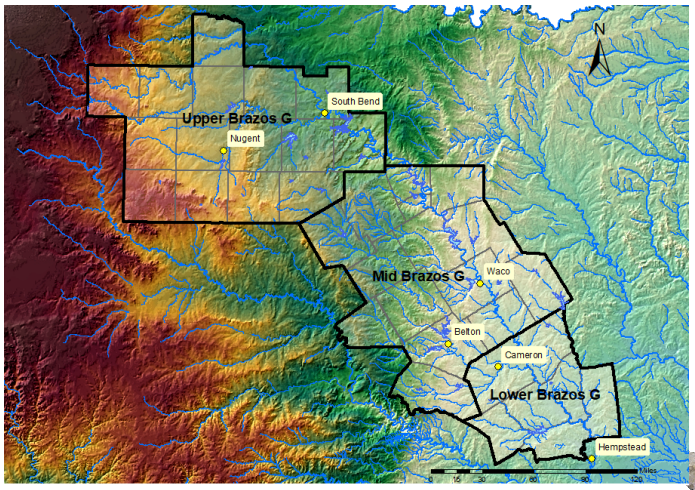
- Upper Brazos G: **14 of 14 reservoirs indicate new FY** (critical year either 2004/05 or 2014/15)
- Mid Brazos G: **2 of 14 reservoirs indicate new FY** (2015 is critical year)
  - Lake Granbury (main stem reservoir impacted by Upper Brazos G conditions)
  - Lake Proctor (upper Little River watershed)
- Lower Brazos G: **1 of 5 reservoirs indicate different DOR** (Lake Limestone – early 1960's)

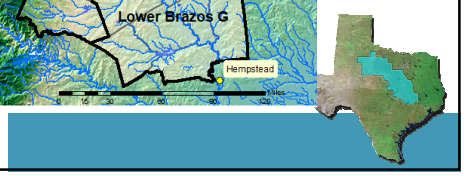
Conclusions for Reservoir Supplies:

- 1950's is no longer DOR in Upper Brazos G
- 1950's remains DOR in Mid and Lower Brazos G, except for Granbury and Proctor
- Lake Limestone worst drought is 1960's

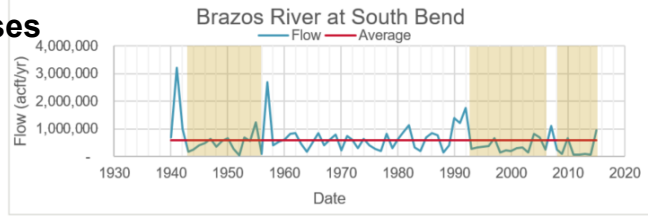
Streamflow Analyses

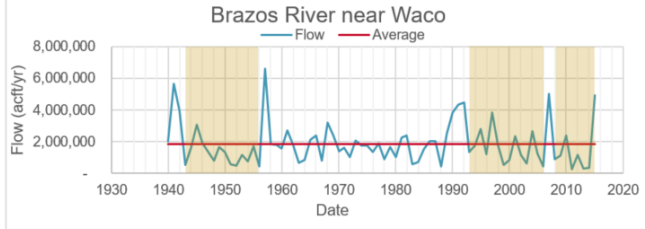
- Chose one tributary and one main stem gage in each sub-area
- Identified three primary drought periods: 1950's, 2000's and 2010's

