2026 PANHANDLE WATER PLAN

Initially Prepared Plan / Volume II / Appendices

VOLUME II. APPENDICES.

2026 PANHANDLE WATER PLAN
INITIALLY PREPARED PLAN

MARCH 2025

Prepared for:

PANHANDLE WATER PLANNING GROUP

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2026 PANHANDLE WATER PLAN. VOLUME II. APPENDICES.

APPENDIX A

AGRICULTURAL WATER DEMAND PROJECTIONS

2026 Regional Water Planning: Region A Livestock Water Use

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The Agricultural subcommittee of the Region A Water Planning Group was charged with reviewing and analyzing the livestock water use estimates for Region A proposed by the Texas Water Development Board (TWDB) for use in developing the 2026 Regional Water Plan (RWP) for Region A to determine the acceptability of the TWDB estimates or if modifications needed to be recommended. The Agricultural subcommittee identified a Livestock Industry focus group to review the Texas Water Development Board draft projections of livestock water use in the Region for the 2026 planning cycle and the analysis of those estimates prepared by Texas A&M AgriLife personnel. The focus group worked together with Region O to review and update the livestock demands in the Panhandle and High Plains regions. This memorandum discusses the changes in the projected livestock demands for Region A.

The Livestock Industry focus group met at the Panhandle Regional Planning Commission on May 18, 2022, to discuss the 2026 regional water plan. Representatives from the fed cattle, dairy and swine confined livestock operations as well as producers, water district and TWDB personnel were in attendance. The group reviewed TWDB methodology and their 2026 livestock water use estimates; the methodology employed in Region A to make livestock water use estimates in previous planning efforts; and the TWDB and RWP estimates made in the 2021 plan. County level water use estimates varied as much as 79.40% between the two projections. In addition, there were differences between the water use per species as well as the delineation of species water use that had been developed over previous water planning efforts in Region A which were necessary to accurately reflect the livestock Industry composition in the region. Additionally, changing conditions warranted reexamination of the future potential growth/contraction of the various livestock enterprises. Based on the information/analysis presented, the Agricultural subcommittee charged Texas A&M AgriLife to estimate livestock water use for the 2026 RWP using methodology developed in the previous regional water planning efforts. Subsequently, the Agricultural subcommittee provided guidance on inventory, water use by species and what the future may look like for the various livestock water user groups. Results of this meeting were incorporated into the development of the revised livestock water use estimates for the 2026 water plan. The remainder of this memorandum is delineated into six sections: revised inventory estimates; changing conditions; livestock water use by species; future growth/contraction; results; and summary & conclusions.

Revised Inventory Estimates

Determination of livestock numbers by county is vital to the accurate estimation of water use. Livestock inventories by species were updated/estimated for each county of Region A. As in

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previous efforts, eight livestock water use groups were evaluated. The groups include fed beef, beef cows, summer stockers, winter stockers, dairy cattle, equine, swine and poultry. The procedure developed in previous planning efforts was utilized to develop the estimates of 2021 county level inventories by species.

In the 2026 Regional Water Plan, updated inventory projections were estimated and utilized to replace the inventory projections made in the 2021 RWP to improve the accuracy of the baseline for making future projections. The information obtained to update inventory estimates came from several different sources including: Texas Agricultural Statistics Service (TASS), the 2017 USDA Census of Agriculture supplemented with previous USDA Census of Agriculture (Census of Agriculture) estimates, Milk Market Administrator records, Texas A&M AgriLife Extension County Agents and Specialists, Industry representatives and Commodity Associations.

<u>*Fed Beef*</u>

Neither TASS nor the Census provides estimates of fed beef inventories at the county level due to disclosure concerns. In the past water planning efforts, Texas Cattle Feeders Association (TCFA) personnel made the Region A county level fed cattle estimates. For the 2026 RWP, TCFA personnel again updated county level feedlot inventories via secondary data and personal communications with feedlot managers.

<u>*Beef Cows*</u>

Estimates of beef cow inventory were maintained from the 2021 Regional Water Plan. The estimates used in the 2021 RWP were developed with TASS inventory estimates of 2017 beef cow numbers by county. However, in the 2017 estimates inventories for six counties (Carson, Gray, Lipscomb, Moore, Sherman and Wheeler) were not provided due to disclosure policies. The beef cow inventory in these counties was estimated by applying the percentage change (2017 vs 2010) in the known counties to the 2010 inventories in these counties.

<u>*Summer Stockers*</u>

The procedure for estimating the number of summer stockers remained the same as the procedure developed in previous Region A water plans. The amount of permanent pastureland per county available for grazing was estimated from the 2017 Census of Agriculture. The total acres available for grazing was augmented by adding in cropland used for grazing assuming the carrying capacity of these improved pastures was double that of the native pasture. This total acreage available for grazing was reduced by the acreage required to support the beef cow inventory in the county, and the remaining acreage was assumed available for summer stockers. The number of potential summer stockers was then derived by dividing the available stocker acres by the estimated stocking rate (acres/head). Stocker estimates were reduced 10% to allow for frictional losses in inventories associated with under stocking. The typical stocking rates for both beef cows and summer stockers used in the analysis were determined by the Texas A&M AgriLife Beef Specialist in the area.

Winter Stockers

A survey of Texas A&M AgriLife County Agents was conducted to identify/update the percentage of irrigated and dryland wheat acreage grazed in a typical year. Results of the survey indicated that 36% and 43% of the irrigated and dryland wheat is grazed on average annually, respectively. This represented a slight change from the previous planning effort that was determined through a similar survey conducted in the Senate Bill 1 planning effort (with irrigated wheat utilization changed from 50% to 36% and dryland wheat utilization changed from 25% to 43%). In the 2026 RWP, winter stocker numbers were adjusted to reflect a new wheat crop acreage base (2017 – 2021 average) using Farm Service Agency (FSA) recorded planted acreage. Stocking rates for irrigated and dryland wheat determined by producer surveys were utilized with the wheat acreage and the percentage grazed to estimate the baseline winter stocker inventory by county.

Dairy Cattle

The methodology for determining the number of dairy cows per county was changed to improve the accuracy of estimates. In previous planning efforts, County level dairy inventories were identified through TASS. In counties with less than three dairies which are not reported in TASS data, residual dairy cows not accounted for were divided evenly between counties where dairies exist. In the current effort, consultation with the Texas A&M AgriLife Extension state Dairy Specialist and data from Milk Market Administrator (MMA) records were used to estimate the number of dairy cows per county. In counties with less than three dairies, which are not reported in MMA statistics, Texas Department of Health records were utilized to identify the dairies. Subsequently, County Agents with knowledge of those operations or the dairies were contacted directly to determine the number of dairy cows.

Equine

Currently, the Census of Agriculture is the only source of county level equine inventories. The 2012 Census of Agriculture estimates used in the 2021 RWP were updated to the inventories reported in the 2017 Census of Agriculture for the 2026 effort. In addition, the equine inventory was expanded to include burrows, mules and donkeys.

Swine

A number of large confined hog operations exist in Region A. Due to disclosure limitations the location and size of these operations are not available through TASS or Census data. The methodology for estimating these operations by county and by type (farrowing, nursery or finishing) were similar to previous water plans. These companies were surveyed directly with the assistance of Texas A&M AgriLife Extension County Agents to determine the actual inventories to use in the 2026 RWP effort. The 2017 Census of Agriculture was utilized to estimate inventories in counties without commercial scale operations. Total Inventory estimates were back checked for accuracy via current and past TASS records.

Poultry

Virtually no poultry currently exists within Region A. In the 2021 RWP, county level inventories were identified through the 2012 Census of Agriculture. For the current water planning effort these inventories were updated based on the 2017 Census of Agriculture.

Changing Conditions

Though the TWDB includes water use from agricultural manufacturing in the manufacturing category, agricultural processing capacity and agricultural manufacturing capacity serve as a demand factor for additional agricultural production. The livestock industry focus group thought the influx of agricultural manufacturing capacity in the region was worth noting, considering it is likely to induce an increase in water use in certain livestock categories in the future. The estimated direct water use of the projects is noted for reference here.

Two cheese plants in Region A and a cheese plant in Region O will soon come online to process the surplus of milk in the region. Cacique is constructing a new 200,000 square foot dairy processing facility in Amarillo to produce Mexican-style cheeses, creams, and yogurts. The Cacique facility is expected to come online in late 2022. Additionally, a privately owned plant in Moore County is expected to break ground in the immediate future. The new Moore County facility is expected to be largely served by the developer's dairy inventory. Finally, Leprino Foods is constructing a new 850,000 square foot dairy processing facility in Lubbock (Region O) to produce mozzarella cheese and dairy ingredients. The Leprino Foods facility is expected to come online in 2026. The existing surplus of milk in the area coupled with the of natural growth in production (milk/cow) suggests that the facilities themselves are expected to have minimal influence on dairy inventory.

In August, Producer Owned Beef LLC announced the construction of a new beef harvest facility outside of Amarillo. The new facility will break ground in 2023, with expected completion between 2025 and 2026. When complete, the facility will harvest 3,000 head of fed beef daily, all sourced from Texas, Oklahoma, New Mexico. The new facility will represent a roughly 17% increase in harvest capacity, and over time is expected to induce a supply response in fed cattle, which may increase their water use over time.

Caviness Beef Packers will open a new facility in Amarillo replacing its older ground beef and patty processing facility in Amarillo. The newer facility will be roughly 2.4 times larger than the existing facility, creating additional demand for beef trimmings, and therefore a need for more beef cows, though those cows may be sourced outside Region A.

This new water use for each of the new food processing or beef harvesting facilities will be considered in the review and update of the projected manufacturing demands. They are not included in the livestock water use.

Livestock Water Use by Species

Significant time and effort were made in the 2011 Regional Water Plan to form advisory committees consisting of industry experts to review water use estimates by species. The estimates developed by the committees were implemented in the 2011 RWP. In subsequent Region A water planning efforts advisory committees were utilized to review/update species water use numbers based on research and actual water use by these species. In the 2026 planning effort a livestock advisory committee again reviewed these species water use numbers for the current water plan and with an exception of dairy decided these estimates were still appropriate; therefore, they were used in developing livestock water use projections in the 2026 RWP (Table 1).

Categories of livestock water use do vary considerably compared to those proposed by TWDB due to the unique composition of livestock operations in the region which the rest of the state as a whole does not have. Failure to consider these differences distorts water use estimates, especially on the county level. The composition of the region's beef industry consists of large inventory of fed beef followed by summer and winter stocker operations, both of which have smaller water requirements per head than beef cows. In addition, there are relatively fewer beef cow herds in the region compared to the rest of the state which makes it necessary to separate these user groups. Hog water use enterprises were separated into three categories (farrowing, nursery, and finishing) rather than the one proposed by TWDB. This was done in order to improve county level water use estimates as some of the counties only have finishing operations, some only nursery operations, some only farrowing operations and some a combination of enterprises. The other major variation in species water use is in the dairy industry. Essentially, all the dairies in the region are relatively new (less than 20 years) thus have modern facilities that focus on water reuse. Therefore, based on dairy operators, research and expert opinion, the estimate of 60 gal/day was adopted by the committee.

Table 1. Region A 2026 RWP daily livestock water use estimates per animal.

Species	2026 RWP (gal/day)	2026 TWDB (gal/day)
Beef - All	-----	15
Beef Cows	20	-----
Fed Beef	12.5	-----
Summer Stockers	10	-----
Winter Stockers	8	-----
Dairy Cattle	60	55
Equine	12	12
Poultry - All	0.09	-----
Poultry: Hens	-----	0.09
Poultry: Broilers	-----	0.09
Swine - All	-----	5
Swine: Sows	17.5	-----
Swine: Nursery	2.5	-----
Swine: Finishing	5.0	-----

Projected Future Growth or Contraction of Livestock Sector

The Livestock Industry focus group reviewed the 2021 RWP projected growth/contraction of the various livestock user groups. After review, the focus group recommended changes in the projected growth for seven of the eight categories (Table 2). The fed beef growth projections from 2022-2030 remained the same; 5.00% decadal growth in Dallam, Hansford, Hartley, Moore, Ochiltree, and Sherman counties. The expected decadal growth from 2030-2080 was reduced from the 2021 RWP, from 5.00% to 2.50% decadal growth occurring in Dallam, Hansford, Hartley, Moore, Ochiltree and Sherman counties. The focus group felt that as water availability decreases more emphasis will be placed on the cattle industry. Beef cows and summer stocker inventories are expected to grow at a 2.50% per decade throughout the planning horizon. While 2.50% is a projected increase in the inventories, the growth rate is lower than the expected increase used in the 2021 plan (5.00% decadal). No growth is projected in the winter stocker inventories, which is a reduction from the 2021 RWP (5.00% decadal growth rate). Significant increases in dairy inventory are expected throughout the region in the near term. The majority of the dairy industry is expected to grow 10.00% per decade from 2022-2040, and to remain stable from 2040-2080. Moore County is the exception, where an expansion of dairy inventory by 120,000 from 2022-2030 is expected to support a new cheese plant. From 2030 – 2080 the dairy industry in Moore is expected to match the remainder of the region.

The observed decreases in equine inventories across the state led the focus group to flat line any projected growth in this industry within the region. The committee also chose to curb expectations for growth in the poultry industry in the region; no growth is expected in the sector from 2022-2080. The focus group felt like the hog industry had matured and no future growth is anticipated at this time.

Table 2. Region A 2021 RWP and 2026 RWP projected livestock inventory growth by species, 2022 – 2080.

Species	2021 RWP	2026 RWP
	(---Projected Growth Rates---)	
Beef Cows:		
2022 – 2080	5.00% decadal growth rate.	2.50% decadal growth rate.
Fed Beef:		
2022 – 2030	5.00% growth per decade in Dallam, Hansford, Hartley, Moore, Ochiltree, and Sherman Counties. No growth in other counties.	5.00% growth rate per decade in Dallam, Hansford, Hartley, Moore, Ochiltree, and Sherman Counties. No growth in other counties.
2030 - 2080	5.00% growth per decade in Dallam, Hansford, Hartley, Moore, Ochiltree, and Sherman Counties. No growth in other counties.	2.50% growth per decade in Dallam, Hansford, Hartley, Moore, Ochiltree, and Sherman Counties. 0.00% growth in other counties.
Summer Stockers:		
2022 - 2080	5.00% decadal growth rate.	2.5% decadal growth rate.
Winter Stockers:		
2022 - 2080	5.00% decadal growth rate.	0.00% decadal growth rate.
Dairy Cattle:		
2022 - 2030	20.00% decadal growth rate in all dairy counties.	10.00% decadal growth rate for Dallam, Hartley, Lipscomb, Randall, Sherman, and Wheeler. Anticipate an increase of 120,000 cows in Moore.
2030 - 2040	10.00% decadal growth rate in all dairy counties. (2030 – 2070)	10.00% decadal growth rate in all dairy counties.

Species	2021 RWP	2026 RWP
	(---Projected Growth Rates---)	
2040 – 2080		0.00%
Equine		
2022 – 2080	0.00%	0.00%
Poultry:		
2022 - 2080	In 2030, add 1,000,000 capacity operations in Armstrong, Carson, Childress, Collingsworth, Gray, Oldham, and Wheeler Counties. No other growth is assumed.	0.00%
Swine:		
2022 - 2080	Dallam County inventory scaled up to reflect new operation. 0.00% growth in other counties.	No growth in any of the counties.

Results

A comparison of Region A projected livestock water use from the 2021 Regional Water Plan and the revised projections for the 2026 plan for 2030 - 2080 is illustrated in Figure 1. In 2030, projected water use between the two projections was approximately 22.2% different with greater near-term use being projected in the 2026 RWP as a function of revising dairy cow inventory upwards more than 120,000 head by 2030 compared to the 2021 RWP projections. The 2021 RWP and 2026 RWP estimates begin to converge as they approach 2070. The relatively slower expansion rates and in certain cases inventory declines anticipated by the focus group in dairy, swine, beef cow, summer stocker, winter stocker, and poultry water user groups, and incorporated into the 2026 RWP led to annual livestock water use in 2070 projected 11.3% higher in the revised 2026 RWP compared to the 2021 RWP estimates.

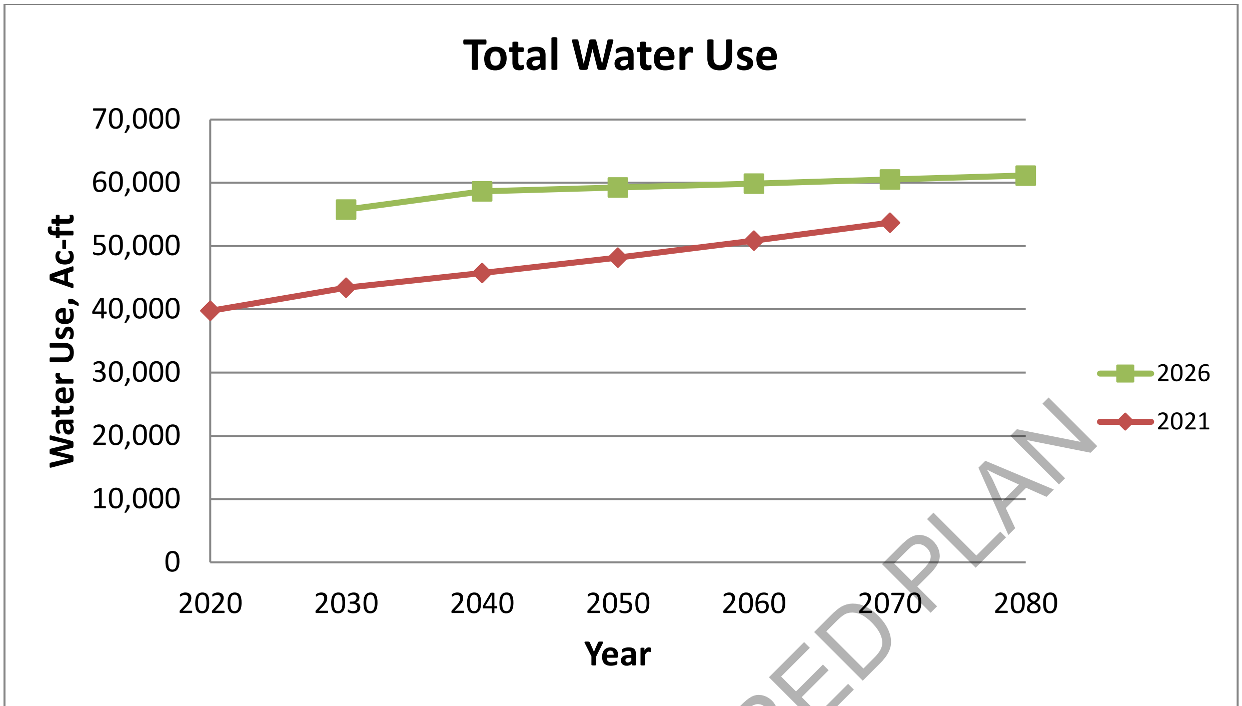

Figure 1. Region A comparison of estimated livestock water use between 2021 RWP and 2026 RWP for selected years.

A summary of the impacts of changes in livestock inventories and future projections utilized in the 2026 RWP compared to the 2021 RWP is presented in Table 3. In this table, a comparison of baseline inventories and ending inventories is made between the two projections. The 2030 inventories were updated in the 2026 RWP to reflect current inventories that were estimated based on 2021 data and any projected changes from then to 2030. Projected growth rates were altered to account for changing industry conditions based on the recommendations of the Industry focus group. The 2030 inventory for fed beef increased 184,000 head from the 2020 baseline used in the 2021 RWP. Most of the increase that occurred between the baselines was anticipated in the 2016 RWP. There were relatively small revisions between the baselines to beef cow numbers, summer stockers, poultry, and swine inventories. A change in the regional cropping patterns and an updated estimate of the percentage of wheat acres grazed resulted in somewhat more stockers (19,000+) being placed on winter wheat pastures compared to the 2021 RWP. A higher-than-expected growth in the dairy industry plus a one-time expansion of 120,000 cows in Moore County prior to 2030 account for the significant change (almost 217,000 cows) to estimates of dairy inventory between the baselines. Downward revisions in 2017 Census Data compared to 2012 Census Data account for the loss of equine inventory.

The variance in the 2070 (2021 RWP) and 2080 (2026 RWP) poultry inventories was due to the focus group abandoning expectations for the arrival of poultry operations in the region in the 2026 RWP. The changes in the ending inventories reflect the changes in future growth rates adopted by the industry focus group. Future growth rates in all species were reduced except for equine where no growth was projected in either planning effort.

Table 3. Region A baseline and ending livestock inventories by species for 2021 and 2026 RWPs.

Species	2021 RWP	2026 RWP	2021 RWP	2026 RWP
	2020	2030	2070	2080
	(----------Number of Head----------)			
Beef Cows	236,649	237,838	303,673	296,463
Fed Beef	1,302,964	1,487,384	1,562,908	1,629,448
Summer Stockers	380,312	382,224	488,027	433,048
Winter Stockers	226,441	245,715	290,576	245,715
Dairy Cattle	112,155	329,076	203,552	363,505
Equine	16,802	9,078	16,802	9,078
Poultry	6,267	8,272	7,006,267	8,272
Swine	552,259	565,192	610,621	565,192

Region A annual livestock water use projections by county for selected years during the 2026 RWP over a 50-year horizon are presented in Table 4. Overall, water use in the Region A livestock sector is predicted to increase 9.70% from 55,766 ac-ft. usage projected in 2030 to 61,157 ac-ft. projected in 2080. While this increase is significant, it still will represent less than 5.00% percent of the total agricultural water use within the region during 2080. Six counties (Hartley, Dallam, Moore, Sherman, Hansford, and Ochiltree) account for 71.20% of the livestock water use in the region during 2030 climbing to 76.6% by 2070. These six counties are characterized by extensive fed beef operations in conjunction with significant sized dairy and/or swine operations.

Table 4. 2026 RWP Livestock Water Use by County in Region A, 2030 – 2080, Ac-ft.

County	2030	2040	2050	2060	2070	2080
Armstrong	345	353	361	369	377	385
Carson	337	343	350	357	364	371
Childress	328	335	343	351	359	368
Collingsworth	462	473	484	496	508	520
Dallam	5,222	5,475	5,543	5,613	5,684	5,757
Donley	1,064	1,075	1,087	1,099	1,112	1,125
Gray	1,759	1,814	1,823	1,833	1,842	1,852
Hall	341	350	358	367	376	385
Hansford	4,705	4,805	4,907	5,013	5,120	5,231
Hartley	11,784	12,674	12,782	12,892	13,005	13,120
Hemphill	1,093	1,108	1,123	1,138	1,154	1,170

County	2030	2040	2050	2060	2070	2080
Hutchinson	522	531	541	551	561	572
Lipscomb	859	876	889	902	916	930
Moore	13,844	15,099	15,158	15,219	15,281	15,345
Ochiltree	2,835	2,878	2,909	2,942	2,975	3,009
Oldham	1,323	1,337	1,351	1,365	1,379	1,394
Potter	506	516	527	538	549	560
Randall	2,778	2,792	2,803	2,814	2,825	2,837
Roberts	384	394	404	414	424	435
Sherman	3,970	4,091	4,159	4,228	4,300	4,373
Wheeler	1,305	1,346	1,364	1,382	1,400	1,419
Total	**55,766**	**58,665**	**59,265**	**59,880**	**60,511**	**61,157**

Projected water use by the various Region A livestock water user groups for selected years is presented in Table 5. By 2080 the largest livestock water use group is projected to be the dairy industry with an annual usage of 24,431 ac-ft. per year followed closely by the fed cattle industry (22,815 ac-ft. per year). These two user groups account for 77.20% of projected livestock water use in 2080. Overall, confined livestock operations (fed beef, dairy and swine) accounted for 83.10% of the livestock water use. Beef cows, winter & summer stockers and swine are all projected to use more than 3,500 ac-ft. per year with estimated demand of 6,037 ac-ft., 4,151 ac-ft. and 3,600 ac-ft., respectively. Poultry and equine accounted for less than one percent of the projected livestock water consumption in 2080.

Table 5. Region A 2026 RWP livestock water use by species for selected years in Ac-ft.

Species	2030	2040	2050	2060	2070	2080
Fed Cattle	20,826	21,205	21,593	21,990	22,398	22,815
Beef Cows	5,328	5,463	5,601	5,743	5,888	6,037
Stockers	3,772	3,844	3,918	3,994	4,072	4,151
Dairy Cows	22,117	24,431	24,431	24,431	24,431	24,431
Swine	3,600	3,600	3,600	3,600	3,600	3,600
Equine	122	122	122	122	122	122
Poultry	1	1	1	1	1	1
Total	**55,766**	**58,665**	**59,265**	**59,880**	**60,511**	**61,157**

A comparison of Region A projected livestock water use from the 2026 TWDB Livestock Estimates and the 2026 RWP estimates for 2030 - 2080 is illustrated in Figure 2. In 2030, projected water use between the two projections was approximately 13.18% different with greater near-term use projected in the 2026 RWP as a function of revising baseline dairy cow inventory upwards nearly 217,000 head by 2030 compared to the 2026 TWDB projections. A lot of the inventory increase can be attributed to the development new dairy capacity in Moore County with an anticipated 120,000 cows. The 2026 TWDB estimates and 2026 RWP estimates begin to converge as they approach 2070. The relatively slower expansion rates, and in certain cases inventory declines, anticipated and included in the RWP by the focus group in dairy, swine, beef cow, summer stocker, winter stocker, and poultry water user groups led to annual livestock water use in 2080 being projected 2.64% higher in the updated 2026 RWP estimates compared to the 2026 TWDB estimates. The discrepancies in the two series highlight the need for the inclusion of local knowledge to determine accurate water use estimates through the planning horizon.

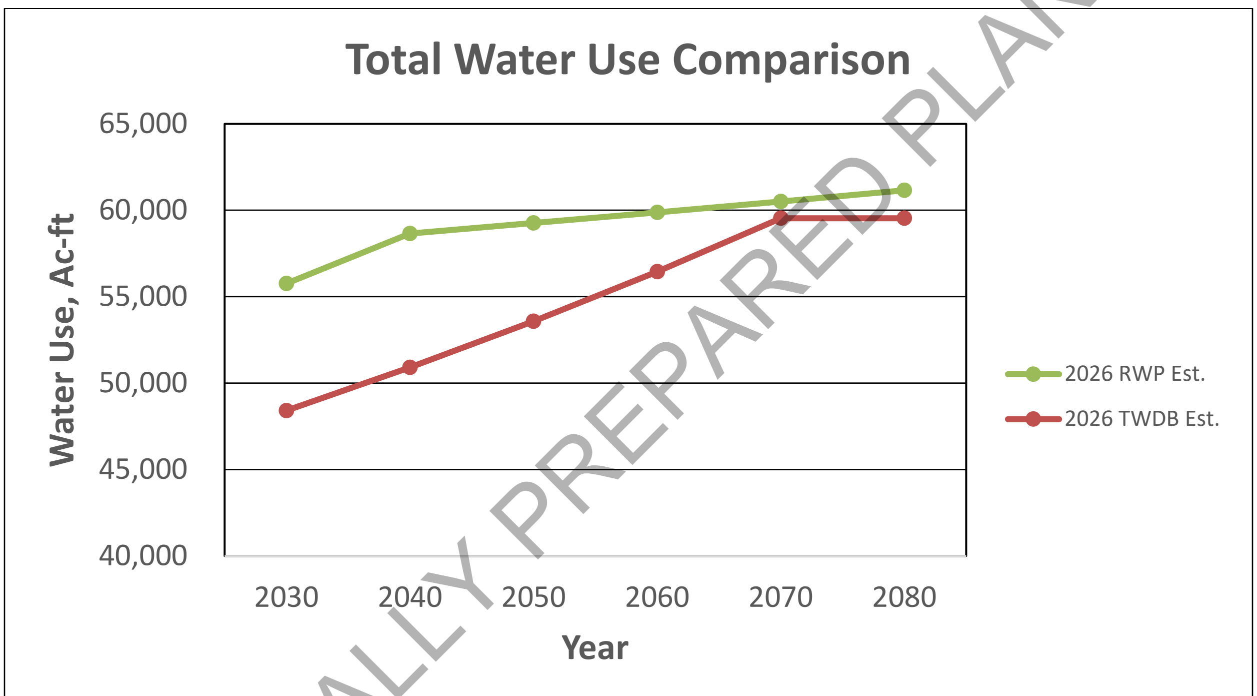

Figure 2. Region A comparison of estimated livestock water use between 2026 RWP Estimates and 2026 TWDB Estimates for selected years.

A comparison of the TWDB 2026 draft livestock water use projections and the proposed 2026 RWP projections by county for Region A is given in Table 6. Overall, the proposed 2026 RWP livestock water use estimates in 2030 were 13.18% higher than TWDB estimates. The water use estimates tended to converge over time with the difference being only 2.70% by 2080. However, the differences in the estimates were extreme on the county level. Almost half of the counties had more than a 20.00% difference in water use in 2080 highlighted by Moore County where changing conditions unknown to the TWDB led to an underestimate livestock water use 155.90%. In other counties differences in water use could be due to changing conditions, missed estimated inventories, differences in the composition of livestock enterprise types, etc.

Table 6. Comparison of 2026 TWDB RWP Draft Projections and Proposed 2026 RWP Water Demand Projections - Livestock

County	2026 TWDB RWP Draft Projections (ac-ft.)						Proposed 2026 RWP Projections (ac-ft.)						Change from 2026 TWDB to 2026 RWP (%)					
	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
ARMSTRONG	680	707	734	763	793	793	345	353	361	369	377	385	-49.2	-50.1	-50.9	-51.7	-52.5	-51.4
CARSON	476	494	512	530	550	550	337	343	350	357	364	371	-29.2	-30.5	-31.7	-32.7	-33.9	-32.6
CHILDRESS	324	337	350	364	379	379	328	335	343	351	359	368	1.2	-0.5	-2.0	-3.6	-5.2	-3.0
COLLINGSWORTH	459	478	498	519	541	541	462	473	484	496	508	520	0.6	-1.1	-2.8	-4.5	-6.2	-3.9
DALLAM	5,845	6,152	6,483	6,839	7,224	7,224	5,222	5,475	5,543	5,613	5,684	5,757	-10.7	-11.0	-14.5	-17.9	-21.3	-20.3
DONLEY	957	981	1,007	1,033	1,061	1,061	1,064	1,075	1,087	1,099	1,112	1,125	11.2	9.6	8.0	6.4	4.8	6.0
GRAY	2,123	2,220	2,325	2,441	2,567	2,567	1,759	1,814	1,823	1,833	1,842	1,852	-17.1	-18.3	-21.6	-24.9	-28.2	-27.8
HALL	439	461	484	509	535	535	341	350	358	367	376	385	-22.3	-24.2	-26.0	-27.9	-29.7	-28.0
HANSFORD	5,283	5,514	5,755	6,010	6,276	6,276	4,705	4,805	4,907	5,013	5,120	5,231	-10.9	-12.9	-14.7	-16.6	-18.4	-16.6
HARTLEY	9,385	10,084	10,841	11,663	12,555	12,555	11,784	12,674	12,782	12,892	13,005	13,120	25.6	25.7	17.9	10.5	3.6	4.5
HEMPHILL	1,206	1,239	1,274	1,310	1,348	1,348	1,093	1,108	1,123	1,138	1,154	1,170	-9.4	-10.6	-11.9	-13.1	-14.4	-13.2
HUTCHINSON	453	474	497	522	548	548	522	531	541	551	561	572	15.2	12.1	8.8	5.5	2.4	4.3
LIPSCOMB	1,132	1,180	1,234	1,288	1,345	1,345	859	876	889	902	916	930	-24.1	-25.8	-28.0	-30.0	-31.9	-30.9
MOORE	4,361	4,717	5,106	5,531	5,996	5,996	13,844	15,099	15,158	15,219	15,281	15,345	217.4	220.1	196.9	175.2	154.9	155.9
OCHILTREE	3,184	3,354	3,532	3,721	3,920	3,920	2,835	2,878	2,909	2,942	2,975	3,009	-11.0	-14.2	-17.6	-20.9	-24.1	-23.2
OLDHAM	1,469	1,503	1,540	1,579	1,619	1,619	1,323	1,337	1,351	1,365	1,379	1,394	-9.9	-11.1	-12.3	-13.6	-14.8	-13.9
POTTER	493	513	534	557	580	580	506	516	527	538	549	560	2.7	0.7	-1.3	-3.5	-5.4	-3.4
RANDALL	3,566	3,613	3,662	3,716	3,773	3,773	2,778	2,792	2,803	2,814	2,825	2,837	-22.1	-22.7	-23.5	-24.3	-25.1	-24.8
ROBERTS	368	386	406	426	448	448	384	394	404	414	424	435	4.5	2.1	-0.6	-2.9	-5.3	-3.0
SHERMAN	5,010	5,264	5,535	5,824	6,135	6,135	3,970	4,091	4,159	4,228	4,300	4,373	-20.8	-22.3	-24.9	-27.4	-29.9	-28.7
WHEELER	1,203	1,237	1,272	1,308	1,347	1,347	1,305	1,346	1,364	1,382	1,400	1,419	8.5	8.8	7.2	5.6	3.9	5.3
Region Total	48,416	50,908	53,581	56,453	59,540	59,540	55,766	58,665	59,266	59,883	60,511	61,158	15.2	15.2	10.6	6.1	1.6	2.7

Summary and Conclusions

Texas A&M AgriLife was charged with reviewing and analyzing the livestock water use estimates for Region A proposed by TWDB for use in developing the 2026 Region A water plan to determine the acceptability of the TWDB estimates or if modifications needed to be recommended. The results of the analysis were presented to the Livestock Industry focus group of the regional water planning group on May 18, 2022. The review of the proposed TWDB livestock water use estimates revealed that on a regional basis their estimates differed by approximately 10.0% from projections made in the 2021 plan, and that the variation in county level estimates was extreme (as much as 79.4%). Given the variation, the committee decided the livestock water use estimates needed to be redone for the 2026 RWP using the methodology specifically developed for the region due to its unique characteristics in previous water plans.

The process to revise livestock water use for the 2026 plan included: updating livestock inventories by county, reviewing/revising water use by species and reviewing/revising where warranted projected growth/decline of the various livestock categories over the planning horizon. An Industry focus group consisting of representatives from the various livestock user groups was established that provided guidance on water use estimates per animal and determined projected changes in the livestock Industry that will occur during the planning horizon. In addition, representatives of the confined livestock operations were instrumental in developing inventory estimates by county which are not available at that level of detail from published sources.

In the revised 2026 estimates, water use in the Region A livestock is predicted to increase 9.7% from 55,766 ac-ft. usage in 2030 to 61,157 ac-ft. in 2080. Confined livestock operations (fed beef, dairy and swine) accounted for 83.1% of the livestock water use. Compared to the 2021 plan, annual water use estimates increased 11.3% (53,700 ac-ft. vs 60,511 ac-ft.) by 2070. The relative projected increase in water use can be traced to increasing the estimated baseline inventory of dairy cattle by almost 217,000 cows prior to 2030, though revised slower expected growth rates and no growth in other sectors in the 2026 RWP compared to the 2021 RWP decrease the difference in the two plans by 2070.

Comparing the TWDB 2026 draft livestock water use projections and the proposed 2026 RWP projections led to some interesting results. Overall, the proposed 2026 RWP livestock water use estimates in 2030 were 13.18% higher than TWDB estimates. The water use estimates tended to converge over time with the difference being only 2.64% by 2080. However, the differences in the estimates were extreme on the county level. Almost half of the counties had more than a 20.0% difference in water use in 2080 highlighted by Moore County where changing conditions unknown to the TWDB led to an underestimate of livestock water use by 155.90%.

It can be concluded that due to the unique characteristics of the livestock industry in the region that water use estimates should be made through the regional water planning effort rather than at the state level for the current as well as future water planning efforts. The region’s livestock water use is dominated by confined livestock operations which are difficult to find location, type and size information on at a regional, much less county basis, due to disclosure reasons. First-hand knowledge of the region and the confined livestock operations is paramount in making accurate assessments of inventories at the regional and county levels as well as identifying changing conditions within these operations that will potentially affect water use in the future. Furthermore, the unique composition of livestock enterprise types within the region requires additional delineation of water use per animal not currently considered in TWDB estimates to accurately estimate livestock water use within the region.

APPENDIX B

ANALYSIS FOR SURFACE WATER AND GROUNDWATER AVAILABILITY

Surface Water

Reservoir Sedimentation Rates

Over time sediment that is carried with inflows accumulates in reservoirs, which reduces the storage capacity of the reservoir and can affect the reservoir supply. In the PWPA, reservoir sedimentation rates were estimated from published documents and volumetric surveys. The total accumulated sediment is calculated as:

[Sedimentation Rate] X [Drainage Area] X [Number of years from the Volumetric Survey]

This formula is used to estimate the reservoir capacity for decades 2030, 2050 and 2080. The total sediment quantity is applied to the base area-capacity-elevation (ACE) curve using either a conical or trapezoidal method (depending upon the best fit for the reservoir) to develop the new ACE. For Lake Meredith and Greenbelt Reservoir, the sediment distribution was adjusted to account for historical storage since these reservoirs have never filled to the conservation capacity. **Table B-1** shows the sedimentation calculations for the reservoir in the PWPA.

Table B-1: Estimated Sedimentation Rates and Projected Capacities

Reservoir	Drainage Area (SqMi)	Sediment Rate (ac ft/SqMi)	Year of Initial Capacity	Conservation Capacities (ac ft)				Sediment Rate Source
				Initial	2030	2050	2080	
Meredith[1]	6,048	0.088	1995	500,000	500,000	500,000	500,000	TWDB, 2003
Palo Duro[2]	440	0.20	1986	60,897	NA	54,422	NA	FNI, 1986
Greenbelt	266	0.75	1966	59,800	47,018	43,028	37,043	TBWE, 1959

[1]At conservation pool Lake Meredith has a total capacity of over 800,000 acre-feet per year. However, the Canadian River Compact limits the right of Texas to retain water in conservation storage within Lake Meredith to 500,000 ac-ft. The remaining storage is for sedimentation and inactive storage. The yield analyses assume the usable portion of the reservoir is the first 500,000 ac-ft above the inactive pool for all planning decades. As a result, sedimentation has no impact on the yield of Lake Meredith and conservation capacity does not change.

[2]The yield for Palo Duro Reservoir was analyzed only under 2060 sediment conditions, which are reported under year 2050 in the table above. Since the reservoir has little to no yield no additional yield analyses were performed.

Water rights which are the basis for surface water existing supply volumes will be submitted electronically to the TWDB as part of the IPP submittal as required.

Hydrologic Models

Two river basins lie within the PWPA, the Red River Basin and the Canadian River Basin. According to regional planning rules and guidelines, surface water supplies must be determined using the latest version of the TCEQ Water Availability Models (WAMs) with full authorization unless a hydrologic variance is granted by the TWDB. The Canadian River WAM was initially published in 2001 covers the hydrologic period-of-record from 1948 to 1998. The Canadian WAM was updated by FNI to extend the hydrology from 1940 through 2004, but even with this update, the WAM does not include the most recent drought that is the new drought of record for much of the region. The Red River WAM was recently updated by the TCEQ and includes the hydrologic period through

2018, which does include the most recent drought. In light of the limitations of the Canadian WAM, the PWPG requested to use an Excel-based model with extended hydrology for Lake Meredith and Palo Duro Reservoir. The TCEQ-approved Red River WAM was used to evaluate the supplies from Lake Greenbelt. The requested hydrologic variances are detailed in the PWPG's request letter to TWDB dated. TWDB approved the PWPG's variance request in a letter dated. Both letters are included in **Attachment B-1**.

Existing water supplies provided by run-of-river water rights in the Red and Canadian River Basins were determined using Run 3 of the Red River WAM and Run 3 of the Canadian River WAM with extended hydrology.

Versions and Dates of Hydrologic Models

Table B-2 lists the hydrologic models used to determine Source Water Availability in the PWPA. More discussion on Source Water Availability is included in Chapter 3 of this report.

Table B-2: Hydrologic Models Used in Determining Surface Water Availability

Hydrologic Model	Date Used	Run Used	Model Inputs/ Outputs Files Used	Comments
Canadian WAM	Oct 2004	Run 3, extended hydrology 2000 through 2004	Canadian.dat, .out	Used to determine run-of-river supplies.
Palo Duro Reservoir Operations Model	October 17, 2023	Spreadsheet model with extended hydrology and leakage calculation	PaloDuroOp_LossFit.xlsb	Used to determine 2060 firm yield. Yield was held constant across the planning period because it is so small.
Lake Meredith Operations Model	Feb 2018	Spreadsheet model with extended hydrology	2021Meredith_firmyield_2020.xlsb 2021Meredith_firmyield_2070.xlsb 2021Meredith_safeyield_2020.xlsb 2021Meredith_safeyield_2070.xlsb	Yield for 2080 was extrapolated. Firm and Safe Yield.
Red WAM	Jan 2, 2024	Run 3	red3.dat, .out	Used to determine run-of-river supplies.
Red WAM	Oct 2023	Run 3 with sedimentation	Red3GB_FY2030.dat, .out Red3GB_FY2050.dat, .out Red3GB_FY2080.dat, .out Red3GB_SY2030.dat, .out Red3GB_SY2050.dat, .out Red3GB_SY2080.dat, .out	2030, 2050 and 2080 firm and safe yield

None of the models include return flows.

Reservoir Yields

Table B-2 presents the yields for major reservoirs in the PWPA. For Lake Meredith, the firm yield does not change because the 500,000 acre-feet of conservation capacity does not change. The yield from Palo Duro Reservoir is very low because of leakage from the reservoir into surrounding formations.

Table B-3: Estimated Firm and Safe Yields for Major Reservoirs in the PWPA

Scenario	2030	2040	2050	2060	2070	2080
Lake Meredith						
Firm Yield (ac-ft/yr)	28,200	28,200	28,200	28,200	28,200	28,200
Safe Yield (ac-ft/yr)	24,600	24,600	24,600	24,600	24,600	24,600
Greenbelt Reservoir						
Firm Yield (ac-ft/yr)	4,000	3,850	3,700	3,433	3,167	2,900
Safe Yield (ac-ft/yr)	3,140	2,970	2,800	2,592	2,383	2,175
Palo Duro Reservoir						
Firm Yield (ac-ft/yr)	39	39	39	39	39	39

Alternative Models

PWPA 2006 WAM

As part of the 2006 PWPA plan, FNI modified and extended the hydrology for the TCEQ Canadian WAM, referred to in this Appendix as the PWPA 2006 WAM. In addition to adding hydrology from January 1940 through December 1947 and January 1999 through September 2004, the hydrology from January 1948 through December 1998 was adjusted to include different loss factors, estimates of missing flow data, adjustments for the construction of Lake Meredith, and adjustments for the construction of Ute Reservoir in New Mexico. The basic data setup for the model is the same as the TCEQ Canadian WAM, except that it explicitly models Ute Reservoir in New Mexico. Data from this model has been used in every PWPA water plan since 2006.

Lake Meredith Operations Model

The TCEQ has not updated the hydrology for the Canadian WAM since its original development in the early 2000s. On-going drought since that time has led to the PWPA developing models of Lake Meridith with extended hydrology to assess the impact on yield. Lake Meredith yield analyses for the 2026 Plan utilize the same Excel-based reservoir model originally developed by Freese and Nichols for the 2016 Plan and updated for the 2021 Panhandle Water Plan. A review of the reservoir content since 2017 shows the reservoir recovering from the minimum elevation recorded in 2013. Therefore, further extension of the hydrology for Lake Meredith would not result in lower yields. Assuming critical drought conditions do not recur, a meaningful yield analysis can be conducted for the reservoir using the previous model.

The model incorporates hydrologic data such as inflow, net evaporation, water demands and priority releases, reservoir configuration, and other parameters to perform a monthly water balance on a single reservoir over a certain historical period. The seniority of the lake's water rights, and extremely minimal history of water rights releases supports the use of a focused, simplified model. This enables estimation of firm and safe yields for the reservoir for Regional Planning purposes.

Input parameters for the model were compiled from several sources. The PWPA 2006 WAM served as the primary source of data. In this version of the WAM, hydrology was added for the years 1940 through 1947 and 1999 through 2004. Additional data were obtained from Canadian River Municipal Water Authority (CRMWA) records, TWDB records, and prior Regional Plans. The combination of sources used for the study allowed for simulation of historical hydrology for the reservoir site from 1940 through December 2017. Specific sources include:

a) ***Inflows*** **–** Inflows (runoff) into Lake Meredith were determined by multiple methods for different date ranges of the historical simulation period. For January 1940 through September 2004, modeled inflows into the lake were extracted from the PWPA 2006 WAM. For October 2004 through December 2011, a water balance approach was used to estimate Lake Meredith inflows on a monthly basis from CRMWA records. CRMWA inflow estimates were used directly to extend the hydrology through the end of 2017.

b) ***Net reservoir evaporation*** **–** As with inflow data, monthly net evaporation was compiled from multiple sources. For the time period from January 1940 through September 2004, net evaporation depths were extracted from the PWPA 2006 WAM. Values for the remainder of the desired simulation period were calculated from CRMWA evaporation and precipitation records

c) ***Area-Capacity-Elevation Data*** **–** The area-capacity-elevation properties of the reservoir were based on the volumetric survey of Lake Meredith performed by the Texas Water Development Board (TWDB) in June 1995 and published in March 2003. Estimated area-capacity-elevation relationships were projected for the years 2030, 2050 and 2080 assuming a sedimentation rate of 0.088 ac-ft/mi^2/yr from the TWDB report and a contributing drainage area of 6,048 square miles downstream of Ute Reservoir. The reservoir has never filled to the full permitted amount. Historical storage reached a high point in 1972 and has trended significantly downward since then. As a result, instead of the common assumption of uniform distribution of sediment, FNI assumed that the sediment distribution was based on the amount of time a particular elevation slice was inundated.

d) ***Seepage*** **–** Studies performed as part of the 2006 planning cycle note the potential for seepage losses for Lake Meredith. The development of the PWPA 2006 WAM in the 2006 planning cycle included adjustment of naturalized flows due to seepage at the lake, which covers the period from January 1940 through September 2004. The hydrology from October 2004 through December 2011 is based on a water balance methodology and accounts for seepage loss based on CRMWA records. Hydrology from January 2012 to December 2017 is based directly on CRMWA estimates of inflow, which include adjustments for seepage.

e) ***Operating Range*** **–** While Lake Meredith has a substantial potential storage capacity, a minimum elevation and a maximum conservation capacity constrain the usable portion of the reservoir to a smaller volume. According to CRMWA's website, the lake's inactive pool elevation is 2,860 ft above mean sea level (ft-msl). Therefore, the model was constrained not to fall below this level during firm and safe yield estimation. Note that the 2003 TWDB Report of the 1995 volumetric survey states that the lowest gate outlet invert elevation is at elevation 2,850 ft-msl. If this additional 10 feet of storage volume becomes accessible, yield could be increased by around 10%. The maximum conservation volume is constrained by the interstate Canadian River Compact, which limits the right of Texas to retain water in conservation storage within Lake Meredith to 500,000 ac-ft. While the initial permitted conservation pool elevation of the reservoir (2,936.5 ft-msl) corresponds to a volume in excess of 800,000 ac-ft, all but 500,000 ac-ft is for sedimentation and inactive storage. The model assumes the usable portion of the reservoir is the first 500,000 ac-ft above the inactive pool. The volumes corresponding to 500,000 ac-ft of conservation storage plus the inactive pool are listed in **Table B-1**.

f) ***Upstream Reservoir Impacts*** **–** Ute reservoir in New Mexico is located on the Canadian River upstream of Lake Meredith and could conceivably impact inflows to Lake Meredith. The hydrology used in the model from 1940 through September 2004 was extracted from the PWPA 2006 WAM, which includes full permitted diversions from Ute Reservoir. Flows at the USGS stream gage at Logan, New Mexico downstream of Ute Reservoir typically show very low flows. Between 2001 and 2016, there was only one significant spill from Ute Reservoir, which does not appear to have had substantial impact on Lake Meredith. In 2017, a larger spill from Ute contributed to an increase of several feet in Lake Meredith. This spill is included in the estimate of inflow to Lake Meredith. This approach is consistent with the approaches taken in the PWPA 2006 WAM and the extension for the 2021 Regional Plan.

g) ***Starting Volume*** **–** The Excel-based reservoir model used for this study was set to a starting volume equal to the maximum allowable storage of 500,000 ac-ft above the inactive pool. This was done to maintain consistency with the approach taken with the TCEQ WAM, which assumes that reservoirs are full at the beginning of the simulation.