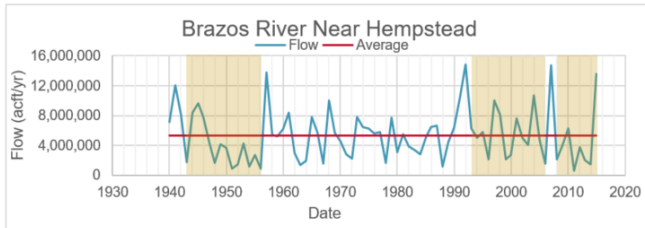


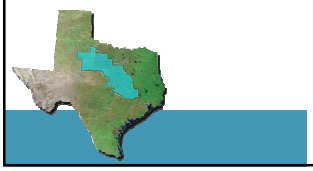


Streamflow Analyses Mainstem Gages



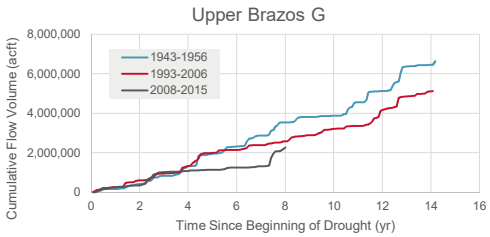




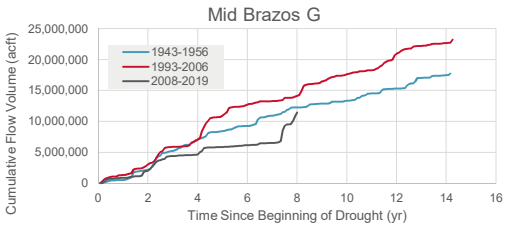


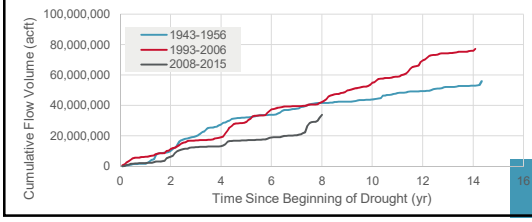
Streamflow Analyses Mainstem Gages

South Bend



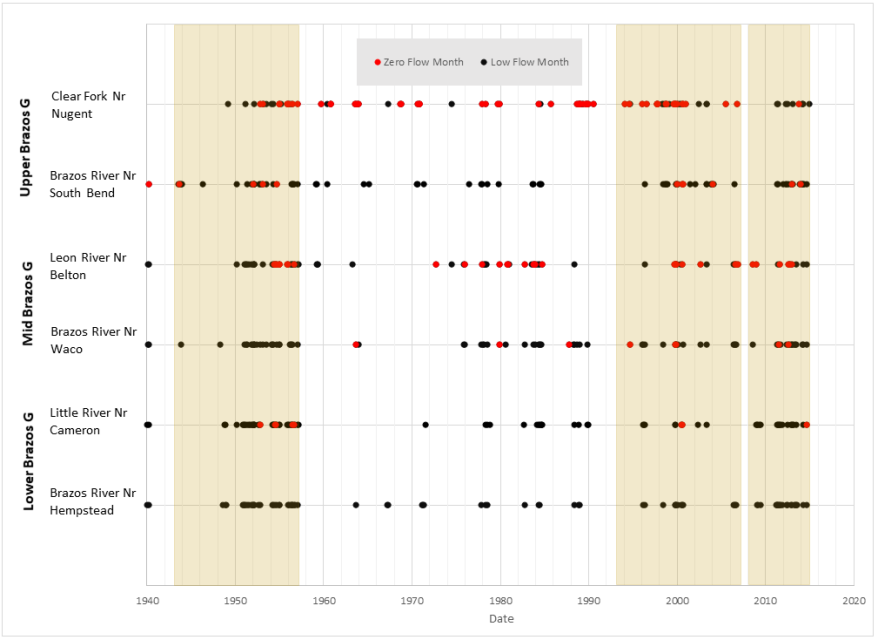
Waco





Hempstead

Streamflow Analyses



Conclusions from Streamflow Analyses

- Upper Brazos G: 1950's is no longer the DOR
- Mid Brazos G: 1950's remains DOR
- Lower Brazos G: 1950's remains DOR

However, recent drought periods included single years more severe than occurred in 1950's, impacting short-term supplies to run-of-river water rights.

Sensitivity of Groundwater to Drought Conditions

Reviewed GAM modeling reports and summarized "drought sensitivity" for each major and minor aquifer system in Brazos G, as documented by the GAM modeling efforts.

- High sensitivity: Edwards (BFZ) in both outcrop and downdip areas
- Moderate sensitivity: Seymour, Trinity, Brazos River Alluvium, Woodbine in their outcrop areas
- Low or Very Low sensitivity: all others

QUESTIONS?

Tasks 7.2 & 7.3 – Drought Response Activities

BRAZOS G WATER PLANNING GROUP

Brazos G Regional Water Planning Group

Agenda Item 6.6.4
September 25, 2019

SUSAN ROTH water and wastewater consulting

Task 7.2: Drought Contingency Plans

- Entities are required to develop, implement, and submit updated Drought Contingency Plans to TCEQ **every five years** (TWC Ch. 11 & 30 TAC Ch. 288):
  - Retail Public Water Suppliers (systems with less than 3,300 connections must have the plan available for TCEQ inspection but not required to submit plans to TCEQ)
  - Wholesale Public Water Suppliers
- Current deadline to submit updated Drought Contingency Plans to the TCEQ: **May 1, 2019**
- 2016 Brazos G Water Plan: **24 entities' DCPs reviewed** (retail systems; 42% adopted between 2000-2003)
- 2021 Brazos G Water Plan: **62 entities' DCPs reviewed** (retail systems; 82% adopted between 2018-2019)