Palo Duro Operations Model

Like the Lake Meredith model, the Palo Duro Operations model is an Excel-based simulation of the reservoir using historical data. Development of the model was motivated by on-going drought conditions in the PWPA that are not reflected in the TCEQ Canadian WAM. It is also motivated by low water levels since the reservoir was completed in 1991. These low water levels appear to be the result of leakage from the reservoir into surrounding geologic formations. These losses are not reflected in the TCEQ WAM. There has been little to no water use from the reservoir since it was built.

The model incorporates hydrologic data such as inflow, net evaporation, water demands, reservoir configuration, and other parameters to perform a monthly water balance on a single reservoir over a certain historical period. There are no downstream water rights in Texas so priority releases are not required. Leakage was determined by manually fitting loss by water surface elevation until the modeled elevation trace was a reasonable match to the historical elevation records. This enables estimation of firm and safe yields for the reservoir for Regional Planning purposes.

Input parameters were obtained from the PWPA 2006 WAM, USGS gage data, and TWDB evaporation and precipitation data. Specific sources include:

a) **Inflows –** Inflows (runoff) into Palo Duro Reservoir from January 1940 through September 1999 were obtained from the PWPA 2006 WAM. Flows from October 1999 through December 2022 are derived from historical flows measured at the Palo Duro Creek near Spearman gage (USGS 07233500) multiplied by the ratio of the drainage area of the gage to the drainage area of the reservoir. The gage is located upstream of the reservoir.
b) **Net Reservoir Evaporation –** Net reservoir evaporation was calculated using distance weighted average derived from TWDB evaporation and precipitation data for quadrangles 106, 107, 206 and 207. Effective runoff was calculated using historical unit runoff (measured runoff divided by drainage area) from the Spearman gage.
c) **Area-Capacity-Elevation Data –** The volumetric properties of the reservoir were derived from the original area-capacity-elevation data for the reservoir assuming a sedimentation rate of 0.20 acre-feet per square mile.
d) **Leakage –** Leakage rates were determined by manually adjusting a loss curve until the reservoir elevation in the model had a reasonable match with historical elevations measured at the reservoir from July 1999 through December 2022. The loss rates varied from 5,000 acre-feet per month at higher elevations to 0 acre-feet per month in lower elevations, with an average of 1,300 acre-feet per month.
e) **Operating Range –** Storage in the reservoir is limited to the assumed conservation storage at elevation 2,892 feet, which is 54,422 acre-feet at assumed 2060 conditions. Other storage volumes were not examined because the yield of the reservoir is close to zero.
f) **Upstream Impacts –** There are no reservoirs upstream and very few water rights.
g) **Starting Volume –** the reservoir is assumed to be full at the beginning of the simulation period (January 1940).

Groundwater

Written Summary of Modeled Available Groundwater (MAGs)

The MAGs for this planning cycle came from two GAM run summary documents as follows: 1) GAM RUN 21-007 MAG (GR 21-007), which summarizes the MAG volumes for all aquifers within GMA-1, and 2) GAM RUN 21-001, which summarizes the MAG volumes for all aquifers in GMA-6 (**Table B-4**).

GR 21-007 summarizes MAGS for the Ogallala, Rita Blanca, and Dockum Aquifers using the High Plains Aquifer System (HPAS) GAM. The Ogallala MAG volume for GMA-1 ranges from 3,156,169 acre-feet per year in 2030 to 1,998,736 acre-feet per year in 2080, which includes the volume from the Rita Blanca Aquifer where present. For the Dockum Aquifer, the volumes range from 327,077 acre-feet per year in 2030 to 242,020 acre-feet per year in 2080. The Blaine Aquifer in Wheeler County was designated to be non-relevant in the last cycle of Joint Groundwater Planning.

GR 21-011 summarizes the MAG volumes for the Seymour, Blaine, Ogallala, and Dockum Aquifers in GMA-6. The Ogallala Aquifer in Collingsworth County was designated as non-relevant by GMA-6. The only other counties in GMA-6 with Ogallala MAG volumes (Dickens and Motley) are not located within the PWPA. Therefore, there are no Ogallala MAG volumes in GR 21-011 for the PWPA. This is also true for the Dockum Aquifer.

The Seymour and Blaine Aquifers are only relevant within Childress, Collingsworth and Hall Counties. In these three counties, Seymour Aquifer MAG volumes range from 51,488 acre-feet per year in 2030 to 53,052 acre-feet per year in 2080, and the Blaine Aquifer MAG volume is 31,404 for all years between 2030 and 2080.

Table B-4: GAM Models Used in Determining Ground Water Availability

GAM Version	Date Results Published	Model Inputs/ Outputs Files Used	Comments
GR 21-007	February 23, 2023	HPAS GAM (2015) and files submitted with the explanatory report	GMA-1
GR 21-011	November 14, 2022	-Seymour Aquifer refined model (2014) Pod 7 only. -Seymour and Blaine Aquifers GAM (2004) except for Pod 7.	GMA-6 Ogallala and Dockum MAG volumes are non-applicable to Region A.

Documented Methodologies Utilized for Non-MAGs Availabilities

Non-MAG availabilities are applicable to both those portions of aquifers designated as non-relevant and those portions of aquifers that are either undifferentiated or designated as "other." For this planning cycle, these non-MAG availabilities are listed in **Table B-5**. The methodology used to determine the availability for the Whitehorse/Quartermaster formation is included in **Attachment B-3**. For the non-relevant aquifers in Collinsworth and Wheeler Counties, historical use was used. There is little reported historical use from the Ogallala in Collingsworth County, but the aquifer does extend into this county. A small amount of supply was assumed for this non-relevant portion of the Ogallala.

Table B-5: Summary of Non-MAG Availability Volumes, in Acre-feet per Year

County	Aquifer	Availability (ac ft/yr)	Method
Armstrong	Whitehorse/ Quartermaster	370	See **Attachment B-2**
Childress		233	
Collingsworth		309	
Donley		479	
Hall		1,086	
Wheeler		276	
Collingsworth	Ogallala[1]	50	No active wells, very small area
Wheeler	Blaine[2]	1,750	Historical pumping 2007-2016

1) Ogallala Aquifer in Collingsworth County designated as non-relevant for this planning cycle.
2) Blaine Aquifer in Wheeler County designated as non-relevant for this planning cycle.

Local Supplies

In the PWPA, local supplies are used for livestock demands. These supplies, which come from both groundwater and surface water, are based on historical use data provided by TWDB. Since the supplies are based on historical use data, the PWPA cannot verify that the supplies firm. **Table B-6** shows the local livestock supplies from surface water.

Table B-6: Local Surface Water Supplies

Livestock Local Supply						
County	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Armstrong	79	79	79	79	79	79
Carson	96	96	96	96	96	96
Childress	38	38	38	38	38	38
Collingsworth	18	18	18	18	18	18
Dallam	1,786	1,786	1,786	1,786	1,786	1,786
Donley	240	240	240	240	240	240
Gray	600	600	600	600	600	600
Hall	128	128	128	128	128	128
Hansford	1,958	1,958	1,958	1,958	1,958	1,958
Hartley	3,480	3,480	3,480	3,480	3,480	3,480
Hemphill	223	223	223	223	223	223
Hutchinson	164	164	164	164	164	164
Lipscomb	168	168	168	168	168	168
Moore	823	823	823	823	823	823
Ochiltree	443	443	443	443	443	443
Oldham	737	737	737	737	737	737
Potter	154	154	154	154	154	154
Randall	908	908	908	908	908	908
Roberts	66	66	66	66	66	66
Sherman	646	646	646	646	646	646
Wheeler	437	437	437	437	437	437
Total	**13,192**	**13,192**	**13,192**	**13,192**	**13,192**	**13,192**

ATTACHMENT B-1

HYDROLOGIC VARIANCE REQUEST AND APPROVAL

Region A
Panhandle Water
Planning Group

P.O. Box 9257, Amarillo, Texas 79105 | Phone: 806-372-3381 | Fax: 806-373-3268

July 18, 2023

Jeff Walker
Texas Water Development Board
1700 North Congress
Austin, Texas 78711-3231

RE: Hydrologic Variance Requests for Water Availability Determination of Current Surface Water Supplies in the Panhandle Region (Region A)

Dear Mr. Walker,

Surface water supplies in the Panhandle Water Planning Area (Region A) are obtained from the upper Red River Basin and the Canadian River Basin. The major surface water supplies in Region A are Lake Meredith and Palo Duro Reservoir in the Canadian River Basin and Greenbelt Reservoir in the Red River Basin.

In accordance with regional planning rules and guidelines, surface water supplies must be determined using the latest version of the TCEQ Water Availability Models (WAMs) with full authorization unless a hydrologic variance is granted by the TWDB. Regional planning rules also require the use and reporting of the firm yield for all surface water reservoirs. Changes to reservoir volumes due to sedimentation do not require a hydrologic variance request.

The TCEQ-approved WAMs for the Canadian and Red River Basins, with modifications, have been used for determining the available surface water supplies for the region for previously developed water plans. The period of record for the hydrology for the TCEQ-approved Canadian WAM is 1948 to 1998. Previous modifications by Region A have included the extension of hydrology for the Canadian WAM from 1998 to 2004 and extension of hydrology for Lake Meredith through 2017. The Red River WAM was recently updated with hydrology through 2018.

The updated Red River WAM and extended hydrology for Lake Meredith are sufficient to assess water supplies for sources in the Red River Basin and Lake Meredith. However, there has been no specific hydrology updates conducted for Palo Duro Reservoir in the Canadian River Basin. Therefore, the Panhandle Water Planning Group (PWPG) respectfully requests extending the hydrology for Palo Duro Reservoir and the additional hydrologic variance requests as discussed below. As

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intended by Senate Bill 1, the assessment of surface water availability in Region A will be conducted to accurately reflect water supplies that are available for use.

Safe Yield

Region A requests the use of safe yield for the allocation and distribution of surface water supplies from reservoirs within the region. Safe yield is the amount of water that can be used during the critical drought while leaving a minimum one- year supply in reserve. Safe yield is consistent with the current operations of surface water in the region and previous regional water planning. In accordance with the TWDB planning rules, firm yields will also be determined and reported in the plan.

Canadian River Basin
Water supplies from Lake Meredith will be assessed using the extended hydrology through 2017 that was approved for the 2021 Panhandle Water Plan. The hydrology for the Palo Duro Reservoir will be extended through the most recently available data (2022), and the run-of-river water rights will be assessed using the Canadian WAM with the extended hydrology through 2004.

Red River Basin
No changes are proposed.

The hydrologic variance request forms are included in Attachment A. Please contact Simone Kiel of Freese and Nichols at 817-735-7446 if you have any questions regarding our request.

Sincerely,

Ben Weinheimer

Ben Weinheimer
Chairman, Region A - Panhandle water Planning Group

CC: Michelle Foss, TWDB
Jarian Fred, PRPC
Simone Kiel, Freese and Nichols, Inc.

ATTACHMENT A
HYDROLOGIC VARIANCE REQUEST FORMS

PANHANDLE WATER PLANNING AREA (REGION A)

Surface Water Hydrologic Variance Request Checklist

Texas Water Development Board (TWDB) rules[1] require that regional water planning groups (RWPG) use most current Water Availability Models (WAM) from the Texas Commission on Environmental Quality (TCEQ) and assume full utilization of existing water rights and no return flows for surface water supply analysis. Additionally, evaluation of existing stored surface water available during Drought of Record conditions must be based on Firm Yield using anticipated sedimentation rates. However, the TWDB rules also allow, and **we encourage**, RWPGs to use more representative, water availability modeling assumptions; better site-specific information; or justified operational procedures other than Firm Yield with written approval (via a Hydrologic Variance) from the Executive Administrator in order to better represent and therefore prepare for expected drought conditions.

RWPGs must use this checklist, which is intended to save time and reduce effort, to request a Hydrologic Variance for estimating the availability of surface water sources. For Questions 4 – 10, please indicate whether the requested variance is for determining Existing Supply, Strategy Supply, or both. Please complete a separate checklist for each river basin in which variances are being requested.

Water Planning Region: A

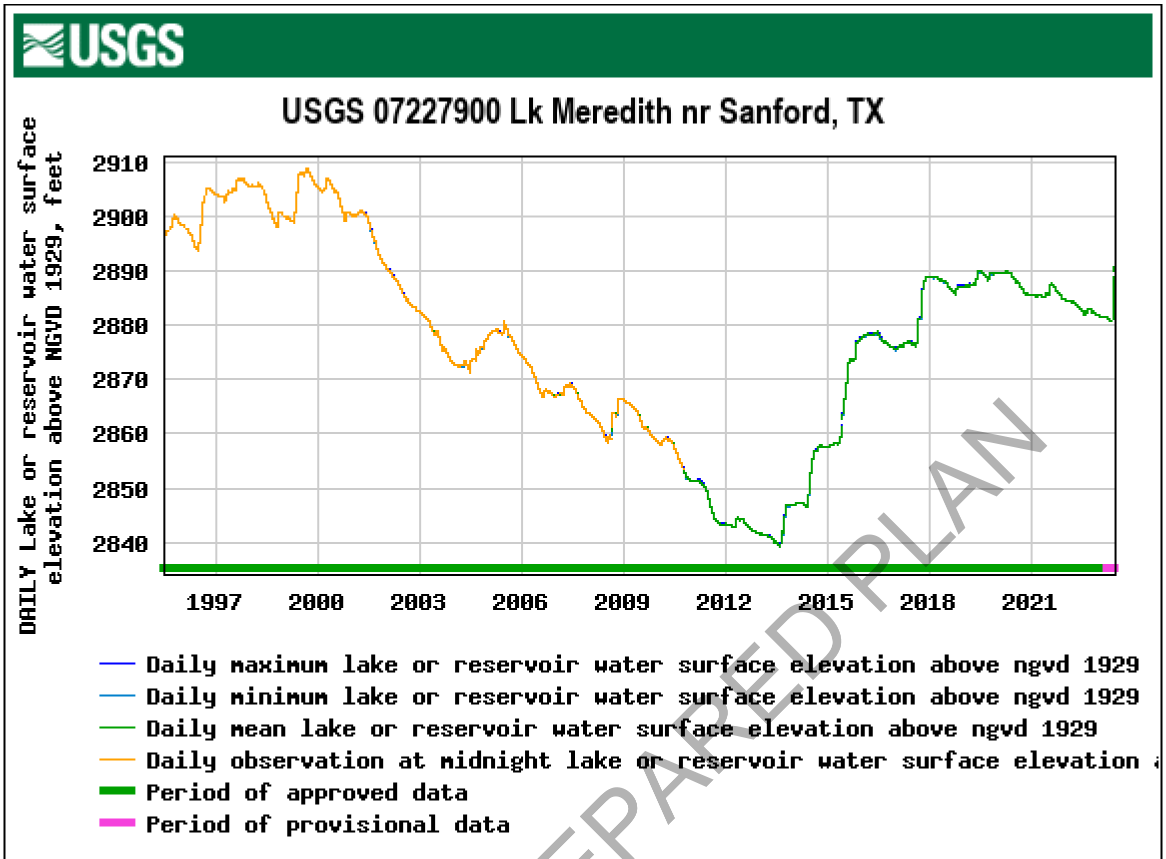
1. Which major river basin does the request apply to? Please specify if the request only applies part of the basin or only to certain reservoirs.

   Canadian River Basin. Lake Meredith, Palo Duro Reservoir, and Run-of-River.

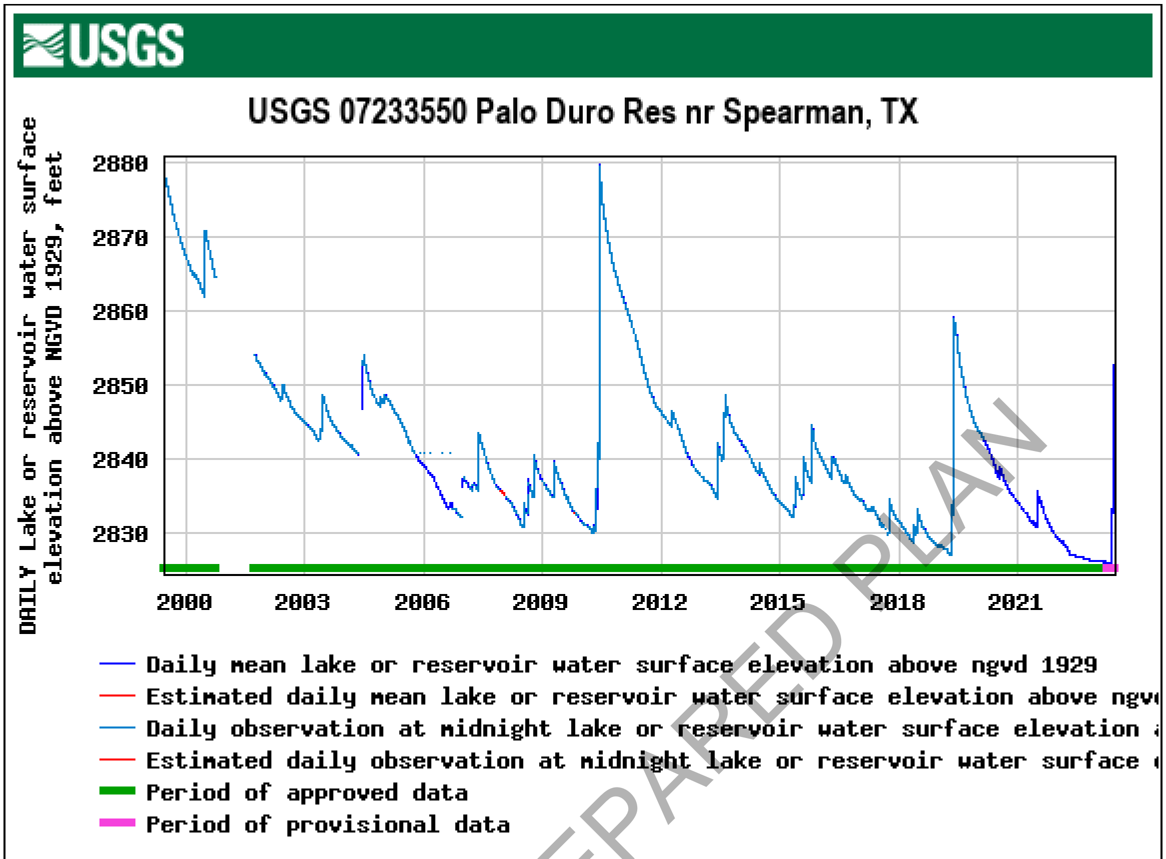
2. Please give a brief, bulleted, description of the requested hydrologic variances including how the alternative availability assumptions vary from rule requirements, how the modifications will affect the associated annual availability volume(s) in the regional water plan, and why the variance is necessary or provides a better basis for planning. You must provide more-detailed descriptions in the subsequent checklist questions. Attach any available documentation supporting the request.

   - Lake Meredith's request is the same as was approved for the fifth cycle of planning. Water supplies from Lake Meredith will be assessed using the extend hydrology through 2017 to capture the impact of continued low flows through 2016. As can be seen in the graph below, Lake Meredith has not reached similar low elevations since the hydrology was previously extended during the last planning cycle and an extension will not change the yield.

[1] 31 Texas Administrative Code (TAC) §§ 357.10(14) and 357.32(c)



- Region A requests to extend the hydrology for Palo Duro Reservoir through the most recently available data (2022). Last round Palo Duro Reservoir was assessed using the Canadian WAM with the extended hydrology through 2004. As can be seen below, Palo Duro Reservoir has experienced lower elevations since 2004.



- The Canadian River Basin Run-of-River for Region A's request is to use the same approved methodology as last round. Which includes assessment using the Canadian WAM with the extended hydrology through 2004.
- Safe yield – We request the use of safe yield for the reservoirs in Region A. Safe yield is consistent with the current operations of surface water in the region and previous regional water planning.

3. Was this request submitted in a previous planning cycle? If yes, please indicate which cycle and note how it is different, if at all, from the previous request?

Yes

Lake Meredith request remains the same as the previous planning cycle.

Run-of-River request remains the same as the previous planning cycle.

Palo Duro Reservoir request is new this cycle and hydrology is requested to be extended through the most recently available data (2022). Last cycle Palo Duro Reservoir was assessed using the Canadian WAM with hydrology through 2004.

4. Are you requesting to extend the period of record beyond the current applicable WAM hydrologic period? If yes, please describe the proposed methodology. Indicate whether you believe there is a new drought of record in the basin.

   Yes

   Existing Supply

   See response to #2 above for Palo Duro Reservoir. Hydrology will be extended using a mass balance method. There has been a new drought of record since 2004, which is the last year of available hydrology for the Canadian Basin.

5. Are you requesting to use a reservoir safe yield? If yes, please describe in detail how the safe yield would be calculated and defined, which reservoir(s) it would apply to, and why the modification is needed or preferrable for drought planning purposes.

   Yes

   Existing Supply

   Safe yield is the amount of water that can be used during the critical drought while leaving a minimum one-year supply in reserve. Safe yield is consistent with current operations of surface water in the region and previous regional water planning. This safe yield calculation would apply to Lake Meredith and Palo Duro Reservoir in the Canadian River Basin.

6. Are you requesting to use a reservoir yield other than firm yield or safe yield? If yes, please describe, in a bulleted list, each modification requested including how the alternative yield was calculated, which reservoir(s) it applies to, and why the modification is needed or preferrable for drought planning purposes. Examples of alternative reservoir yield analyses may include using an alternative reservoir level, conditional reliability, or other special reservoir operations.

   No

   Choose an item.

   Click or tap here to enter text.

7. Are you requesting to use a different model (such as a RiverWare or Excel-based models) than RUN 3 of the applicable TCEQ WAM? If yes, please describe the model being considered including how it incorporates water rights and prior appropriation and how it is more conservative than RUN 3 of the applicable TCEQ WAM.

   Yes

Existing Supply

We are requesting the use of an Excel spreadsheet model to calculate the reservoir yields for Lake Meredith and Palo Duro Reservoir. This model utilizes the hydrology through 2004 from the Canadian River WAM Run 3 that respects water right priorities. The hydrology extension is limited to only reservoir yield evaluations and is more conservative than WAM Run 3 because these models will capture new droughts of record that result in lower reliable supply.

8. Are you requesting to use a modified TCEQ WAM? If yes, please describe in a bulleted list all modifications in detail including all specific changes to the WAM and whether the modified WAM is more conservative than the TCEQ WAM RUN 3. Examples of WAM modifications may include adding subordination agreements, contracts, updated water rights, modified spring flows, updated lake evaporation, updated sedimentation[2], system or reservoir operations, or special operational procedures into the WAM.