SUSAN ROTH water and wastewater consulting

Drought Contingency Plan Review – Trigger/Response Categories

- **Drought Contingency Plan Triggers**
  - Contamination
  - Demand/Capacity Based
  - Failure
  - Groundwater Level
  - Production Rate
  - Reservoir Level
  - Supply Based
  - Time
  - Wholesale Provider
  - Other

SUSAN ROTH
water and wastewater consulting

Drought Contingency Plan Review – Trigger/Response Categories

- **Drought Contingency Plan Responses**
  - Assessment and Identification
  - Water Rate Change or Surcharge
  - Irrigation Schedule
  - Mandatory Reduction
  - Notification of Public Agencies or Specific Users
  - Prohibited Use
  - Public Notification
  - Discontinue Water Diversions
  - Suspend Service
  - Water Allocation
  - Other

SUSAN ROTH
water and wastewater consulting

DCP Trigger/Response List (Brazos G): Retail & Wholesale* Public Water Suppliers

Entity Name	DCP Date	No. of Stages	Water Supply	DCP Triggers	DCP Responses
Central Texas WSC*	2018	4	SW & GW	Reservoir Level & Supply Based	Irrigation Schedule, Notifications, Mandatory Reduction & Prohibited Use
City of College Station	2019	3	GW	Contam.,Demand/ Capacity Based, Failure, Supply Based, Time & Wholesale Provider	Irrigation Schedule, Notifications, Mandatory Reduction, Prohibited Use, Suspend Service & Water Allocation
City of Taylor	2019	6	SW	Contamination, Demand/Capacity Based, Failure & Supply Based	Irrigation Schedule, Notifications, Prohibited Use, Water Allocation & Water Rate Surcharge
City of Waco	2019	4	SW	Reservoir Level & Supply Based	Irrigation Schedule, Notifications, Mandatory Reduction & Prohibited Use
Eastland County WSC*	2019	4	SW	Demand/Capacity Based, Failure, Reservoir Level & Supply Based	Assessment, Irrigation Schedule, Notifications, Mandatory Reduction, Prohibited Use, Water Allocation & Water Rate Charge

Drought Management for Groundwater Conservation Districts

- Drought response plans should be different for Groundwater Conservation Districts (GCDs) compared to Retail and Wholesale Water Providers; **GCDs are water regulators and not water suppliers**.
- GCDs **generally more concerned about long-term pumping** (decades usage) than short-term drought conditions.
- Many of the GCDs monitor the Palmer Drought Severity Index (PDSI) to gauge the severity of drought conditions; the GCDs then **notify all of their permitted public water suppliers to implement their respective DCPs**.
- GCDs each focus on their **respective DFCs** based on **aquifer characteristics** (i.e. Carrizo-Wilcox vs. Trinity).

SUSAN ROTH
water and wastewater consulting

Task 7.3 – Existing & Potential Emergency Interconnects

- TCEQ requires **all PWSs to have a monitoring plan**; information is summarized for each PWS in the **TCEQ Texas Drinking Water Watch Database** and revised when changes are made to sample sites/frequency of monitoring.
- TCEQ's monitoring plan template are based on 30 TAC, Ch. 290, Subchapter F; the availability of each PWS water source is categorized as Permanent, Seasonal, Interim or **Emergency in the database (not including capacity for emergency interconnect)**.
- 2016 Brazos G Water Plan: **32 emergency interconnects identified** based on TCEQ Texas Drinking Water Watch Database and results of the 2013 Brazos G Survey
- 2021 Brazos G Water Plan: **100 emergency interconnects identified** in the TCEQ Texas Drinking Water Watch Database

SUSAN ROTH
water and wastewater consulting

Q&A Discussion*

***Note:** information presented in previous slides will be included in greater detail in Sections 7.2 and 7.3 of the 2021 Brazos G Plan.*