   No

   Choose an item.

   Click or tap here to enter text.

9. Are you requesting to include return flows in the modeling? If yes, are you doing so to model an indirect reuse water management strategy (WMS)? Please provide complete details regarding the proposed methodology for determining reuse WMS availability.

   No

   Choose an item.

   Click or tap here to enter text.

10. Are any of the requested Hydrologic Variances also planned to be used by another region for the same basin? If yes, please indicate the other Region. Please indicate if unknown.

   No

   Click or tap here to enter text.

11. Please describe any other variance requests not captured on this checklist or add any other information regarding the variance requests on this checklist.

[2] Updating anticipated sedimentation rates does not require a hydrologic variance under 31 TAC § 357.10(14). The Technical Memorandum will require providing details regarding the sedimentation methodology utilized. Please consider providing that information with this request.

Click or tap here to enter text.

Surface Water Hydrologic Variance Request Checklist

Texas Water Development Board (TWDB) rules[1] require that regional water planning groups (RWPG) use most current Water Availability Models (WAM) from the Texas Commission on Environmental Quality (TCEQ) and assume full utilization of existing water rights and no return flows for surface water supply analysis. Additionally, evaluation of existing stored surface water available during Drought of Record conditions must be based on Firm Yield using anticipated sedimentation rates. However, the TWDB rules also allow, and **we encourage**, RWPGs to use more representative, water availability modeling assumptions; better site-specific information; or justified operational procedures other than Firm Yield with written approval (via a Hydrologic Variance) from the Executive Administrator in order to better represent and therefore prepare for expected drought conditions.

RWPGs must use this checklist, which is intended to save time and reduce effort, to request a Hydrologic Variance for estimating the availability of surface water sources. For Questions 4 – 10, please indicate whether the requested variance is for determining Existing Supply, Strategy Supply, or both. Please complete a separate checklist for each river basin in which variances are being requested.

Water Planning Region: A

1. Which major river basin does the request apply to? Please specify if the request only applies part of the basin or only to certain reservoirs.

   Red River Basin. Greenbelt Lake.

2. Please give a brief, bulleted, description of the requested hydrologic variances including how the alternative availability assumptions vary from rule requirements, how the modifications will affect the associated annual availability volume(s) in the regional water plan, and why the variance is necessary or provides a better basis for planning. You must provide more-detailed descriptions in the subsequent checklist questions. Attach any available documentation supporting the request.

   - Safe yield – The use of safe yield will decrease the available volumes. Safe yield is consistent with the current operations of surface water in the region and previous regional water planning.

3. Was this request submitted in a previous planning cycle? If yes, please indicate which cycle and note how it is different, if at all, from the previous request?

   Yes

   Safe yield was also requested in the fifth cycle. This request for safe yield is not different.

[1] 31 Texas Administrative Code (TAC) §§ 357.10(14) and 357.32(c)

4. Are you requesting to extend the period of record beyond the current applicable WAM hydrologic period? If yes, please describe the proposed methodology. Indicate whether you believe there is a new drought of record in the basin.

   No

   Choose an item.

   Click or tap here to enter text.

5. Are you requesting to use a reservoir safe yield? If yes, please describe in detail how the safe yield would be calculated and defined, which reservoir(s) it would apply to, and why the modification is needed or preferrable for drought planning purposes.

   Yes

   Existing Supply

   Safe yield is the amount of water that can be used during the critical drought while leaving a minimum one-year supply in reserve. Safe yield is consistent with current operations of surface water in the region and previous regional water planning. This safe yield calculation would apply to Greenbelt Lake in the Red River Basin.

6. Are you requesting to use a reservoir yield other than firm yield or safe yield? If yes, please describe, in a bulleted list, each modification requested including how the alternative yield was calculated, which reservoir(s) it applies to, and why the modification is needed or preferrable for drought planning purposes. Examples of alternative reservoir yield analyses may include using an alternative reservoir level, conditional reliability, or other special reservoir operations.

   No

   Choose an item.

   Click or tap here to enter text.

7. Are you requesting to use a different model (such as a RiverWare or Excel-based models) than RUN 3 of the applicable TCEQ WAM? If yes, please describe the model being considered including how it incorporates water rights and prior appropriation and how it is more conservative than RUN 3 of the applicable TCEQ WAM.

   No

   Choose an item.

   Click or tap here to enter text.

8. Are you requesting to use a modified TCEQ WAM? If yes, please describe in a bulleted list all modifications in detail including all specific changes to the WAM and whether the modified WAM is more conservative than the TCEQ WAM RUN 3. Examples of WAM modifications may include adding subordination agreements, contracts, updated water rights, modified spring flows, updated lake evaporation, updated sedimentation[2], system or reservoir operations, or special operational procedures into the WAM.

   No

   Choose an item.

   Click or tap here to enter text.

9. Are you requesting to include return flows in the modeling? If yes, are you doing so to model an indirect reuse water management strategy (WMS)? Please provide complete details regarding the proposed methodology for determining reuse WMS availability.

   No

   Choose an item.

   Click or tap here to enter text.

10. Are any of the requested Hydrologic Variances also planned to be used by another region for the same basin? If yes, please indicate the other Region. Please indicate if unknown.

    Unknown

    Click or tap here to enter text.

11. Please describe any other variance requests not captured on this checklist or add any other information regarding the variance requests on this checklist.

    Click or tap here to enter text.

[2] Updating anticipated sedimentation rates does not require a hydrologic variance under 31 TAC § 357.10(14). The Technical Memorandum will require providing details regarding the sedimentation methodology utilized. Please consider providing that information with this request.

Texas Water Development Board

P.O. Box 13231, 1700 N. Congress Ave.
Austin, TX 78711-3231, www.twdb.texas.gov
Phone (512) 463-7847, Fax (512) 475-2053

December 11, 2023

Mr. Ben Weinheimer
Chair
Region A Regional Water Planning Group
c/o Panhandle Regional Planning Commission
PO Box 9257
Amarillo, TX 79105

Dear Chairman Weinheimer:

I have reviewed your request dated July 18, 2023, for approval of alternative water supply assumptions to be used in determining existing surface water availability. This letter confirms that the TWDB approves the following assumptions:

1. Use extended hydrology through 2017 for Lake Meredith to assess existing supply.
2. Use extended hydrology through 2022 for Palo Duro Reservoir to assess existing supply.
3. Use the Canadian WAM with hydrology extended through 2004 for the assessment of run-of-river existing supply.
4. Use of a one-year safe yield for the allocation and distribution of surface water supplies from Lake Meredith and Palo Duro Reservoir in the Canadian River Basin.
5. Use an Excel spreadsheet model to calculate the reservoir yields for Lake Meredith and Palo Duro Reservoir.
6. Use safe yield for determining existing supply from Greenbelt Reservoir in the Red River Basin.

The TWDB has developed alternative auxiliary extended naturalized flows and reservoir evaporation data for certain river basins, which are available for RWPG consideration and optional use. These data sets are currently available through 2021 and will soon be available through 2022 for the Canadian WAM on the following website: https://www.twdb.texas.gov/surfacewater/data/ExtendedNatFlow/index.asp. The region is also authorized to apply these data sets to extend the hydrology through 2022 for sources in the Canadian River Basin, should the region choose to do so.

Although the TWDB approves the use of a one-year safe yield for developing estimates of current water supplies, firm yield for each reservoir must still be reported to TWDB in the online planning database and plan documents. For the purpose of evaluating potentially feasible water management strategies, the TCEQ WAM Run 3 is to be used, unless a separate hydrologic variance for water management strategy availability is submitted and approved by the TWDB.

While the TWDB authorizes these modification to evaluate existing water supplies for development of the 2026 Region A RWP, it is the responsibility of the RWPG to ensure that the resulting estimates of water availability are reasonable for drought planning purposes and will reflect conditions expected in the event of actual drought conditions; and in all other regards will be evaluated in accordance with the most recent version of regional water planning contract Exhibit C, *General Guidelines for Development of the 2026 Regional Water Plans.*

If you have any questions, please do not hesitate to contact Michele Foss of our Regional Water Planning staff at 512-463-9225 or michele.foss@twdb.texas.gov if you have any questions.

Sincerely,

Jeff Walker
Executive Administrator

c: Alex Guerrero, Panhandle Regional Planning Commission
Jarian Fred, Panhandle Regional Planning Commission
Kristal Williams, P.E., Freese and Nichols, Inc.
Simone Kiel, P.E., Freese and Nichols, Inc.
Michele Foss, Water Supply Planning
Nelun Fernando, Ph.D., Surface Water

ATTACHMENT B-2

METHODOLOGY FOR THE WHITEHORSE/QUARTERMASTER FORMATION

Methodology for Other Aquifer Groundwater Availability: Region A

The estimate of recoverable volume for the Whitehorse and Quartermaster formations ("other aquifers") for Region A was calculated using TWDB Driller's Log averages for each county/formation and GIS coverage areas from the Geological Atlas of Texas outcrops for each of the counties/areas. Specifically, average well depth from recent driller's logs (2003-2013) was subtracted from the average water level that was measured at time of drilling to get an estimated saturated thickness for each county and zone (**Figure 1**). The cleaved surface area was then multiplied by the estimated saturated thickness and a Specific Yield of 0.0025 (0.25%) to get the estimated recoverable volume of water in storage (**Table 1**). **Table 2** shows the total volume of water available per year over a period of 100 years. 100 years was the time period chosen to provide the estimate of yearly availability due to the fact that these are shallow outcrop aquifers, which in our estimation, fully recharge every 100 years.

Figure 1: Outcrops of Whitehorse and Quartermaster formations and zone delineations for recoverable volume calculations for "Other" aquifers, Region A

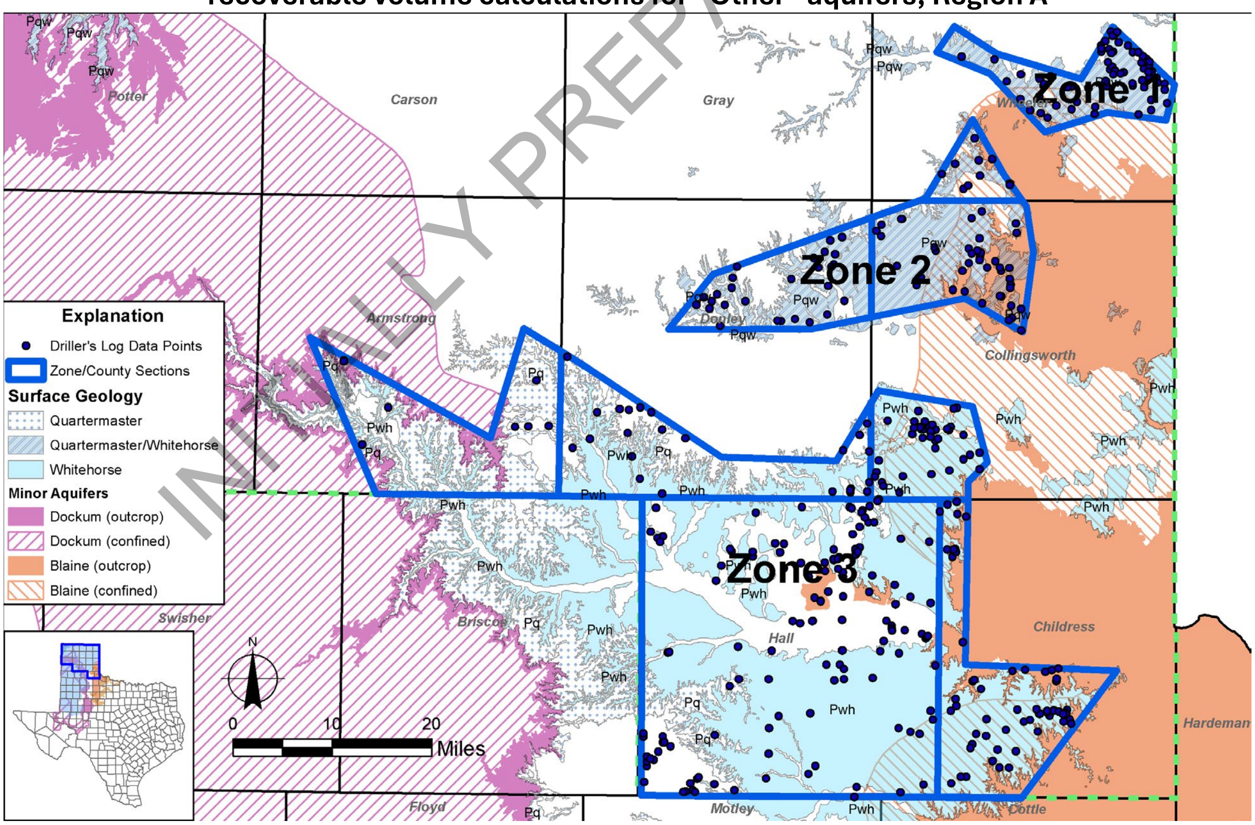


Table 1: Calculations by County and Zone

County	Zone	Average Depth (ft)	Average Water Level (ft)	Area (acres)	Estimated Saturated Thickness (ft)	Estimated Recoverable Volume (ac ft)
Armstrong	3	186	88	151,691	97	36,958
Childress	3	123	57	140,954	66	23,335
Collingsworth	2	155	81	109,997	74	20,345
Collingsworth	3	102	41	69,496	61	10,604
Donley	2	156	75	90,776	81	18,398
Donley	3	166	83	142,307	83	29,519
Hall	3	126	50	573,300	76	108,555
Wheeler	1	163	35	72,773	128	23,253
Wheeler	2	119	49	25,214	70	4,386

Table 2: Total Calculated Volume Available Per Year Over 100 Years

County	Availability (ac ft/yr) over 100 years
Armstrong	370
Childress	233
Collingsworth	309
Donley	479
Hall	1,086
Wheeler	276

APPENDIX C

AGRICULTURAL WATER MANAGEMENT STRATEGIES

2026 Panhandle Regional Water Plan Task 5 Report:
Agricultural Water Management Strategies

Steve Amosson and Bridget Guerrero[1]

Irrigation was estimated to account for 90% of the water demands in the Panhandle Water Planning Area (PWPA) in 2020. A total of 10 counties, Armstrong, Collingsworth, Dallam, Hall, Hartley, Hutchinson, Moore, Oldham, Randall, and Sherman are projected to have irrigation needs in the future. These counties are projected to reach a total need of 427,490 acre-feet (ac-ft) per year in 2030, increasing to 552,891 ac-ft per year in 2040 and are estimated to remain above 2030 needs levels (456,156 ac-ft per year) in 2080. Given the limited renewability of aquifers in the area, there is no readily available water supply in or near the high demand irrigation counties that could be developed to fully meet these needs. Therefore, water management strategies for reducing irrigation demands for all 21 counties in the PWPA were examined. A more detailed analysis of strategies focusses on the 10 counties, which are the counties in the region projected as having irrigation water demands that cannot be met with existing supplies. Table 1 shows the projected irrigation needs for the PWPA.

Table 1: Projected Irrigation Needs in the PWPA (acre-feet per year), 2030-2080.

County	2030	2040	2050	2060	2070	2080
Armstrong	0	0	(196)	(726)	(1,334)	(1,855)
Collingsworth	(16,131)	(19,039)	(18,908)	(18,515)	(18,538)	(19,069)
Dallam	(121,228)	(156,912)	(148,470)	(140,598)	(133,194)	(127,842)
Hall	(15,780)	(12,917)	(13,098)	(13,271)	(13,197)	(12,944)
Hartley	(172,558)	(229,447)	(216,085)	(204,225)	(193,294)	(183,960)
Hutchinson	0	0	0	0	0	(1,980)
Moore	(66,665)	(72,883)	(68,994)	(64,716)	(59,954)	(55,444)
Oldham	(319)	(319)	(319)	(319)	(319)	(592)
Randall	(317)	(2,299)	(4,380)	(6,103)	(7,845)	(9,353)
Sherman	(34,490)	(59,073)	(53,887)	(49,819)	(45,778)	(43,115)
Total	**(427,490)**	**(552,891)**	**(524,338)**	**(498,294)**	**(473,455)**	**(456,156)**

[1] Professor and Extension Economist Emeritus, Texas A&M AgriLife Research and Professor of Agricultural Business and Economics, West Texas A&M University.

Methodology

The Panhandle Water Planning Group Agriculture Committee (PWPG-AC) reviewed the agricultural water conservation strategies used in the prior regional water plan, as well as discussed strategies used in other regions, and identified nine strategies that were appropriate for implementing within the region for the 2026 plan. These agricultural water conservation strategies include irrigation scheduling, irrigation equipment changes, change in crop type, change in crop variety, conversion to dryland, soil management, irrigation deferral, advances in plant breeding, and enhanced education. In addition, the PWPG-AC identified three combinations of the previously mentioned strategies that may be employed specifically in irrigation-deficit counties. The combinations of strategies were: 1) change in crop type, irrigation equipment changes, and irrigation scheduling; 2) change in crop variety, irrigation equipment changes, and irrigation scheduling; and 3) change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education. Water savings and implementation costs were estimated for each proposed water management strategy evaluated in the planning effort and are described in the forthcoming sections.

Producer surveys (2016-2024) conducted as a part of the North Plains Groundwater Conservation District (NPGCD) Master Irrigator training that included more than 530,000 irrigated acres were invaluable in estimating baseline values for irrigation scheduling, irrigation systems, and soil management strategies. This intensive four-day training focuses on providing irrigated producers with tools and information to increase their water use efficiency and/or reduce water use. Future adoption rates of conservation strategies from 2030 to 2080 were identified under the guidance of the PWPG-AC, Table 2. The water savings and direct cost of all strategies were evaluated over a 50-year planning horizon. Implementation costs were defined as the costs that would be borne by producers and/or the government associated with employing a strategy. All costs were evaluated in 2023 dollars. A more detailed description of the method utilized for each strategy follows.

Several of the strategies identified for evaluation were crop specific including changes in crop variety, changes in crop type, and advances in plant breeding. Therefore, it was imperative to identify the irrigated crop acreage distribution by county. A five-year average (2019–2023) of Farm Service Agency (FSA) irrigated acreage for the region was used to establish a baseline from which effectiveness of alternative conservation strategies were measured. Baseline acreage estimates were adjusted to account for irrigated acreage by known producers who choose not to report to FSA. Irrigated acreage and water availability were assumed to remain constant in measuring the impact of the various water conservation strategies.

Table 2: Estimated Potential Water Savings, Future Adoption Percentage of Water Conservation Strategies and Strategy Implementation Costs, 2030-2080.

<table>
<tr><th>Water Management Strategy</th><th colspan="2">Annual Regional Water Savings (% of irrigation or ac-in/ac/yr)</th><th>Assumed Baseline Use 2023</th><th>Goal for Adoption 2030</th><th>Goal for Adoption 2040</th><th>Goal for Adoption 2050</th><th>Goal for Adoption 2060</th><th>Goal for Adoption 2070</th><th>Goal for Adoption 2080</th><th>Cost</th><th>Cost Frequency</th></tr>
<tr><td>Irrigation Scheduling</td><td colspan="2">10%</td><td>65.6%</td><td>70.0%</td><td>75.0%</td><td>80.0%</td><td>85.0%</td><td>90.0%</td><td>93.0%</td><td>$15.00</td><td>Annual</td></tr>
<tr><td>Irrigation Equipment Changes</td><td colspan="2">MESA or LESA to LEPA 9.15%</td><td>33.4%</td><td>40.0%</td><td>50.0%</td><td>60.0%</td><td>70.0%</td><td>80.0%</td><td>90.0%</td><td>$151.25</td><td>One-time</td></tr>
<tr><td>Change in Crop Type</td><td colspan="2">10</td><td>0.0%</td><td>5.0%</td><td>10.0%</td><td>15.0%</td><td>20.0%</td><td>25.0%</td><td>30.0%</td><td>$111.25</td><td>Annual</td></tr>
<tr><td rowspan="2">Change in Crop Variety</td><td colspan="2">Corn 3.7</td><td rowspan="2">20.0%</td><td rowspan="2">25.0%</td><td rowspan="2">30.0%</td><td rowspan="2">35.0%</td><td rowspan="2">40.0%</td><td rowspan="2">45.0%</td><td rowspan="2">50.0%</td><td>$98.01</td><td>Annual</td></tr>
<tr><td colspan="2">Sorghum 6.2</td><td>$80.97</td><td>Annual</td></tr>
<tr><td>Conversion to Dryland</td><td colspan="2">16.0</td><td>0.0%</td><td>2.0%</td><td>4.0%</td><td>6.0%</td><td>8.0%</td><td>10.0%</td><td>12.0%</td><td>$1,835.00</td><td>One-time</td></tr>
<tr><td>Soil Management</td><td colspan="2">1.75</td><td>83.4%</td><td>85.0%</td><td>86.5%</td><td>88.0%</td><td>89.5%</td><td>91.0%</td><td>92.5%</td><td>$ -</td><td>None</td></tr>
<tr><td>Irrigation Deferral</td><td colspan="2">16.0</td><td>0.0%</td><td>5.0%</td><td>5.0%</td><td>5.0%</td><td>5.0%</td><td>5.0%</td><td>5.0%</td><td>$130.00</td><td>Annual</td></tr>
<tr><td rowspan="2">Advances in Plant Breeding</td><td rowspan="2">Corn, Cotton, Soybean, Wheat, and Sorghum</td><td>Starting in 2030 5%</td><td rowspan="2">0.0%</td><td rowspan="2">50.0%</td><td rowspan="2">75.0%</td><td rowspan="2">85.0%</td><td rowspan="2">95.0%</td><td rowspan="2">95.0%</td><td rowspan="2">95.0%</td><td>$5.00</td><td rowspan="2">Annual</td></tr>
<tr><td>Starting in 2040 10%</td><td>$10.00</td></tr>
<tr><td>Enhanced Education</td><td colspan="2">5%</td><td>0.0%</td><td>10.0%</td><td>10.0%</td><td>10.0%</td><td>10.0%</td><td>10.0%</td><td>10.0%</td><td>$400,000.00</td><td>Annual</td></tr>
</table>

Description of Agricultural Conservation Strategies Including Baseline Values, Projected Adoption Rates and Implementation Costs

In this plan, the PWPG-AC identified nine potential agricultural water conservation strategies to be evaluated. These strategies include irrigation scheduling, irrigation equipment changes, change in crop type, change in crop variety, conversion to dryland, soil management, irrigation deferral, advances in plant breeding, and enhanced education. Two alternative strategies to resolve long-term or short-term issues are discussed. These alternative strategies are precipitation enhancement and drilling additional wells. Precipitation enhancement is considered a limited-use strategy since it cannot be implemented by an individual producer and little interest has been shown in implementing this strategy by groundwater districts in the region except for the Panhandle Groundwater Conservation District. Drilling additional wells, while not a conservation solution, can provide an option to relieve needs of individual producers where water is available. A description of each of these strategies is presented in the following sections.

Irrigation Scheduling

Irrigation scheduling refers to the process of allocating irrigation water according to crop requirements based on meteorological demands and field conditions. Proper and accurate irrigation scheduling to ensure the crop is not over or underwatered is critical to ensure profitable agricultural production and conservation of water resources. The prevalent soil-based irrigation scheduling method utilized in the region today employs soil moisture probes that estimate soil moisture at different depths to schedule irrigation. Irrigation scheduling based on crop evapotranspiration reported by ET networks in the region is also an important weather-based irrigation-scheduling method since this data references the climatic demand, which varies annually and can vary substantially within the season. Proper and accurate irrigation scheduling can save up to 2 to 3 ac-in of irrigation per year for corn. In this analysis, the water savings from this strategy were assumed to be 10% of the water applied for each crop seasonally.

The percentage of baseline irrigated acreage utilizing some form or degree of irrigation scheduling was set at 65.6% for the 2023 baseline given the results of the NPGCD Master Irrigator surveys. The PWPG-AC expects this rate to continue to increase steadily per decade, reaching an adoption level of 93.0% in 2080.

The cost of irrigation scheduling varies significantly depending on the level of service, equipment costs, and the area served. More money tends to be invested in irrigation scheduling of higher value crops. A range of $13.25 to $16.75 per acre for irrigation was identified based on discussions with industry representatives, depending on the level of service. An average cost of $15.00 per acre annually was assumed for irrigation scheduling.

Irrigation Equipment Changes

Current irrigation methods practiced in the Texas Panhandle are dominated by center pivot irrigation: Mid Elevation Spray Application (MESA), Low Elevation Spray Application (LESA), and Low Elevation Precision Application (LEPA). In addition, a small amount of subsurface drip irrigation (SDI) is used in the region. The average application efficiency of MESA, LESA, and LEPA is 78%, 85%, and 90%, respectively (Personal communication. Nicholas Kenny, NPK Ag). These application efficiencies are the percentage of irrigation water applied that is used by the crop with the remainder being lost to runoff, evaporation or deep percolation. Switching from low-efficiency irrigation systems such as MESA to more efficient irrigation systems such as LEPA improves the efficiency of irrigation system water use and can help conserve groundwater resources. Changing irrigation systems can be a costly strategy to conserve irrigation water, but that expense can be partially offset by the decrease in pumping cost. Establishing MESA, LESA, LEPA or SDI systems requires a major investment, however, with more than 99.0% of existing systems being center pivots retrofitting MESA and LESA to LEPA using conversion kits are comparatively less expensive. Thus, the water conservation strategy of changing irrigation equipment includes converting MESA and LESA to LEPA to improve application efficiency of existing center pivot systems. The regional water savings estimate in 2023 from this strategy is 9.15% of water applied per acre for conversion MESA/LESA to LEPA. This was estimated based on the average amount of water applied per irrigated acreage, the current percentage use of the various systems in the region, and the application efficiency of those systems (MESA and LESA vs, LEPA). It should be noted that water savings from this strategy would vary by county and over time as the amount of water pumped changes.

Results of the NPGCD Master Irrigator surveys indicate that 33.4% of the current irrigation systems are LEPA, 13.4% are MESA, and 53.1% are LESA with the remainder in SDI (0.1%). The PWPG-AG anticipates with appropriate incentives, the conversion of LESA or MESA center pivots to more efficient systems could increase, reaching 90.0% by 2080. Another system that is starting to appear in the region is Mobile Drip Irrigation (MDI) which would have an application efficiency somewhere between LEPA and SDI. Currently, an insignificant amount of acreage employs MDI, therefore, MDI was excluded from the analysis.

Since 97.8% of the high-efficiency irrigation systems are LEPA, the cost for implementing this strategy was assumed to be the cost of converting MESA or LESA systems to LEPA. The implementation cost of this strategy was estimated using the costs associated with the change in irrigation equipment required for each of the systems and their respective adoption rate. The cost of replacing an existing 125-acre system with 30-inch spacing was estimated at $216.07 per acre (personal communication, T-L Irrigation and Senninger Irrigation). This included replumbing, new hoses, heads, weights and labor. It was assumed the cost to retrofit a system with 60-inch spacing would be half the amount of 30-inch spacing ($108.04 per acre). Currently it is estimated that 60% of the systems have 60-inch spacing with the remainder on 30-inch spacing (personal communication, Senninger Irrigation). Therefore, the composite cost utilized in the analysis was $151.25 per acre, which included replacing heads, adding weights, and installation labor.

Change in Crop Type

Incorporation of crops with lower water requirements can be an effective water conservation strategy. Corn, cotton, wheat and grain sorghum are the four major crops in the Panhandle region accounting for about 90% of the total irrigated acreage. Corn has one of the highest water requirements of any irrigated crop grown in the Texas High Plains because of a longer growing season than most other spring crops, which can adversely affect yield in limited-moisture situations (Howell et al., 1996). The seasonal evaporative demand for corn is 28 to 32 inches, wheat is 26 to 28 inches, cotton is 13 to 27 inches, and grain sorghum is 13 to 24 inches. To date, the majority of water used for irrigation has been applied to high water-use crops such as corn. On the other hand, cotton, wheat and grain sorghum can tolerate lower moisture availability and are more suited to deficit irrigation practices.

A survey of 25 producers and crop consultants was conducted to determine/validate actual water use per acre of corn and cotton during the 2016 to 2018 time period. The survey indicated the application of 20.6 ac-in to corn and 9.9 ac-in to cotton per acre. A conservative average of 10 ac-in was utilized to estimate water savings for this strategy with increased implementation of cotton or limited irrigated sorghum or wheat production from current levels reaching 30% by 2080.

The cost of implementing this water conservation strategy was evaluated in terms of reduced land values as a result of reduced water availability. The annual cost was estimated as the difference between the rental rate for irrigated cropland ($211.25/acre) with good water availability that would be necessary for corn production and that of irrigated cropland with relatively weak water availability ($100.00/acre) capable of sustaining limited irrigated crops (ASFMRA, 2022; 2023). Therefore, $111.25 per acre was assumed to be the annual cost for implementation of this strategy.

Change in Crop Variety

Short-season varieties can have a lower evaporative demand when compared to long-season varieties. Short-season varieties of corn and grain sorghum are generally viewed to use less water than the conventional longer-season varieties due to their shorter maturity. Water savings may be enhanced by planting a short-season hybrid outside the normal production window, which can also help avoid high evaporative demand periods such as during the pollination period. Thus, converting from long-season to short-season varieties of corn and grain sorghum can be a useful water conservation strategy. However, typically short-season varieties result in lower yields that can decrease overall profitability.

The results of a panel of industry and university experts formed in the 2021 planning cycle were utilized as the basis for evaluating this strategy. The panel delineated both corn and sorghum into three maturity classes; full, medium, and short season, estimating yields and water use for each class, as well as the current percentage of each class being planted. Analysis of the estimates provided by the panel indicated that moving to short-season corn from full/mid-season varieties could save 3.7 ac-in per acre but would result in an estimated 18% yield loss. Changing to a short-season sorghum variety from full/mid-season varieties was estimated to save 6.2 ac-in but would result in a 32% yield reduction. It was estimated that 20% of both corn and sorghum acreage is currently planted in short-season varieties, reaching an adoption level of 50.0% by 2080.

The implementation cost was assumed to be the compensation needed to account for the loss in yield. A partial budget analysis was conducted using the 2019-2023 Texas A&M AgriLife Crop and Livestock Budgets for the region. The loss in revenue from the reduced yield using a five-year average price for the area versus the savings in seed cost, pumping cost, fertilizer and harvest expense were evaluated. Results of the partial budget analysis indicate a net loss to producers of $98.01 per acre for corn and $80.97 per acre for sorghum for transition to short-season varieties.

Conversion to Dryland

Conversion of irrigated cropland to a dryland cropping system is a potential strategy for conserving water resources in the region. In evaluating this strategy, it was assumed the annual water savings would be 16.0 ac-in per acre, which is the average water used by irrigated crops in the region. Since the conversion of irrigated acreage to dryland production is measured from the baseline acreage (2021-2023 average), the 2023 baseline adoption rate was assumed to be 0%. The PWPG-AC projected the adoption rate to be 2.0% per decade, reaching a total of 12.0% by 2080.

The cost of implementing this water conservation strategy was evaluated in terms of reduced land values and was estimated as the difference between the average land value across all water availability categories for irrigated. Land sales data reported from the American Society of Farm Managers & Rural Appraisers – Texas Chapter for the north panhandle region was utilized to make the analysis. They reported the volume of sales was relatively low during 2023, therefore the average of 2022 and 2023 sales was utilized in making calculations of the conversion costs. The range in prices of irrigated cropland per acre is reported for three classes of water availability: good \$3,000-\$7,000; average \$2,500-\$3,500; and weak \$1,500-\$2,500. The simple average (\$3,166) was used as the average land value for irrigated cropland in the region. The average land value of dryland crop production ranged from \$850 to \$1,200 per acre in the western parts of the region where there is less rainfall and from \$1,250 to \$2,000 in the eastern parts of the region, resulting in an overall average of \$1,331 per acre. Therefore, the implementation cost to retire an acre of irrigated land was \$1,835 (\$3,166-\$1,331). It should be noted that the amount of compensation required for this strategy would need to vary considerably depending on the water availability on a specific piece of land and the value of the dryland acreage in that part of the region. Also, implementing this strategy would be detrimental to the regional economy because of the reduced production and decrease in inputs used.

Soil Management

Effective soil management through the use of conservation tillage can increase the efficiency of both irrigation and rainfall events by increasing soil infiltration, reducing runoff, reducing evaporative loss, and conserving available moisture within the soil profile. Conservation tillage is defined as tillage practices that minimize soil and water loss by maintaining a surface residue cover of more than 30% on the soil surface. Conservation tillage is a term covering a wide range of tillage practices with the common characteristic of reduced soil and water loss. Different tillage practices such as minimum tillage, reduced tillage, no-till; ridge tillage, vertical tillage and strip tillage are often interchangeably used with the term conservation tillage. In this analysis after consultation with USDA and TAMU scientists familiar with the region, the water savings from adopting effective soil management strategies is assumed to be 1.75 ac-in per acre.

Results of the NPGCD Master Irrigator surveys indicate conservation tillage in some form (minimum till, strip till or no-till) is practiced on 83.4% of the irrigated land in the region. Even given the relatively high level of adoption, members of the PWPG-AG expect conservation tillage can increase in the future albeit at a slow rate. They project an initial decadal increase of approximately 1.5% slowing in later years of the planning horizon until 92.5% of all irrigated acreage practices some sort of conservation tillage.

The implementation cost of soil management strategy was estimated as the difference between the cost of conventional tillage and conservation tillage. In the Region A 2016 planning effort, a detailed partial budget analyzing the cost of conventional versus conservation tillage practices was conducted resulting in an estimated cost savings of \$2.59/acre in favor of conservation tillage. However, a cost study performed on North Central Farm Management Association records (1996–2004) indicates a cost savings of \$2.05 per acre for conventional/reduced till compared to no-till operations. The difference between these two studies is negligible and probably due to variances in input prices. Thus, the annualized cost difference between conventional and conservation tillage is assumed to be zero for this study. Epplin et al. (2005) appears to validate this assumption. Their analysis of Oklahoma wheat farms indicates a slight cost advantage to conventional tillage in small wheat farms (less than 700 acres) while there was a small cost advantage to no-till operations in large farms. While there is little to no difference in the annualized cost, it should be noted that the necessary chemical control costs and change in equipment such as the additional purchase of a strip tiller or no-till planter is a substantial investment which can impede the adoption process.

Irrigation Deferral

The irrigation deferral strategy involves a producer giving up their rights to irrigate for a specified period of time while receiving compensation for the loss in income. In this strategy, a producer would agree to give up his right to irrigate for a 5-year period and the producer would receive an annual payment as compensation. In evaluating this strategy, it was assumed the annual water savings would be 16.0 ac-in per acre, which is the average water used by irrigated crops in the region. Since this strategy has not been implemented yet, the baseline adoption rate used in the evaluation was 0%. The Ag subcommittee of PWPG decided that 5% of the irrigated acreage would participate in this strategy by 2030 and this level (5%) would be maintained through 2080.

The cost of implementing this strategy was assumed to be the difference in the cash rental rates of average irrigated land and dryland in the area. Cash rental rates reported from the American Society of Farm Managers & Rural Appraisers – Texas Chapter for the north panhandle region was utilized to make the analysis. The volume of cash rental rates reported is relatively small, therefore the average of 2022 and 2023 of rental rates was utilized to identify a more reliable estimate in making calculations of the compensation costs that would be required to entice producers to participate. The average irrigated rental rate reported for irrigated land was $161.25 per acre and the dryland averaged $31.25 per acre for the 2022/2023 time period resulting in an estimated compensation rate required of $130.00 per acre.

Advances in Plant Breeding

Biotechnology utilized in plant breeding increases crop productivity and enhances efficiency of production inputs such as irrigation. Previously, plant breeding efforts were mainly concentrated on hybridization and selection to produce improved planting materials like composite seeds and F1 hybrid seeds. The success stories in this era were hybrid corn and semi-dwarf varieties of wheat and rice that triggered the green revolution. The advances made in genetic engineering led to the plant biotechnology era, which began in the 1980s when transgenic plants were produced. Transgenic planting materials for several crops are commercially available now. The commercial varieties for several crops with genetically modified organisms (GMOs) are also widely in use. From a water conservation standpoint, varieties with higher water-use efficiency and enhanced drought tolerance can lead to substantial water savings. Thus, the adoption of drought tolerant varieties with high water-use efficiency can be a potential water conservation strategy. Drought-tolerant varieties for corn, cotton, soybeans, wheat and grain sorghum are expected to be released by 2030 and reduce water use by 5% followed by a second wave by 2040 that will decrease water use an additional 5% compared to current varieties. It should be noted that in the last two water plans the anticipated decrease was 15% by 2030 and an additional 15% by 2040, however, these new varieties have failed to occur, leading agricultural scientists to reduce their anticipated effectiveness in reducing water use.

The new drought tolerant varieties have yet to hit the market; therefore, the 2023 baseline adoption rate was assumed to be 0%. The adoption rate was projected to be 50% in the first decade of market deployment (2030) for all major crops; corn, soybeans, wheat and sorghum; and escalate to 95% by the end of the planning horizon, assuming new varieties are cost effective.

The implementation cost of this strategy was the additional cost of drought-tolerant seeds, estimated at $1.00 for every 1% reduction in water use. Therefore, it was assumed a 5% reduction in water use will cost $5.00 per acre and a 10% reduction will cost $10.00 per acre. Cost estimates were made after consultation with seed industry personnel and researchers working in the area. These costs were then multiplied by the annual total acreage for corn, cotton, sorghum, wheat and soybeans affected by the incorporation of this strategy.

Enhanced Education

The need for an enhanced education effort was identified as a strategy in the 2026 Region A plan. The purpose of this strategy was to develop and maintain an educational system for irrigators to accelerate the adoption of current /new management techniques/technology that can provide water savings, and/or improve water use efficiency while enhancing profitability. The cornerstone of the strategy would be the Master Irrigator training, a four-day program that addresses these issues developed and conducted by the North Plains Underground Water District. A three-year post survey of graduates found that 85.7% had improved their water use efficiency and 55.4% had reduced their water use based on what they had learned in the training.

In this strategy, the Master Irrigator training (once annually) would be rotated among areas of Region A and possibly Region O. In off years, these areas would have a one-day hands-on short course specifically related to a topic taught in the Master Irrigator program. In addition, a social media component will be included to link Master Irrigator graduates and other interested individuals. The purpose of the network would be to “back sell” programming efforts, as well as provide information on new ideas/concepts in water conservation.

It was assumed that 10.0% of the acreage would be impacted each decade resulting in an average of 5.0% water savings on that land. The life of the changes was assumed to be 10 years before other equipment/management changes would enhance water savings for producers. The cost to maintain the educational system was estimated at $400,000/year including $150,000 in operational cost and $250,000 in potential cost-share funds to encourage adoption of new/different irrigation equipment/management strategies that reduce water use while maintaining profitability.

Combination Strategies

The PWPG-AC identified three combinations of the previously mentioned strategies that may be employed specifically in irrigation-deficit counties. The combinations of strategies were: 1) change in crop type, irrigation equipment changes, and irrigation scheduling; 2) change in crop variety, irrigation equipment changes, and irrigation scheduling; and 3) change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education. When implementing multiple strategies, the impact on potential water savings is not additive in most instances. The cumulative water savings from use of multiple strategies was estimated using a stepwise procedure; first by revising water use after implementing one strategy and then using the revised water use as the base for the second strategy and repeating the process for the third and fourth strategy (where applicable). The implementation costs for the strategy combinations were additive in nature.

Regional Results and Analysis

Cumulative water savings and implementation cost for each of the water conservation strategies and combinations of strategies are presented in Table 3 and costs are further delineated in to capital and operational in Table 4. More than 81 million ac-ft of water is projected to be utilized for irrigation within the region over the 50-year planning horizon without adoption of any new conservation strategies or increases in the implementation of current strategies. Since final implementation rates of conservation strategies do not occur until 2080, the water savings and total implementation cost of all strategies were evaluated over a 50-year planning horizon. Total implementation costs include both the capital and operational costs associated with each strategy. Capital costs include the cost of additional equipment required and operational costs include variable production costs as well as the opportunity cost of land, where applicable. The method for calculating water savings and implementation costs of each strategy and all combination strategies is given in previous sections. Each of the conservation strategies is discussed in order of projected magnitude of water savings followed by the combinations of strategies that were considered.

Table 3: Estimated Water Savings and Costs Associated with Proposed Water Conservation Strategies in Region A (2030-2080).

Water Management Strategy	Regional Water Savings by Conservation Strategy (ac-ft/yr)						Cumulative Water Savings (WS)	Cumulative Implementation Cost (IC)	IC/WS
	2030	2040	2050	2060	2070	2080	(million ac-ft)	(million $)	($/ac-ft)
Irrigation Scheduling	8,527	18,217	27,907	37,598	47,288	53,102	1.40	$156.80	$112.37
Irrigation Equipment Changes	11,704	29,437	47,169	64,902	82,635	100,368	2.36	$102.33	$43.39
Change in Crop Type	20,331	40,662	60,993	81,324	101,655	121,986	3.05	$407.13	$133.50
Change in Crop Variety	11,258	22,515	33,773	45,030	56,288	67,545	1.69	$446.48	$264.40
Conversion to Dryland	38,760	77,521	116,281	155,041	193,802	232,562	5.81	$266.41	$45.82
Soil Management	3,388	6,563	9,739	12,915	16,091	19,267	0.49	$0.00	$0.00
Irrigation Deferral	96,901	96,901	96,901	96,901	96,901	96,901	4.85	$471.85	$97.39
Advances in Plant Breeding	41,798	125,394	142,113	158,833	158,833	158,833	6.27	$469.75	$74.92
Enhanced Education	9,690	9,690	9,690	9,690	9,690	9,690	0.48	$20.00	$41.28
Crop Type, Irrigation Equipment, and Irrigation Scheduling	40,421	87,657	134,512	180,987	227,081	269,363	6.71	$666.25	$99.34
Crop Variety, Irrigation Equipment, and Irrigation Scheduling	31,387	69,681	107,684	145,397	182,821	216,414	5.37	$705.60	$131.40
Crop Type, Plant Breeding, Irrigation Equipment, Irrigation Scheduling, and Enhanced Education	91,683	221,471	284,130	346,240	391,491	433,268	13.35	$1,156.00	$86.59

Table 4: Estimated Water Savings and Costs (Capital and Operational) Associated with Proposed Water Conservation Strategies in Region A (2030-2080).

Water Management Strategy	Cumulative Water Savings (WS)	Capital Cost	Operational Cost	Cumulative Implementation Cost (IC)	IC/WS
	(million ac-ft)	(million $)	(million $)	(million $)	($/ac-ft)
Irrigation Scheduling	1.40	-	$156.80	$156.80	$112.37
Irrigation Equipment Changes	2.36	$102.33	-	$102.33	$43.39
Change in Crop Type	3.05	-	$407.13	$407.13	$133.50
Change in Crop Variety	1.69	-	$446.48	$446.48	$264.40
Conversion to Dryland	5.81	$266.41	-	$266.41	$45.82
Soil Management	0.49	-	-	$0.00	$0.00
Irrigation Deferral	4.85	$471.85	-	$471.85	$97.39
Advances in Plant Breeding	6.27		$469.75	$469.75	$74.92
Enhanced Education	0.48		$20.00	$20.00	$41.28
Crop Type, Irrigation Equipment, and Irrigation Scheduling	6.71	$102.33	$563.92	$666.25	$99.34
Crop Variety, Irrigation Equipment, and Irrigation Scheduling	5.37	$102.33	$603.27	$705.60	$131.40
Crop Type, Plant Breeding, Irrigation Equipment, Irrigation Scheduling, and Enhanced Education	13.35	$102.33	$1,053.67	$1,156.00	$86.59

Anticipated advances in plant breeding (drought-tolerant varieties) in corn, cotton, sorghum, soybeans and wheat were estimated to generate the most water savings as an individual strategy at 6.3 million ac-ft over the 50-year planning horizon. Implementing this strategy is expected to cost $469.8 million resulting in an average cost of $74.92 per ac-ft of water saved. The cost of implementation would probably be absorbed by producers.

Converting irrigated land to dryland production had the second largest savings from an individual strategy standpoint yielding water savings of 5.8 million ac-ft. The estimated change in land values resulted in an implementation cost of $266.4 million and a resultant cost of $45.82 per ac-ft of water saved. It should be noted that this strategy is extremely detrimental to the regional economy because of the reduction in yield output and associated expenditures resulting in the Ag subcommittee of PWPG assigning it a low adoption rate.

Irrigation deferral which involves a temporary suspension of irrigation activities by a producer ranked third in water savings with 4.8 million ac-ft over the 50-year planning horizon. However, it was projected to be the most expensive at $471.9 million, resulting in an estimated cost per ac-ft of $97.39. Producers would be compensated for participation in this strategy and it would have the same type of negative impacts on the regional economy as the conversion to dryland strategy.

Changing the crop type from irrigated corn to irrigated cotton or limited irrigated sorghum or wheat, yielded the fourth highest savings at 3.0 million ac-ft. The change results in an estimated implementation cost of $407.1 million, or $133.50 per ac-ft of water saved.

Conversion of less efficient irrigation delivery systems in the region, such as MESA and LESA to more efficient LEPA systems resulted in a savings of 2.4 million ac-ft. Investment in these more efficient systems results in an implementation cost of $102.3 million which translates into a cost of $43.39 per ac-ft of water saved.

The change to shorter season corn and sorghum varieties yielded the sixth largest water savings of 1.7 million ac-ft. The implementation cost for this strategy was estimated at $446.5 million, resulting in the highest cost per ac-ft of water saved at $264.40. The results of this strategy are very dependent on the yield reductions of short-season varieties and crop prices. Lower prices and smaller yield reductions increase the feasibility of this strategy. At this time, the lack of economic feasibility has limited the adoption of this strategy.

Proper irrigation scheduling is estimated to save 1.4 million ac-ft over the 50-year planning horizon and ranks seventh in water savings. Implementation costs are projected to total $156.8 million, averaging $112.37 per ac-ft of water saved.

The soil management conservation strategy encompasses the adoption of conservation tillage. Increasing the level of soil management yielded the second lowest water savings of 490,000 ac-ft which can be traced to the high level of adoption that has already occurred in the region (83.4%). The implementation cost of increased soil management was assessed by evaluating the cost differential between conventional and reduced till. The change in the relative cost of fuel and chemicals and conservation tillage methods was similar to conventional tillage; therefore, no annualized costs were assumed for conservation tillage practices. It should be noted that the initial cost of converting to conservation tillage such as the additional purchase of a strip tiller or no-till planter could impede the adoption process.

Implementation of the enhanced education strategy was projected to result in the smallest amount of water savings at 480,000 ac-ft over the planning horizon, however it was also estimated to have the lowest cumulative cost at $20.0 million dollars, which resulted in it having the lowest cost per ac-ft of water saved, $41.28. It should be noted that more than 62.5% of the cost of this strategy is assumed to be cost-share funding for producers to encourage them to adopt water conservation equipment/techniques that they learn through the educational effort.