SUSAN ROTH
water and wastewater consulting

Schedule to Develop the 2021 Brazos G Plan

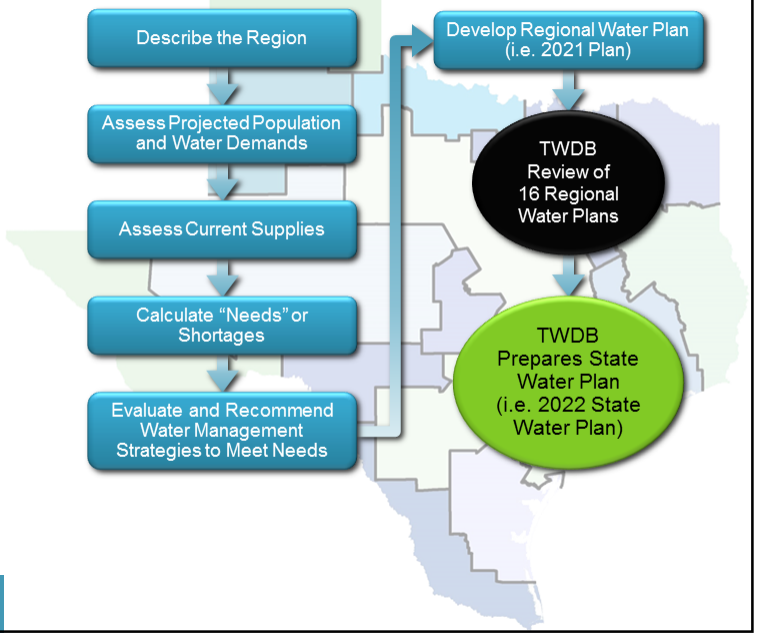
Agenda Item 6.6.5

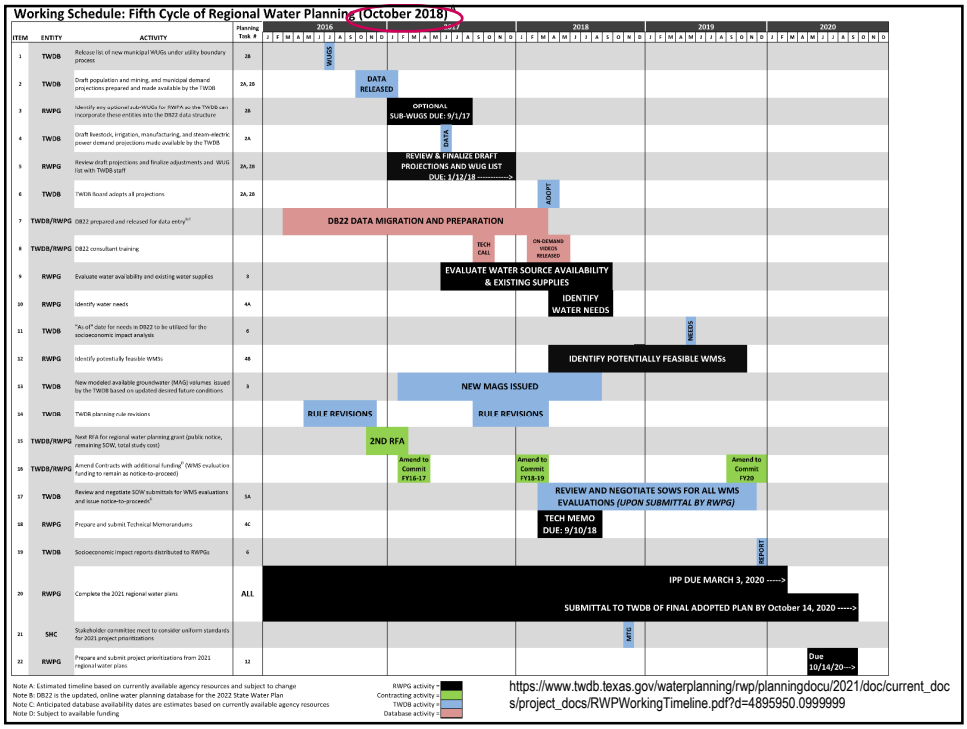
September 25, 2019

HDR

BRAZOS G WATER PLANNING GROUP

Regional Water Planning Process





Working Schedule for the 2021 Planning Cycle

- September '19 – March '20 – develop 2021 Plan
  - September, October, November
    - Review WMS evaluations
    - Review draft Chapters 2 (demands), 3 (supplies) and 4 (needs)
    - Review Chapter 7 Drought Preparations
    - Review Chapter 8 Policy Recommendations
    - Review initial plans for some WUGs and WWPs
  - November Brazos G mtg
    - Review WMS evaluations
    - Review initial plans for most WUGs and WWPs
    - Review Chapter 1 Description of Region
    - Finalize Chapters 2-4 and 7
    - Review/adopt Chapter 8. Policy Recommendations
  - December Brazos G mtg
    - Finalize Chapter 1 Description of Region
    - Review final WMS evaluations
    - Finalize plans for most WUGs/WWPs
    - Adopt policy recommendations for Chapter 8
  - January '20 Brazos G mtg
    - Clean up for remaining tasks
  - January '20 Sub-regional meetings?
  - February '20 Brazos G mtg
    - Review/approve Initially Prepared Plan
- March 3, 2020 – Initially Prepared Plan