The Ag subcommittee of PWPG identified three combinations of strategies to be used in water-deficit irrigated counties. These strategies were also evaluated for the region. The combination of change in crop type, irrigation equipment changes, and irrigation scheduling resulted in an estimated water savings of 6.7 million ac-ft; the strategy of implementing change in crop variety, irrigation equipment changes, and irrigation scheduling was projected to save 5.4 million ac-ft of water; and the combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education had estimated water savings of 13.4 million ac-ft. The interaction between some strategies results in lower water savings from implementing multiple strategies. The combination of change in crop type, irrigation equipment changes, and irrigation scheduling had implementation costs of $666.3 million, with the second lowest per acre cost of $99.34 per ac-ft of water saved. Change in crop variety, irrigation equipment changes, and irrigation scheduling would cost $705.6 million or $131.4 per acre foot of water saved. Change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education has the largest estimated total implementation cost at $1.2 billion, however is the most cost effective at $86.59 per acre foot of water saved.

It should be noted that if cost effectiveness is the primary consideration in evaluating the strategies, then the preference order of the strategies changes. Reordering the strategies based on dollars per ac-ft of water savings results in enhanced education being the most effective ($41.28/ac-ft) followed by irrigation equipment changes ($43.39/ac-ft), conversion to dryland ($45.82/ac-ft), advances in plant breeding ($74.92/ac-ft), irrigation deferral ($97.39/ ac-ft), irrigation scheduling ($112.37/ac-ft), change in crop type ($133.50/ ac-ft), and change in crop variety ($264.40/ ac-ft).

Irrigation Deficit County Analysis

Ten of the counties in Region A are projected to have irrigation deficits at some point during the 50-year planning horizon including: Armstrong, Collingsworth, Dallam, Hall, Hartley, Hutchinson, Moore, Oldham, Randall, and Sherman. Since the effectiveness of conservation strategies can be affected by the crop composition as well as other regional factors, each deficit county is evaluated individually. Water savings by conservation strategy is estimated as well as the projected irrigation demand and irrigation needs. Initially, estimates of water savings by conservation strategies were calculated with baseline values for water use by crops and irrigated acreage in determining their effectiveness. In subsequent decades, water savings were modified based on two factors. The first was a reduction in water availability, which was measured from the baseline water use, negatively impacting the effectiveness of conservation strategies. The second was the partial offset in that loss due to water savings achieved by implementing the conservation strategy in the prior period, which would be able to be used in the current period. The three combinations of strategies were evaluated; however, it is important to note that the implementation of certain strategies can diminish the effectiveness of other implemented strategies. Additional analysis of estimated water savings and associated cost by strategy and county id provided in Appendices A and B.

Armstrong County:
Irrigation Needs and Water Savings from Conservation Strategies

It is projected that Armstrong County will have an irrigation need of 196 ac-ft in 2050 increasing to 1,855 in 2080 (Table 5). Conversion to dryland was the most effective individual water-saving strategy evaluated when fully implemented in Armstrong County, reducing annual use by 864 ac-ft. The effectiveness of the remaining strategies once fully implemented ranked as follows: advances in plant breeding (518 ac-ft), irrigation deferral (360 ac-ft), irrigation equipment changes (327 ac-ft), change in crop type (286 ac-ft), change in crop variety (182 ac-ft), irrigation scheduling (173 ac-ft), soil management (72 ac-ft), and enhanced education (32 ac-ft). Therefore, implementing any individual strategy will not generate sufficient water savings to compensate for projected needs.

The combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education was estimated to be the most effective combination strategy generating 1,304 ac-ft of water savings in 2080. The combination of change in crop type, irrigation equipment changes, and irrigation scheduling and the strategy of change in crop variety, irrigation equipment changes, and irrigation scheduling were less effective in generating water savings at 770 ac-ft and 669 ac-ft in 2080, respectively. Therefore, projected irrigation needs cannot be met regardless of the conservation strategy or combination of strategies evaluated in the 2070 and 2080 time periods.

Table 5: Armstrong County Projected Annual Irrigation Need and Water Savings by Strategy (ac-ft/year), 2030-2080.

		2030	2040	2050	2060	2070	2080
	Projected Irrigation Demand	6,324	6,324	6,324	6,324	6,324	6,324
	Projected Irrigation Need	0	0	-196	-726	-1,334	-1,855
	Projected Water Savings						
Water Saving Strategies	Irrigation Scheduling	28	59	91	123	154	173
	Irrigation Equipment Changes	38	96	154	212	270	327
	Change in Crop Type	48	95	143	190	238	286
	Change in Crop Variety	30	61	91	122	152	182
	Conversion to Dryland	144	288	432	576	720	864
	Soil Management	13	24	36	48	60	72
	Irrigation Deferral	360	360	360	360	360	360
	Advances in Plant Breeding	136	409	463	518	518	518
	Enhanced Education	32	32	32	32	32	32
	Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling	113	249	383	517	650	770
	Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling	96	215	333	450	566	669
	Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education	280	685	871	1,056	1,186	1,304

Collingsworth County: Irrigation Needs and Water Savings from Conservation Strategies

It is projected that Collingsworth County will have an irrigation need of 16,131 ac-ft in 2030 (Table 6). This annual shortfall will increase to 19,069 ac-ft by 2080. Conversion to dryland was the most effective individual water-saving strategy evaluated when fully implemented in Collingsworth County, reducing annual use by 6,117 ac-ft. The effectiveness of the remaining strategies once fully implemented ranked as follows: advances in plant breeding (3,601 ac-ft), irrigation equipment changes (2,568 ac-ft), irrigation deferral (2,549 ac-ft), irrigation scheduling (1,359 ac-ft), soil management (507 ac-ft), enhanced education (248 ac-ft), change in crop variety (81 ac-ft), and change in crop type (47 ac-ft). Therefore, implementing any individual strategy will not generate sufficient water savings to compensate for projected needs.

The combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education was estimated to be the most effective combination strategy generating 7,646 ac-ft of water savings in 2080. The combination of change in crop variety, irrigation equipment changes, and irrigation scheduling and the strategy of change in crop type, irrigation equipment changes, and irrigation scheduling were less effective in generating water savings at 3,936 ac-ft and 3,903 ac-ft in 2080, respectively. Therefore, projected irrigation needs cannot be met regardless of the conservation strategy or combination of strategies evaluated in any of the time periods.

Table 6: Collingsworth County Projected Annual Irrigation Need and Water Savings by Strategy (ac-ft/year), 2030-2080.

		2030	2040	2050	2060	2070	2080
	Projected Irrigation Demand	49,594	49,594	48,069	42,856	43,325	50,738
	Projected Irrigation Need	-16,131	-19,039	-18,908	-18,515	-18,538	-19,069
	Projected Water Savings						
Water Saving Strategies	Irrigation Scheduling	218	466	699	845	1,077	1,359
	Irrigation Equipment Changes	300	753	1,188	1,474	1,909	2,568
	Change in Crop Type	8	16	23	27	34	47
	Change in Crop Variety	14	27	39	47	59	81
	Conversion to Dryland	1,020	2,039	3,059	3,768	4,816	6,117
	Soil Management	89	173	249	295	372	507
	Irrigation Deferral	2,549	2,549	2,549	2,330	2,340	2,549
	Advances in Plant Breeding	948	2,843	3,222	3,339	3,372	3,601
	Enhanced Education	248	248	242	215	218	248
	Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling	524	1,228	1,915	2,364	3,044	3,903
	Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling	530	1,239	1,933	2,385	3,071	3,936
	Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education	1,715	4,290	5,347	6,196	6,961	7,646

Dallam County:
Irrigation Needs and Water Savings from Conservation Strategies

Dallam County is projected to have an irrigation need of 121,228 ac-ft in 2030 (Table 7). This annual shortfall peaks in 2040 at 156,912 ac-ft before falling to 127,842 ac-ft by 2080. Conversion to dryland was the most effective individual water-saving strategy evaluated when fully implemented in reducing annual use by 25,895 ac-ft. The effectiveness of the remaining strategies once fully implemented ranked as follows: advances in plant breeding (21,250 ac-ft), change in crop type (13,829 ac-ft), irrigation equipment changes (12,342 ac-ft), irrigation deferral (10,328 ac-ft), change in crop variety (7,848 ac-ft), irrigation scheduling (6,407 ac-ft), soil management (1,977 ac-ft), and enhanced education (1,145 ac-ft).

The combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education was estimated to be the most effective combination strategy generating 61,509 ac-ft of water savings in 2080. The combination of change in crop type, irrigation equipment changes, and irrigation scheduling and the strategy of change in crop variety, irrigation equipment changes, and irrigation scheduling were less effective in generating water savings at 34,223 ac-ft and 27,656 ac-ft in 2080, respectively. Therefore, projected irrigation needs cannot be met regardless of the conservation strategy or combination of strategies evaluated in any of the time periods.

Table 7: Dallam County Projected Adjusted Annual Irrigation Need and Water Savings by Strategy (ac-ft/year), 2030-2080.

		2030	2040	2050	2060	2070	2080
	Projected Irrigation Demand	340,629	340,629	302,733	270,229	246,027	227,823
	Projected Irrigation Need	-121,228	-156,912	-148,470	-140,598	-133,194	-127,842
	Projected Water Savings						
Water Saving Strategies	Irrigation Scheduling	1,499	3,202	4,405	5,327	6,131	6,407
	Irrigation Equipment Changes	2,057	5,174	7,494	9,296	10,876	12,342
	Change in Crop Type	3,276	6,552	8,923	10,732	12,330	13,829
	Change in Crop Variety	1,898	3,797	5,125	6,137	7,024	7,848
	Conversion to Dryland	5,901	11,802	16,346	19,815	22,932	25,895
	Soil Management	516	999	1,322	1,567	1,781	1,977
	Irrigation Deferral	14,752	14,752	13,750	12,271	11,162	10,328
	Advances in Plant Breeding	7,655	22,965	24,886	25,052	22,981	21,250
	Enhanced Education	1,703	1,703	1,522	1,359	1,237	1,145
	Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling	6,808	14,817	21,220	26,130	30,524	34,223
	Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling	5,437	12,088	17,274	21,255	24,792	27,656
	Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education	16,125	39,254	50,093	56,216	59,183	61,509

Hall County: Irrigation Needs and Water Savings from Conservation Strategies

The irrigation need in Hall County is projected to be 15,780 ac-ft in 2030 (Table 8). This annual shortfall will decrease to 12,944 ac-ft by 2080. Conversion to dryland was the most effective individual water-saving strategy evaluated when fully implemented in reducing annual use by 3,745 ac-ft. The effectiveness of the remaining strategies once fully implemented ranked as follows: advances in plant breeding (2,788 ac-ft), irrigation equipment changes (1,726 ac-ft), irrigation deferral (1,560 ac-ft), irrigation scheduling (913 ac-ft), soil management (310 ac-ft), enhanced education (167 ac-ft), change in crop variety (15 ac-ft), and change in crop type (3 ac-ft). The least effective strategies generated little to no water savings due to the existing crop composition within Hall County (i.e., very little feed grain production).

The combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education was estimated to be the most effective combination strategy generating 5,469 ac-ft of water savings in 2080. The combination of change in crop variety, irrigation equipment changes, and irrigation scheduling and the strategy of change in crop type, irrigation equipment changes, and irrigation scheduling were less effective in generating water savings at 2,607 ac-ft and 2,595 ac-ft in 2080, respectively. Therefore, projected irrigation needs cannot be met regardless of the conservation strategy or combination of strategies evaluated in any of the time periods.

Table 8: Hall County Projected Annual Irrigation Need and Water Savings by Strategy (ac-ft/year), 2030-2080.

		2030	2040	2050	2060	2070	2080
	Projected Irrigation Demand	33,325	33,325	36,767	39,870	38,604	33,860
	Projected Irrigation Need	-15,780	-12,917	-13,098	-13,271	-13,197	-12,944
	Projected Water Savings						
Water Saving Strategies	Irrigation Scheduling	147	313	480	647	813	913
	Irrigation Equipment Changes	201	506	811	1,116	1,421	1,726
	Change in Crop Type	1	1	2	2	3	3
	Change in Crop Variety	3	5	8	10	13	15
	Conversion to Dryland	624	1,248	1,872	2,496	3,121	3,745
	Soil Management	55	106	157	208	259	310
	Irrigation Deferral	1,560	1,560	1,560	1,560	1,560	1,560
	Advances in Plant Breeding	734	2,201	2,495	2,788	2,788	2,788
	Enhanced Education	167	167	167	167	167	167
	Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling	347	816	1,281	1,743	2,202	2,595
	Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling	350	820	1,287	1,751	2,212	2,607
	Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education	1,244	3,161	3,904	4,640	5,085	5,469

Hartley County:
Irrigation Needs and Water Savings from Conservation Strategies

It is projected that Hartley County will have an irrigation need of 172,558 ac-ft in 2030 (Table 9). The annual shortage will increase to 229,447 ac-ft in 2040 before falling to 183,960 ac-ft by 2080. Conversion to dryland was the most effective individual water-saving strategy evaluated when fully implemented in reducing annual use by 33,571 ac-ft. The effectiveness of the remaining strategies once fully implemented ranked as follows: advances in plant breeding (22,184 ac-ft), change in crop type (15,983 ac-ft), irrigation equipment changes (14,566 ac-ft), irrigation deferral (13,338 ac-ft), change in crop variety (7,976 ac-ft), irrigation scheduling (7,561 ac-ft), soil management (2,544 ac-ft), and enhanced education (1,351 ac-ft).

The combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education was estimated to be the most effective combination strategy generating 68,746 ac-ft of water savings in 2080. The combination of change in crop type, irrigation equipment changes, and irrigation scheduling and the strategy of change in crop variety, irrigation equipment changes, and irrigation scheduling were less effective in generating water savings at 40,033 ac-ft and 31,232 ac-ft in 2080, respectively. Therefore, projected irrigation needs cannot be met regardless of the conservation strategy or combination of strategies evaluated in any of the time periods.

Table 9: Hartley County Projected Annual Irrigation Need and Water Savings by Strategy (ac-ft/year), 2030-2080.

		2030	2040	2050	2060	2070	2080
	Projected Irrigation Demand	399,114	399,114	353,126	319,907	291,824	268,823
	Projected Irrigation Need	-172,558	-229,447	-216,085	-204,225	-193,294	-183,960
	Projected Water Savings						
Water Saving Strategies	Irrigation Scheduling	1,756	3,752	5,139	6,305	7,272	7,561
	Irrigation Equipment Changes	2,410	6,062	8,742	11,001	12,900	14,566
	Change in Crop Type	3,762	7,525	10,199	12,439	14,323	15,983
	Change in Crop Variety	1,923	3,847	5,161	6,265	7,180	7,976
	Conversion to Dryland	7,535	15,070	20,853	25,668	29,827	33,571
	Soil Management	659	1,276	1,681	2,023	2,303	2,544
	Irrigation Deferral	18,837	18,837	17,555	15,885	14,486	13,338
	Advances in Plant Breeding	8,005	24,015	25,719	26,218	24,100	22,184
	Enhanced Education	1,996	1,996	1,776	1,608	1,467	1,351
	Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling	7,902	17,211	24,539	30,628	35,875	40,033
	Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling	6,071	13,567	19,302	24,081	28,157	31,232
	Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education	17,858	42,977	54,821	62,270	66,131	68,746

Hutchinson County:
Irrigation Needs and Water Savings from Conservation Strategies

It is projected that Hutchinson County will have an irrigation need of 1,980 ac-ft by 2080 (Table 10). Conversion to dryland was the most effective individual water-saving strategy evaluated when fully implemented in reducing annual use by 8,496 ac-ft. The effectiveness of the remaining strategies once fully implemented ranked as follows: change in crop type (5,843 ac-ft), advances in plant breeding (5,453 ac-ft), irrigation deferral (3,540 ac-ft), irrigation equipment changes (3,204 ac-ft), change in crop variety (2,785 ac-ft), irrigation scheduling (1,695 ac-ft), soil management (704 ac-ft) and enhanced education (309 ac-ft).

The combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education was estimated to be the most effective combination strategy generating 16,099 ac-ft of water savings in 2080. The combination of change in crop type, irrigation equipment changes, and irrigation scheduling and the strategy of change in crop variety, irrigation equipment changes, and irrigation scheduling were less effective in generating water savings at 10,494 ac-ft and 7,520 ac-ft in 2080, respectively. Therefore, projected irrigation needs can be met with the implementation of any strategy or combination of strategies except for irrigation scheduling, soil management, and enhanced education, when implemented individually.

Table 10: Hutchinson County Projected Annual Irrigation Need and Water Savings by Strategy (ac-ft/year), 2030-2080.

		2030	2040	2050	2060	2070	2080
	Projected Irrigation Demand	61,866	61,866	61,866	61,866	61,866	61,866
	Projected Irrigation Need	0	0	0	0	0	-1,980
	Projected Water Savings						
Water Saving Strategies	Irrigation Scheduling	272	582	891	1,200	1,510	1,695
	Irrigation Equipment Changes	374	940	1,506	2,072	2,638	3,204
	Change in Crop Type	974	1,948	2,921	3,895	4,869	5,843
	Change in Crop Variety	464	928	1,392	1,857	2,321	2,785
	Conversion to Dryland	1,416	2,832	4,248	5,664	7,080	8,496
	Soil Management	124	240	356	472	588	704
	Irrigation Deferral	3,540	3,540	3,540	3,540	3,540	3,540
	Advances in Plant Breeding	1,435	4,305	4,879	5,453	5,453	5,453
	Enhanced Education	309	309	309	309	309	309
	Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling	1,614	3,442	5,254	7,052	8,833	10,494
	Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling	1,106	2,432	3,747	5,052	6,347	7,520
	Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education	3,350	8,013	10,368	12,703	14,456	16,099

Moore County:
Irrigation Needs and Water Savings from Conservation Strategies

It is projected that Moore County will have an irrigation need of 66,665 ac-ft in 2030 (Table 11). This annual shortfall will increase to 72,853 ac-ft by 2040 before falling to 55,444 ac-ft by 2080. Conversion to dryland was the most effective individual water-saving strategy evaluated when fully implemented in reducing annual use by 18,511 ac-ft. The effectiveness of the remaining strategies once fully implemented ranked as follows: advances in plant breeding (10,541 ac-ft), change in crop type (8,173 ac-ft), irrigation deferral (7,264 ac-ft), irrigation equipment changes (6,460 ac-ft), change in crop variety (5,227 ac-ft), irrigation scheduling (3,349 ac-ft), soil management (1,370 ac-ft), and enhanced education (598 ac-ft).

The combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education was estimated to be the most effective combination strategy generating 32,908 ac-ft of water savings in 2080. The combination of change in crop type, irrigation equipment changes, and irrigation scheduling and the strategy of change in crop variety, irrigation equipment changes, and irrigation scheduling were less effective in generating water savings at 19,015 ac-ft and 15,765 ac-ft in 2080, respectively. Therefore, projected irrigation needs cannot be met regardless of the conservation strategy or combination of strategies evaluated in any of the time periods.

Table 11: Moore County Projected Annual Irrigation Need and Water Savings by Strategy (ac-ft/year), 2030-2080.

		2030	2040	2050	2060	2070	2080
	Projected Irrigation Demand	191,322	191,322	177,197	158,318	136,819	118,904
	Projected Irrigation Need	-66,665	-72,883	-68,994	-64,716	-59,954	-55,444
	Projected Water Savings						
Water Saving Strategies	Irrigation Scheduling	842	1,798	2,578	3,121	3,413	3,349
	Irrigation Equipment Changes	1,155	2,906	4,384	5,446	6,060	6,460
	Change in Crop Type	2,064	4,127	5,867	7,078	7,747	8,173
	Change in Crop Variety	1,347	2,695	3,800	4,565	4,974	5,227
	Conversion to Dryland	4,386	8,771	12,789	15,634	17,346	18,511
	Soil Management	383	743	1,025	1,217	1,314	1,370
	Irrigation Deferral	10,964	10,964	10,783	9,655	8,361	7,264
	Advances in Plant Breeding	4,083	12,248	13,744	13,880	12,135	10,541
	Enhanced Education	957	957	891	796	688	598
	Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling	4,047	8,766	13,070	16,146	18,004	19,015
	Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling	3,333	7,346	10,927	13,481	14,998	15,765
	Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education	9,064	21,846	28,070	32,986	33,460	32,908

Oldham County:
Irrigation Needs and Water Savings from Conservation Strategies

It is projected that Oldham County will have an irrigation need of 319 ac-ft in 2030 (Table 12). This annual shortfall will increase to 592 ac-ft by 2080. Conversion to dryland was the most effective individual water-saving strategy evaluated when fully implemented in reducing annual use by 665 ac-ft. The effectiveness of the remaining strategies once fully implemented ranked as follows: advances in plant breeding (343 ac-ft), irrigation deferral (277 ac-ft), irrigation equipment changes (261 ac-ft), change in crop type (145 ac-ft), irrigation scheduling (138 ac-ft), change in crop variety (94 ac-ft), soil management (55 ac-ft), and enhanced education (25 ac-ft).

The combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education was estimated to be the most effective combination strategy generating 891 ac-ft of water savings in 2080. The combination of change in crop type, irrigation equipment changes, and irrigation scheduling and the strategy of change in crop variety, irrigation equipment changes, and irrigation scheduling were less effective in generating water savings at 533 ac-ft and 483 ac-ft in 2080, respectively. Therefore, projected irrigation needs can be met with conversion to dryland, individually, or the most effective combination strategy.

Table 12: Oldham County Projected Annual Irrigation Need and Water Savings by Strategy (ac-ft/year), 2030-2080.

		2030	2040	2050	2060	2070	2080
	Projected Irrigation Demand	5,040	5,040	5,040	5,040	5,040	5,040
	Projected Irrigation Need	-319	-319	-319	-319	-319	-592
	Projected Water Savings						
Water Saving Strategies	Irrigation Scheduling	22	47	73	98	123	138
	Irrigation Equipment Changes	30	77	123	169	215	261
	Change in Crop Type	24	48	72	97	121	145
	Change in Crop Variety	16	31	47	63	78	94
	Conversion to Dryland	111	222	332	443	554	665
	Soil Management	10	19	28	37	46	55
	Irrigation Deferral	277	277	277	277	277	277
	Advances in Plant Breeding	90	271	307	343	343	343
	Enhanced Education	25	25	25	25	25	25
	Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling	77	171	265	358	450	533
	Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling	68	154	240	325	409	483
	Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education	191	464	592	719	810	891

Randall County:
Irrigation Needs and Water Savings from Conservation Strategies

It is projected that Randall County will have an irrigation need of 317 ac-ft in 2030 (Table 13). This annual shortfall will increase to 9,353 ac-ft in 2080. Conversion to dryland was the most effective individual water-saving strategy evaluated when fully implemented in reducing annual use by 2,528 ac-ft. The effectiveness of the remaining strategies once fully implemented ranked as follows: advances in plant breeding (1,405 ac-ft), irrigation deferral (1,053 ac-ft), irrigation equipment changes (903 ac-ft), change in crop type (693 ac-ft), change in crop variety (491 ac-ft), irrigation scheduling (478 ac-ft), soil management (209 ac-ft), and enhanced education (87 ac-ft).

The combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education was estimated to be the most effective combination strategy generating 3,482 ac-ft of water savings in 2080. The combination of change in crop type, irrigation equipment changes, and irrigation scheduling and the strategy of change in crop variety, irrigation equipment changes, and irrigation scheduling were less effective in generating water savings at 2,030 ac-ft and 1,834 ac-ft in 2080, respectively. Therefore, projected irrigation needs cannot be met regardless of the conservation strategy or combination of strategies evaluated starting in 2040 and the remaining time periods in the analysis.

Table 13: Randall County Projected Annual Irrigation Need and Water Savings by Strategy (ac-ft/year), 2030-2080.

		2030	2040	2050	2060	2070	2080
	Projected Irrigation Demand	17,442	17,442	17,442	17,442	17,442	17,442
	Projected Irrigation Need	-317	-2,299	-4,380	-6,103	-7,845	-9,353
	Projected Water Savings						
Water Saving Strategies	Irrigation Scheduling	77	164	251	338	426	478
	Irrigation Equipment Changes	105	265	425	584	744	903
	Change in Crop Type	115	231	346	462	577	693
	Change in Crop Variety	82	164	246	328	410	491
	Conversion to Dryland	421	843	1,264	1,685	2,107	2,528
	Soil Management	37	71	106	140	175	209
	Irrigation Deferral	1,053	1,053	1,053	1,053	1,053	1,053
	Advances in Plant Breeding	370	1,110	1,257	1,405	1,405	1,405
	Enhanced Education	87	87	87	87	87	87
	Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling	297	655	1,011	1,364	1,714	2,030
	Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling	263	589	912	1,232	1,551	1,834
	Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education	752	1,841	2,336	2,828	3,170	3,482

Sherman County:
Irrigation Needs and Water Savings from Conservation Strategies

It is projected that Sherman County will have an irrigation need of 34,490 ac-ft in 2030 (Table 13). This annual shortfall will increase to 59,073 ac-ft by 2040 before falling to 43,315 ac-ft by 2080. Conversion to dryland was the most effective individual water-saving strategy evaluated when fully implemented in reducing annual use by 21,772 ac-ft. The effectiveness of the remaining strategies once fully implemented ranked as follows: advances in plant breeding (17,718 ac-ft), change in crop type (13,998 ac-ft), irrigation equipment changes (9,942 ac-ft), irrigation deferral (8,654 ac-ft), change in crop variety (8,148 ac-ft), irrigation scheduling (5,157 ac-ft), soil management (1,652 ac-ft), and enhanced education (921 ac-ft).

The combination of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education was estimated to be the most effective combination strategy generating 54,121 ac-ft of water savings in 2080. The combination of change in crop type, irrigation equipment changes, and irrigation scheduling and the strategy of change in crop variety, irrigation equipment changes, and irrigation scheduling were less effective in generating water savings at 30,780 ac-ft and 24,346 ac-ft in 2080, respectively. Therefore, projected irrigation needs can be met with the most effective combination strategy starting in 2060.

Table 14: Sherman County Projected Annual Irrigation Need and Water Savings by Strategy (ac-ft/year), 2030-2080.

		2030	**2040**	**2050**	**2060**	**2070**	**2080**
	Projected Irrigation Demand	309,522	309,522	271,009	240,767	206,316	183,173
	Projected Irrigation Need	-34,490	-59,073	-53,887	-49,819	-45,778	-43,115
	Projected Water Savings						
Water Saving Strategies	Irrigation Scheduling	1,362	2,910	3,944	4,747	5,148	5,157
	Irrigation Equipment Changes	1,869	4,701	6,711	8,284	9,141	9,942
	Change in Crop Type	3,694	7,388	9,968	11,957	12,997	13,998
	Change in Crop Variety	2,206	4,413	5,890	7,030	7,598	8,148
	Conversion to Dryland	5,568	11,135	15,225	18,376	20,114	21,772
	Soil Management	487	943	1,229	1,450	1,551	1,652
	Irrigation Deferral	13,919	13,919	12,813	11,375	9,765	8,654
	Advances in Plant Breeding	7,168	21,505	23,033	23,067	20,021	17,718
	Enhanced Education	1,548	1,548	1,363	1,211	1,038	921
	Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling	6,901	14,885	21,064	25,826	28,590	30,780
	Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling	5,419	11,938	16,825	20,602	22,736	24,346
	Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education	15,578	37,721	48,227	53,860	54,194	54,121

Alternative Agricultural Conservation/Water Enhancement Strategies

Precipitation enhancement and drilling additional wells were selected as potential alternative strategies by the PWPG Ag subcommittee for the 2026 plan. Precipitation enhancement is already practiced by the Panhandle Groundwater Conservation District, which encompasses 35% of the total acreage within Region A. The remaining groundwater districts within the region have expressed no interest in implementing this strategy, therefore, it was not included in the primary water conservation strategies considered for implementation. While drilling a new well is not a water conservation strategy, it is a method that producers can implement to enhance irrigation water availability to meet needs if untapped supplies are available on their property. Relevant information concerning these two alternatives are presented in the following sections.

Precipitation Enhancement

Precipitation enhancement, commonly known as cloud seeding or weather modification, is a process in which clouds are inoculated with condensation agents (such as silver iodide) to enhance rainfall formation. Cloud seeding is also used as a technique for hail suppression or reducing hailstone size (Encyclopedia Britannica, 2014). The strategy of precipitation enhancement is adopted only by the counties in the Panhandle Groundwater Conservation District (PGCD). In 2022, a total of 31 seeding flights and 14 reconnaissance flights were made in the district. In 2023, a total of 14 seeding flights and 3 reconnaissance flights were made in the district. Based on the literature, it is assumed to have water savings of one acre-inch per acre for all irrigated acreage in the region by precipitation enhancement. In consultation with PGCD personnel, the cost of this strategy was reported to be 4.0 cents per acre in both 2022 and 2023.

Additional Irrigation Supply from Groundwater Wells

The PWPG does not advocate new groundwater wells as a strategy to meet future irrigation needs, however, it is an option for irrigation water users who require additional supplies. Cost estimates were gathered to determine the expense of installing irrigation wells. Calculations assumed a 12¾", 16", and 16¼" cased well costs of $127.50/ft, $175/ft, and $178.50/ft, respectively. Pumping equipment cost estimates varied as to whether a submersible pump or electric turbine was employed (personal communication with Nich Kenny and Curry Drilling). Three scenarios are presented with differing pumping rates, well depths, and well casings (Table 15).

Table 15: Estimated Costs of Irrigation Wells in Region A*

Pumping Rate (gpm)	Approximate Well Depth (ft.)	Approximate Well Casing Diameter (in.)	Approximate Pumping Unit Diameter (in.)	Well Drilling, Development, Testing Cost	Pumping Equipment Cost	Total Cost
400	375	12 ¾	4	$47,814	$28,000[1]	$75,814
800	500	16	8	$87,500	$125,000[2] $131,000[3]	$212,500 $218,500
400	650	16 ¼	6	$116,000	$105,000[4]	$221,000

*Does not include electrical delivery or pipeline to discharge.
[1] Assumes submersible pump and associated equipment.
[2] Assumes turbine pump with gearhead and associated equipment.
[3] Assumes turbine pump with 150 hp electric motor and associated equipment.
[4] Assumes turbine pump with 100 hp electric motor and associated equipment.

Summary and Conclusions

Prioritizing and implementing the nine irrigation conservation strategies will depend on the individual irrigator and regional support for the strategy. The one strategy that has the largest water savings is the adoption of drought-tolerant varieties of corn, cotton, sorghum, soybeans and wheat, which are being developed with the aid of advances in plant breeding. It is estimated to have the potential to save 6.3 million ac-ft over the 50-year planning horizon which is more than the other strategies evaluated. The cumulative water savings of the remaining strategies in millions of ac-ft are as follows: conversion to dryland (5.8), irrigation deferral (4.8), change in crop type (3.1), irrigation equipment changes (2.4), change in crop variety (1.7), irrigation scheduling (1.4), soil management (0.5) and enhanced education (0.5). The combination strategy of change in crop type, irrigation equipment changes, advances in plant breeding, irrigation scheduling and enhanced education resulted in the largest cumulative projected water savings of 13.4 million ac-ft over the planning horizon. The other combinations considered included: changes in crop type, irrigation scheduling and irrigation equipment changes, and crop variety, irrigation scheduling and irrigation equipment changes resulted in projected savings of 6.7 million ac-ft and 5.4 million ac-ft, respectively.

Implementation cost can be a critical barrier to the adoption or rate of adoption of water conservation strategies. The estimated cost of adopting the various strategies expressed in $/ac-ft of water savings varied considerably. No annualized costs for soil management suggests there are no implementation costs, which is erroneous. The initial cost of converting to conservation tillage such as the additional purchase of a strip tiller or no-till planter can impede the adoption process. However, the savings in conventional tillage methods offset the investment costs once the implements are prorated over their useful life.

Reordering the strategies based on dollars per ac-ft of water savings from least to most expensive results in enhanced education being the most effective ($41.28/ac-ft) followed by irrigation equipment changes ($43.39/ac-ft), conversion to dryland ($45.82/ac-ft), advances in plant breeding ($74.92/ac-ft), irrigation deferral ($97.39/ ac-ft), irrigation scheduling ($112.37/ac-ft), change in crop type ($133.50/ac-ft), and change in crop variety ($264.40/ac-ft). The combination strategy consisting of change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling and enhanced education not only had the greatest amount of irrigation savings but was also the most cost effective ($86.59/ac-ft). The second most effective combination strategy evaluated included changes in crop type, irrigation equipment changes and irrigation scheduling ($99.34)/ac-ft). Implementing changes in crop variety, irrigation scheduling and irrigation equipment changes resulted in a projected cost per acre-foot of water saved of $131.40.

Water conservation strategies can have significantly different impacts on the regional economy, which is often measured by the change in gross receipts or costs. The impact on the regional economy should be a major consideration in prioritizing strategies to be implemented. In this planning effort, no attempt was made to quantify the impacts of individual strategies on the regional economy. However, it is apparent that at least three of the strategies will have a negative impact. Implementing the conversion to dryland strategy would be detrimental to the regional economy because of the reduced production and decrease in inputs used. For the same reasons, the irrigation deferral strategy will have a similar negative impact. Change in crop variety will also have a negative impact on the regional economy, albeit to a lesser degree.

None of the conservation strategies or combinations of strategies considered were able to offset shortfalls in projected irrigation needs in five of the ten counties in any of the time periods in the planning horizon. These counties are Collingsworth, Dallam, Hall, Hartley and Moore. In addition, Randall County is projected to be able to meet irrigation needs only in 2030 by utilizing the combination strategy of changing crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education. Irrigation needs in Sherman County are projected to be met in the latter part of the planning horizon by employing the same combination strategy. Oldham county has irrigation needs in all time periods, but these shortages can be rectified by utilizing any of the three combinations strategies. Armstrong county is projected to have an irrigation need starting in 2050 which can be met by a number of strategies; however, the deficit is expected to grow in later years where only the previously mentioned combination strategy can offset the need. Hutchinson county is projected to have an irrigation need at the end of the time horizon which could be met by a number of conservation strategies or any of the combination strategies.

A couple of caveats to this analysis need to be mentioned. First, the associated water savings with these strategies are "potential" water savings. Advances in plant breeding is projected to be the most effective individual strategy and is a part of the suite of strategies that make up the recommended combination. However, the water savings potential of this strategy was reduced from the previous water plan since only some improvement has occurred, short of industry projections. Thus, several of the deficit counties may not be able to meet irrigation needs with the current conservation strategies as evaluated. Second, depending on the economics, the improved water-use efficiencies generated from some of these strategies may increase the depletion rate of the Ogallala Aquifer.

It needs to be stated that accurately evaluating the effectiveness of agricultural conservation strategies is difficult. Changes in irrigation demand, supply, needs, strategy implementation rates, conservation strategies, future crop composition, which is primarily determined by relative profitability, as well as accounting for the potential interaction between all these factors can impact the potential effectiveness of conservation strategies and these factors need to be considered in projections.

Irrigated agriculture in this region faces several challenges. First, the Ogallala Aquifer, which is the primary source of water within the region, is mostly nonrenewable with minimal recharge rates. Five of the major irrigated counties are not projected to meet their irrigation needs in any of the time periods over the 50-year planning horizon, regardless of the conservation strategy employed. Five additional counties are not projected to meet irrigation needs in at least one of the time periods. In order to maintain the economic viability of irrigated agriculture in the region, the accelerated adoption of current conservation strategies along with the development of new strategies and/or additional sources of water needs to occur.

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Appendix A
Estimated Water Savings for Water Conservation Strategies by County for Selected Years

Table A-1: Estimated Water Savings from Irrigation Scheduling by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	28	59	91	123	154	173	**4,553**
Carson	431	921	1,410	1,900	2,390	2,683	**70,511**
Childress	66	141	216	290	365	410	**10,779**
Collingsworth	218	466	714	962	1,210	1,359	**35,708**
Dallam	1,499	3,202	4,905	6,608	8,311	9,333	**245,253**
Donley	143	305	467	629	792	889	**23,357**
Gray	163	347	532	717	902	1,012	**26,605**
Hall	147	313	480	647	813	913	**23,994**
Hansford	773	1,651	2,530	3,408	4,287	4,814	**126,494**
Hartley	1,756	3,752	5,747	7,743	9,738	10,936	**287,362**
Hemphill	26	55	85	114	143	161	**4,231**
Hutchinson	272	582	891	1,200	1,510	1,695	**44,544**
Lipscomb	191	407	624	841	1,058	1,188	**31,211**
Moore	842	1,798	2,755	3,712	4,668	5,242	**137,752**
Ochiltree	381	815	1,248	1,682	2,115	2,375	**62,412**
Oldham	22	47	73	98	123	138	**3,629**
Potter	15	33	50	67	85	95	**2,500**
Randall	77	164	251	338	426	478	**12,558**
Roberts	42	90	138	186	233	262	**6,886**
Sherman	1,362	2,910	4,457	6,005	7,552	8,481	**222,856**
Wheeler	74	159	244	328	413	463	**12,178**
Total	**8,527**	**18,217**	**27,907**	**37,598**	**47,288**	**53,102**	**1,395,372**

Table A-2: Estimated Water Savings from Irrigation Equipment Changes by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	38	96	154	212	270	327	**7,696**
Carson	591	1,487	2,384	3,280	4,176	5,072	**119,179**
Childress	90	227	364	501	638	775	**18,218**
Collingsworth	300	753	1,207	1,661	2,115	2,568	**60,354**
Dallam	2,057	5,174	8,291	11,407	14,524	17,641	**414,528**
Donley	196	493	790	1,086	1,383	1,680	**39,478**
Gray	223	561	899	1,237	1,576	1,914	**44,969**
Hall	201	506	811	1,116	1,421	1,726	**40,555**
Hansford	1,061	2,668	4,276	5,884	7,491	9,099	**213,801**
Hartley	2,410	6,062	9,714	13,366	17,018	20,670	**485,702**
Hemphill	35	89	143	197	251	304	**7,152**
Hutchinson	374	940	1,506	2,072	2,638	3,204	**75,288**
Lipscomb	262	658	1,055	1,452	1,848	2,245	**52,753**
Moore	1,155	2,906	4,657	6,407	8,158	9,908	**232,829**
Ochiltree	523	1,317	2,110	2,903	3,696	4,489	**105,489**
Oldham	30	77	123	169	215	261	**6,134**
Potter	21	53	85	116	148	180	**4,225**
Randall	105	265	425	584	744	903	**21,226**
Roberts	58	145	233	320	408	495	**11,639**
Sherman	1,869	4,701	7,533	10,366	13,198	16,030	**376,673**
Wheeler	102	257	412	566	721	876	**20,583**
Total	**11,704**	**29,437**	**47,169**	**64,902**	**82,635**	**100,368**	**2,358,469**

Table A-3: Estimated Water Savings from Change in Crop Type by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	48	95	143	190	238	286	**7,139**
Carson	1,402	2,804	4,206	5,609	7,011	8,413	**210,323**
Childress	0	0	0	0	0	0	**0**
Collingsworth	8	16	23	31	39	47	**1,172**
Dallam	3,276	6,552	9,828	13,104	16,380	19,656	**491,391**
Donley	135	270	405	540	676	811	**20,267**
Gray	377	754	1,131	1,508	1,885	2,262	**56,559**
Hall	1	1	2	2	3	3	**75**
Hansford	2,859	5,719	8,578	11,438	14,297	17,157	**428,922**
Hartley	3,762	7,525	11,287	15,049	18,812	22,574	**564,348**
Hemphill	2	4	6	7	9	11	**281**
Hutchinson	974	1,948	2,921	3,895	4,869	5,843	**146,074**
Lipscomb	227	454	681	908	1,134	1,361	**34,033**
Moore	2,064	4,127	6,191	8,254	10,318	12,382	**309,543**
Ochiltree	1,221	2,442	3,664	4,885	6,106	7,327	**183,176**
Oldham	24	48	72	97	121	145	**3,620**
Potter	2	5	7	9	11	14	**344**
Randall	115	231	346	462	577	693	**17,317**
Roberts	104	208	312	416	520	623	**15,586**
Sherman	3,694	7,388	11,082	14,776	18,470	22,164	**554,098**
Wheeler	36	72	107	143	179	215	**5,374**
Total	**20,331**	**40,662**	**60,993**	**81,324**	**101,655**	**121,986**	**3,049,640**

Table A-4: Estimated Water Savings from Change in Crop Variety by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	30	61	91	122	152	182	**4,559**
Carson	780	1,560	2,340	3,119	3,899	4,679	**116,981**
Childress	0	1	1	1	2	2	**48**
Collingsworth	14	27	41	54	68	81	**2,029**
Dallam	1,898	3,797	5,695	7,594	9,492	11,391	**284,770**
Donley	68	136	204	272	340	407	**10,186**
Gray	226	453	679	906	1,132	1,358	**33,962**
Hall	3	5	8	10	13	15	**381**
Hansford	1,325	2,650	3,975	5,301	6,626	7,951	**198,770**
Hartley	1,923	3,847	5,770	7,693	9,617	11,540	**288,500**
Hemphill	3	5	8	10	13	15	**382**
Hutchinson	464	928	1,392	1,857	2,321	2,785	**69,622**
Lipscomb	126	251	377	503	629	754	**18,862**
Moore	1,347	2,695	4,042	5,389	6,736	8,084	**202,093**
Ochiltree	650	1,300	1,951	2,601	3,251	3,901	**97,535**
Oldham	16	31	47	63	78	94	**2,345**
Potter	3	7	10	14	17	21	**520**
Randall	82	164	246	328	410	491	**12,285**
Roberts	71	142	213	285	356	427	**10,671**
Sherman	2,206	4,413	6,619	8,825	11,031	13,238	**330,940**
Wheeler	21	43	64	85	106	128	**3,195**
Total	**11,258**	**22,515**	**33,773**	**45,030**	**56,288**	**67,545**	**1,688,636**

Table A-5: Estimated Water Savings from Conversion to Dryland by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	144	288	432	576	720	864	**21,594**
Carson	2,142	4,284	6,425	8,567	10,709	12,851	**321,269**
Childress	339	677	1,016	1,354	1,693	2,031	**50,786**
Collingsworth	1,020	2,039	3,059	4,078	5,098	6,117	**152,933**
Dallam	5,901	11,802	17,703	23,603	29,504	35,405	**885,126**
Donley	664	1,328	1,992	2,656	3,321	3,985	**99,617**
Gray	841	1,681	2,522	3,363	4,203	5,044	**126,105**
Hall	624	1,248	1,872	2,496	3,121	3,745	**93,617**
Hansford	4,032	8,063	12,095	16,127	20,159	24,190	**604,760**
Hartley	7,535	15,070	22,604	30,139	37,674	45,209	**1,130,217**
Hemphill	82	165	247	329	412	494	**12,354**
Hutchinson	1,416	2,832	4,248	5,664	7,080	8,496	**212,403**
Lipscomb	943	1,887	2,830	3,774	4,717	5,660	**141,509**
Moore	4,386	8,771	13,157	17,543	21,929	26,314	**657,861**
Ochiltree	1,956	3,912	5,868	7,824	9,780	11,736	**293,406**
Oldham	111	222	332	443	554	665	**16,620**
Potter	78	156	233	311	389	467	**11,669**
Randall	421	843	1,264	1,685	2,107	2,528	**63,201**
Roberts	208	415	623	830	1,038	1,246	**31,143**
Sherman	5,568	11,135	16,703	22,270	27,838	33,406	**835,139**
Wheeler	351	703	1,054	1,406	1,757	2,109	**52,719**
Total	**38,760**	**77,521**	**116,281**	**155,041**	**193,802**	**232,562**	**5,814,048**

Table A-6: Estimated Water Savings from Soil Management by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	13	24	36	48	60	72	**1,809**
Carson	187	363	538	714	889	1,065	**26,909**
Childress	30	57	85	113	141	168	**4,254**
Collingsworth	89	173	256	340	423	507	**12,809**
Dallam	516	999	1,483	1,966	2,450	2,933	**74,136**
Donley	58	112	167	221	276	330	**8,344**
Gray	73	142	211	280	349	418	**10,562**
Hall	55	106	157	208	259	310	**7,841**
Hansford	352	683	1,013	1,343	1,674	2,004	**50,653**
Hartley	659	1,276	1,893	2,511	3,128	3,745	**94,664**
Hemphill	7	14	21	27	34	41	**1,035**
Hutchinson	124	240	356	472	588	704	**17,790**
Lipscomb	82	160	237	314	392	469	**11,852**
Moore	383	743	1,102	1,461	1,821	2,180	**55,101**
Ochiltree	171	331	491	652	812	972	**24,575**
Oldham	10	19	28	37	46	55	**1,392**
Potter	7	13	20	26	32	39	**977**
Randall	37	71	106	140	175	209	**5,294**
Roberts	18	35	52	69	86	103	**2,608**
Sherman	487	943	1,399	1,855	2,311	2,768	**69,949**
Wheeler	31	60	88	117	146	175	**4,416**
Total	**3,388**	**6,563**	**9,739**	**12,915**	**16,091**	**19,267**	**486,969**

Table A-7: Estimated Water Savings from Irrigation Deferral by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	360	360	360	360	360	360	**17,995**
Carson	5,354	5,354	5,354	5,354	5,354	5,354	**267,724**
Childress	846	846	846	846	846	846	**42,322**
Collingsworth	2,549	2,549	2,549	2,549	2,549	2,549	**127,444**
Dallam	14,752	14,752	14,752	14,752	14,752	14,752	**737,605**
Donley	1,660	1,660	1,660	1,660	1,660	1,660	**83,014**
Gray	2,102	2,102	2,102	2,102	2,102	2,102	**105,087**
Hall	1,560	1,560	1,560	1,560	1,560	1,560	**78,014**
Hansford	10,079	10,079	10,079	10,079	10,079	10,079	**503,966**
Hartley	18,837	18,837	18,837	18,837	18,837	18,837	**941,847**
Hemphill	206	206	206	206	206	206	**10,295**
Hutchinson	3,540	3,540	3,540	3,540	3,540	3,540	**177,003**
Lipscomb	2,358	2,358	2,358	2,358	2,358	2,358	**117,924**
Moore	10,964	10,964	10,964	10,964	10,964	10,964	**548,217**
Ochiltree	4,890	4,890	4,890	4,890	4,890	4,890	**244,505**
Oldham	277	277	277	277	277	277	**13,850**
Potter	194	194	194	194	194	194	**9,724**
Randall	1,053	1,053	1,053	1,053	1,053	1,053	**52,667**
Roberts	519	519	519	519	519	519	**25,953**
Sherman	13,919	13,919	13,919	13,919	13,919	13,919	**695,949**
Wheeler	879	879	879	879	879	879	**43,932**
Total	**96,901**	**96,901**	**96,901**	**96,901**	**96,901**	**96,901**	**4,845,040**

Table A-8: Estimated Water Savings from Advances in Plant Breeding by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	136	409	463	518	518	518	**20,439**
Carson	2,320	6,961	7,890	8,818	8,818	8,818	**348,072**
Childress	338	1,014	1,149	1,284	1,284	1,284	**50,677**
Collingsworth	948	2,843	3,222	3,601	3,601	3,601	**142,163**
Dallam	7,655	22,965	26,027	29,089	29,089	29,089	**1,148,245**
Donley	480	1,441	1,633	1,825	1,825	1,825	**72,041**
Gray	699	2,096	2,375	2,654	2,654	2,654	**104,776**
Hall	734	2,201	2,495	2,788	2,788	2,788	**110,065**
Hansford	4,206	12,617	14,300	15,982	15,982	15,982	**630,869**
Hartley	8,005	24,015	27,217	30,419	30,419	30,419	**1,200,752**
Hemphill	55	166	188	210	210	210	**8,280**
Hutchinson	1,435	4,305	4,879	5,453	5,453	5,453	**215,269**
Lipscomb	426	1,279	1,450	1,620	1,620	1,620	**63,952**
Moore	4,083	12,248	13,881	15,514	15,514	15,514	**612,376**
Ochiltree	2,078	6,234	7,065	7,896	7,896	7,896	**311,683**
Oldham	90	271	307	343	343	343	**13,545**
Potter	45	136	154	172	172	172	**6,809**
Randall	370	1,110	1,257	1,405	1,405	1,405	**55,476**
Roberts	207	621	704	787	787	787	**31,050**
Sherman	7,168	21,505	24,372	27,239	27,239	27,239	**1,075,234**
Wheeler	320	959	1,086	1,214	1,214	1,214	**47,933**
Total	**41,798**	**125,394**	**142,113**	**158,833**	**158,833**	**158,833**	**6,269,707**

Table A-9: Estimated Water Savings from Enhanced Education by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	32	32	32	32	32	32	**1,581**
Carson	490	490	490	490	490	490	**24,483**
Childress	75	75	75	75	75	75	**3,743**
Collingsworth	248	248	248	248	248	248	**12,399**
Dallam	1,703	1,703	1,703	1,703	1,703	1,703	**85,157**
Donley	162	162	162	162	162	162	**8,110**
Gray	185	185	185	185	185	185	**9,238**
Hall	167	167	167	167	167	167	**8,331**
Hansford	878	878	878	878	878	878	**43,921**
Hartley	1,996	1,996	1,996	1,996	1,996	1,996	**99,778**
Hemphill	29	29	29	29	29	29	**1,469**
Hutchinson	309	309	309	309	309	309	**15,466**
Lipscomb	217	217	217	217	217	217	**10,837**
Moore	957	957	957	957	957	957	**47,830**
Ochiltree	433	433	433	433	433	433	**21,671**
Oldham	25	25	25	25	25	25	**1,260**
Potter	17	17	17	17	17	17	**868**
Randall	87	87	87	87	87	87	**4,360**
Roberts	48	48	48	48	48	48	**2,391**
Sherman	1,548	1,548	1,548	1,548	1,548	1,548	**77,380**
Wheeler	85	85	85	85	85	85	**4,228**
Total	**9,690**	**9,690**	**9,690**	**9,690**	**9,690**	**9,690**	**484,504**

Table A-10: Estimated Water Savings from the Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling Combination by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	113	249	383	517	650	770	**19,121**
Carson	2,416	5,172	7,905	10,616	13,303	15,799	**394,119**
Childress	156	366	575	782	988	1,164	**28,666**
Collingsworth	524	1,228	1,927	2,621	3,311	3,903	**96,117**
Dallam	6,808	14,817	22,763	30,644	38,461	45,608	**1,134,931**
Donley	472	1,061	1,645	2,225	2,800	3,311	**82,026**
Gray	760	1,650	2,533	3,409	4,278	5,074	**126,313**
Hall	347	816	1,281	1,743	2,202	2,595	**63,886**
Hansford	4,676	9,960	15,199	20,394	25,544	30,350	**757,728**
Hartley	7,902	17,211	26,446	35,607	44,694	52,994	**1,318,583**
Hemphill	63	147	231	314	397	468	**11,529**
Hutchinson	1,614	3,442	5,254	7,052	8,833	10,494	**261,947**
Lipscomb	677	1,509	2,335	3,154	3,968	4,695	**116,435**
Moore	4,047	8,766	13,446	18,089	22,693	26,922	**670,406**
Ochiltree	2,118	4,538	6,938	9,318	11,678	13,868	**345,913**
Oldham	77	171	265	358	450	533	**13,207**
Potter	38	89	140	190	240	283	**6,985**
Randall	297	655	1,011	1,364	1,714	2,030	**50,408**
Roberts	203	440	674	907	1,138	1,350	**33,623**
Sherman	6,901	14,885	22,804	30,658	38,447	45,628	**1,136,960**
Wheeler	212	484	755	1,024	1,291	1,524	**37,665**
Total	**40,421**	**87,657**	**134,512**	**180,987**	**227,081**	**269,363**	**6,706,571**

Table A-11: Estimated Water Savings from the Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling Combination by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	96	215	333	450	566	669	**16,588**
Carson	1,796	3,939	6,065	8,175	10,268	12,167	**302,432**
Childress	156	367	576	783	990	1,166	**28,713**
Collingsworth	530	1,239	1,944	2,644	3,339	3,936	**96,959**
Dallam	5,437	12,088	18,690	25,241	31,742	37,569	**931,974**
Donley	405	928	1,446	1,961	2,472	2,919	**72,124**
Gray	610	1,352	2,088	2,818	3,543	4,195	**104,118**
Hall	350	820	1,287	1,751	2,212	2,607	**64,186**
Hansford	3,149	6,920	10,662	14,375	18,059	21,396	**531,657**
Hartley	6,071	13,567	21,008	28,394	35,723	42,263	**1,047,627**
Hemphill	64	149	233	317	400	472	**11,628**
Hutchinson	1,106	2,432	3,747	5,052	6,347	7,520	**186,851**
Lipscomb	577	1,309	2,036	2,758	3,474	4,105	**101,533**
Moore	3,333	7,346	11,328	15,279	19,199	22,741	**564,862**
Ochiltree	1,550	3,407	5,250	7,079	8,893	10,536	**261,791**
Oldham	68	154	240	325	409	483	**11,955**
Potter	40	92	144	195	246	290	**7,159**
Randall	263	589	912	1,232	1,551	1,834	**45,465**
Roberts	170	375	578	779	978	1,159	**28,796**
Sherman	5,419	11,938	18,406	24,823	31,190	36,946	**917,759**
Wheeler	197	456	712	967	1,220	1,440	**35,524**
Total	**31,387**	**69,681**	**107,684**	**145,397**	**182,821**	**216,414**	**5,369,703**

Table A-12: Estimated Water Savings from the Change in Crop Type, Advanced in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education Combination by County for Selected Years and Cumulative over 50 years.

County	Water Savings (ac-ft/yr.)						Cumulative ac-ft over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	280	685	871	1,056	1,186	1,304	**40,781**
Carson	5,213	12,553	16,164	19,743	22,384	24,851	**760,567**
Childress	567	1,444	1,781	2,114	2,314	2,486	**82,195**
Collingsworth	1,715	4,290	5,347	6,396	7,067	7,646	**248,149**
Dallam	16,125	39,254	50,093	60,838	68,502	75,556	**2,348,122**
Donley	1,112	2,649	3,414	4,173	4,739	5,244	**160,869**
Gray	1,640	3,909	5,056	6,193	7,048	7,835	**238,462**
Hall	1,244	3,161	3,904	4,640	5,085	5,469	**180,342**
Hansford	9,738	23,329	30,159	36,927	41,993	46,748	**1,421,456**
Hartley	17,858	42,977	55,238	67,393	76,317	84,521	**2,597,825**
Hemphill	147	341	445	549	630	701	**21,121**
Hutchinson	3,350	8,013	10,368	12,703	14,456	16,099	**488,901**
Lipscomb	1,318	2,991	3,977	4,956	5,760	6,482	**190,011**
Moore	9,064	21,846	28,070	34,239	38,762	42,940	**1,319,800**
Ochiltree	4,619	11,143	14,329	17,486	19,804	21,969	**673,802**
Oldham	191	464	592	719	810	891	**27,770**
Potter	101	242	309	377	426	468	**14,537**
Randall	752	1,841	2,336	2,828	3,170	3,482	**109,265**
Roberts	457	1,102	1,415	1,725	1,952	2,162	**66,516**
Sherman	15,578	37,721	48,351	58,887	66,532	73,626	**2,270,683**
Wheeler	614	1,518	1,909	2,298	2,558	2,788	**88,973**
Total	**91,683**	**221,471**	**284,130**	**346,240**	**391,491**	**433,268**	**13,350,146**

Appendix B
Estimated Implementation Cost for Water Conservation Strategies by County for Selected Years and Cumulative over 50 years

Table B-1: Estimated Implementation Cost of Irrigation Scheduling by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$3,559	$7,603	$11,648	$15,692	$19,736	$22,163	**$582,376**
Carson	$52,948	$113,116	$173,285	$233,453	$293,621	$329,722	**$8,664,236**
Childress	$8,370	$17,881	$27,393	$36,904	$46,416	$52,123	**$1,369,646**
Collingsworth	$25,205	$53,846	$82,488	$111,130	$139,772	$156,957	**$4,124,410**
Dallam	$145,877	$311,646	$477,415	$643,185	$808,954	$908,415	**$23,870,768**
Donley	$16,418	$35,074	$53,731	$72,388	$91,044	$102,238	**$2,686,551**
Gray	$20,783	$44,401	$68,018	$91,635	$115,253	$129,423	**$3,400,897**
Hall	$15,429	$32,962	$50,495	$68,027	$85,560	$96,080	**$2,524,729**
Hansford	$99,670	$212,931	$326,193	$439,454	$552,716	$620,672	**$16,309,638**
Hartley	$186,270	$397,941	$609,612	$821,282	$1,032,953	$1,159,955	**$30,480,578**
Hemphill	$2,036	$4,350	$6,664	$8,977	$11,291	$12,679	**$333,182**
Hutchinson	$35,006	$74,786	$114,565	$154,345	$194,124	$217,992	**$5,728,263**
Lipscomb	$23,322	$49,824	$76,326	$102,828	$129,331	$145,232	**$3,816,313**
Moore	$108,422	$231,628	$354,834	$478,040	$601,247	$675,170	**$17,741,704**
Ochiltree	$48,356	$103,306	$158,256	$213,206	$268,156	$301,126	**$7,912,803**
Oldham	$2,739	$5,852	$8,965	$12,077	$15,190	$17,058	**$448,234**
Potter	$1,923	$4,109	$6,294	$8,480	$10,665	$11,976	**$314,707**
Randall	$10,416	$22,252	$34,089	$45,925	$57,762	$64,864	**$1,704,447**
Roberts	$5,133	$10,965	$16,798	$22,631	$28,463	$31,963	**$839,897**
Sherman	$137,639	$294,046	$450,454	$606,861	$763,269	$857,114	**$22,522,694**
Wheeler	$8,689	$18,562	$28,435	$38,309	$48,182	$54,106	**$1,421,766**
Total	**$958,209**	**$2,047,083**	**$3,135,957**	**$4,224,831**	**$5,313,705**	**$5,967,029**	**$156,797,840**

[1]An average operational cost of $15 per acre annually was assumed for services including any required equipment.

Table B-2: Estimated Implementation Cost of Irrigation Equipment Changes by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$53,829	$81,560	$81,560	$81,560	$81,560	$81,560	**$380,068**
Carson	$800,840	$1,213,394	$1,213,394	$1,213,394	$1,213,394	$1,213,394	**$5,654,417**
Childress	$126,597	$191,814	$191,814	$191,814	$191,814	$191,814	**$893,852**
Collingsworth	$381,222	$577,608	$577,608	$577,608	$577,608	$577,608	**$2,691,655**
Dallam	$2,206,388	$3,343,013	$3,343,013	$3,343,013	$3,343,013	$3,343,013	**$15,578,439**
Donley	$248,319	$376,241	$376,241	$376,241	$376,241	$376,241	**$1,753,285**
Gray	$314,347	$476,283	$476,283	$476,283	$476,283	$476,283	**$2,219,479**
Hall	$233,362	$353,579	$353,579	$353,579	$353,579	$353,579	**$1,647,678**
Hansford	$1,507,509	$2,284,104	$2,284,104	$2,284,104	$2,284,104	$2,284,104	**$10,643,927**
Hartley	$2,817,337	$4,268,692	$4,268,692	$4,268,692	$4,268,692	$4,268,692	**$19,892,105**
Hemphill	$30,796	$46,661	$46,661	$46,661	$46,661	$46,661	**$217,440**
Hutchinson	$529,467	$802,222	$802,222	$802,222	$802,222	$802,222	**$3,738,355**
Lipscomb	$352,744	$534,461	$534,461	$534,461	$534,461	$534,461	**$2,490,586**
Moore	$1,639,876	$2,484,660	$2,484,660	$2,484,660	$2,484,660	$2,484,660	**$11,578,515**
Ochiltree	$731,385	$1,108,159	$1,108,159	$1,108,159	$1,108,159	$1,108,159	**$5,164,020**
Oldham	$41,431	$62,773	$62,773	$62,773	$62,773	$62,773	**$292,525**
Potter	$29,089	$44,074	$44,074	$44,074	$44,074	$44,074	**$205,383**
Randall	$157,543	$238,701	$238,701	$238,701	$238,701	$238,701	**$1,112,349**
Roberts	$77,632	$117,624	$117,624	$117,624	$117,624	$117,624	**$548,130**
Sherman	$2,081,785	$3,154,220	$3,154,220	$3,154,220	$3,154,220	$3,154,220	**$14,698,665**
Wheeler	$131,415	$199,113	$199,113	$199,113	$199,113	$199,113	**$927,867**
Total	**$14,492,911**	**$21,958,957**	**$21,958,957**	**$21,958,957**	**$21,958,957**	**$21,958,957**	**$102,328,738**

[1]The average capital cost of conversion was $151.25 per acre with no change in operational costs.

Table B-3: Estimated Implementation Cost of Change in Crop Type by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$6,354	$12,707	$19,061	$25,414	$31,768	$38,121	**$953,033**
Carson	$187,187	$374,375	$561,562	$748,749	$935,936	$1,123,124	**$28,078,095**
Childress	$0	$0	$0	$0	$0	$0	**$0**
Collingsworth	$1,043	$2,085	$3,128	$4,171	$5,214	$6,256	**$156,409**
Dallam	$437,338	$874,675	$1,312,013	$1,749,351	$2,186,689	$2,624,026	**$65,600,660**
Donley	$18,038	$36,075	$54,113	$72,151	$90,189	$108,226	**$2,705,662**
Gray	$50,338	$100,675	$151,013	$201,350	$251,688	$302,025	**$7,550,630**
Hall	$67	$134	$200	$267	$334	$401	**$10,013**
Hansford	$381,741	$763,481	$1,145,222	$1,526,963	$1,908,703	$2,290,444	**$57,261,104**
Hartley	$502,269	$1,004,539	$1,506,808	$2,009,078	$2,511,347	$3,013,616	**$75,340,408**
Hemphill	$250	$500	$750	$1,000	$1,251	$1,501	**$37,519**
Hutchinson	$130,006	$260,011	$390,017	$520,022	$650,028	$780,033	**$19,500,827**
Lipscomb	$30,289	$60,578	$90,867	$121,157	$151,446	$181,735	**$4,543,372**
Moore	$275,493	$550,986	$826,479	$1,101,973	$1,377,466	$1,652,959	**$41,323,969**
Ochiltree	$163,027	$326,054	$489,081	$652,108	$815,135	$978,162	**$24,454,043**
Oldham	$3,221	$6,443	$9,664	$12,886	$16,107	$19,329	**$483,218**
Potter	$306	$612	$917	$1,223	$1,529	$1,835	**$45,866**
Randall	$15,412	$30,824	$46,236	$61,649	$77,061	$92,473	**$2,311,825**
Roberts	$13,872	$27,743	$41,615	$55,486	$69,358	$83,229	**$2,080,726**
Sherman	$493,147	$986,294	$1,479,442	$1,972,589	$2,465,736	$2,958,883	**$73,972,081**
Wheeler	$4,783	$9,566	$14,349	$19,132	$23,915	$28,698	**$717,439**
Total	**$2,714,179**	**$5,428,359**	**$8,142,538**	**$10,856,717**	**$13,570,897**	**$16,285,076**	**$407,126,898**

[1]The cost of implementing this water conservation strategy was evaluated in terms of reduced land values as a result of reduced water availability, which is reflected in the rental rate difference of $111.25/acre.

Table B-4: Estimated Implementation Cost of Change in Crop Variety by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$7,601	$15,203	$22,804	$30,406	$38,007	$45,609	**$1,140,214**
Carson	$205,825	$411,649	$617,474	$823,298	$1,029,123	$1,234,948	**$30,873,691**
Childress	$50	$100	$150	$200	$249	$299	**$7,482**
Collingsworth	$2,585	$5,171	$7,756	$10,342	$12,927	$15,512	**$387,811**
Dallam	$492,855	$985,710	$1,478,565	$1,971,420	$2,464,275	$2,957,130	**$73,928,247**
Donley	$18,699	$37,397	$56,096	$74,794	$93,493	$112,191	**$2,804,784**
Gray	$57,966	$115,932	$173,898	$231,864	$289,830	$347,796	**$8,694,908**
Hall	$428	$855	$1,283	$1,711	$2,139	$2,566	**$64,156**
Hansford	$378,172	$756,345	$1,134,517	$1,512,690	$1,890,862	$2,269,035	**$56,725,874**
Hartley	$525,753	$1,051,505	$1,577,258	$2,103,011	$2,628,764	$3,154,516	**$78,862,906**
Hemphill	$510	$1,021	$1,531	$2,042	$2,552	$3,063	**$76,567**
Hutchinson	$130,805	$261,610	$392,415	$523,220	$654,025	$784,830	**$19,620,750**
Lipscomb	$33,235	$66,470	$99,704	$132,939	$166,174	$199,409	**$4,985,214**
Moore	$334,189	$668,379	$1,002,568	$1,336,757	$1,670,946	$2,005,136	**$50,128,395**
Ochiltree	$174,717	$349,435	$524,152	$698,870	$873,587	$1,048,305	**$26,207,620**
Oldham	$3,889	$7,778	$11,667	$15,557	$19,446	$23,335	**$583,371**
Potter	$680	$1,359	$2,039	$2,719	$3,398	$4,078	**$101,951**
Randall	$19,719	$39,438	$59,157	$78,876	$98,596	$118,315	**$2,957,867**
Roberts	$17,345	$34,690	$52,035	$69,380	$86,724	$104,069	**$2,601,731**
Sherman	$566,019	$1,132,038	$1,698,057	$2,264,076	$2,830,095	$3,396,115	**$84,902,864**
Wheeler	$5,474	$10,948	$16,422	$21,896	$27,371	$32,845	**$821,117**
Total	**$2,976,517**	**$5,953,034**	**$8,929,550**	**$11,906,067**	**$14,882,584**	**$17,859,101**	**$446,477,518**

[1]The cost per acre-foot saved is $98.01 per acre for corn and $80.97 per acre for sorghum, respectively, which reflects the net change in seed cost, pumping cost, fertilizer, and harvest expenses as well as changes in crop yield.

Table B-5: Estimated Implementation Cost of Conversion to Dryland by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$197,900	$197,900	$197,900	$197,900	$197,900	$197,900	**$989,500**
Carson	$2,944,236	$2,944,236	$2,944,236	$2,944,236	$2,944,236	$2,944,236	**$14,721,179**
Childress	$465,426	$465,426	$465,426	$465,426	$465,426	$465,426	**$2,327,130**
Collingsworth	$1,401,536	$1,401,536	$1,401,536	$1,401,536	$1,401,536	$1,401,536	**$7,007,679**
Dallam	$8,111,641	$8,111,641	$8,111,641	$8,111,641	$8,111,641	$8,111,641	**$40,558,203**
Donley	$912,930	$912,930	$912,930	$912,930	$912,930	$912,930	**$4,564,649**
Gray	$1,155,675	$1,155,675	$1,155,675	$1,155,675	$1,155,675	$1,155,675	**$5,778,376**
Hall	$857,940	$857,940	$857,940	$857,940	$857,940	$857,940	**$4,289,702**
Hansford	$5,542,257	$5,542,257	$5,542,257	$5,542,257	$5,542,257	$5,542,257	**$27,711,283**
Hartley	$10,357,752	$10,357,752	$10,357,752	$10,357,752	$10,357,752	$10,357,752	**$51,788,761**
Hemphill	$113,220	$113,220	$113,220	$113,220	$113,220	$113,220	**$566,101**
Hutchinson	$1,946,549	$1,946,549	$1,946,549	$1,946,549	$1,946,549	$1,946,549	**$9,732,743**
Lipscomb	$1,296,840	$1,296,840	$1,296,840	$1,296,840	$1,296,840	$1,296,840	**$6,484,199**
Moore	$6,028,894	$6,028,894	$6,028,894	$6,028,894	$6,028,894	$6,028,894	**$30,144,469**
Ochiltree	$2,688,888	$2,688,888	$2,688,888	$2,688,888	$2,688,888	$2,688,888	**$13,444,439**
Oldham	$152,317	$152,317	$152,317	$152,317	$152,317	$152,317	**$761,583**
Potter	$106,942	$106,942	$106,942	$106,942	$106,942	$106,942	**$534,710**
Randall	$579,196	$579,196	$579,196	$579,196	$579,196	$579,196	**$2,895,981**
Roberts	$285,409	$285,409	$285,409	$285,409	$285,409	$285,409	**$1,427,047**
Sherman	$7,653,545	$7,653,545	$7,653,545	$7,653,545	$7,653,545	$7,653,545	**$38,267,726**
Wheeler	$483,137	$483,137	$483,137	$483,137	$483,137	$483,137	**$2,415,685**
Total	**$53,282,229**	**$53,282,229**	**$53,282,229**	**$53,282,229**	**$53,282,229**	**$53,282,229**	**$266,411,145**

[1]The implementation cost to retire an acre of average irrigated land was $1,835 assuming the land would be suitable for dryland production.

Table B-6: Estimated Implementation Cost of Soil Management by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$0	$0	$0	$0	$0	$0	**$0**
Carson	$0	$0	$0	$0	$0	$0	**$0**
Childress	$0	$0	$0	$0	$0	$0	**$0**
Collingsworth	$0	$0	$0	$0	$0	$0	**$0**
Dallam	$0	$0	$0	$0	$0	$0	**$0**
Donley	$0	$0	$0	$0	$0	$0	**$0**
Gray	$0	$0	$0	$0	$0	$0	**$0**
Hall	$0	$0	$0	$0	$0	$0	**$0**
Hansford	$0	$0	$0	$0	$0	$0	**$0**
Hartley	$0	$0	$0	$0	$0	$0	**$0**
Hemphill	$0	$0	$0	$0	$0	$0	**$0**
Hutchinson	$0	$0	$0	$0	$0	$0	**$0**
Lipscomb	$0	$0	$0	$0	$0	$0	**$0**
Moore	$0	$0	$0	$0	$0	$0	**$0**
Ochiltree	$0	$0	$0	$0	$0	$0	**$0**
Oldham	$0	$0	$0	$0	$0	$0	**$0**
Potter	$0	$0	$0	$0	$0	$0	**$0**
Randall	$0	$0	$0	$0	$0	$0	**$0**
Roberts	$0	$0	$0	$0	$0	$0	**$0**
Sherman	$0	$0	$0	$0	$0	$0	**$0**
Wheeler	$0	$0	$0	$0	$0	$0	**$0**
Total	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**

[1]The implementation cost was the annualized cost difference between conventional and conservation tillage which was assumed to be zero for this study.

Table B-7: Estimated Implementation Cost of Irrigation Deferral by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$35,050	$35,050	$35,050	$35,050	$35,050	$35,050	**$1,752,520**
Carson	$521,459	$521,459	$521,459	$521,459	$521,459	$521,459	**$26,072,932**
Childress	$82,432	$82,432	$82,432	$82,432	$82,432	$82,432	**$4,121,619**
Collingsworth	$248,228	$248,228	$248,228	$248,228	$248,228	$248,228	**$12,411,420**
Dallam	$1,436,667	$1,436,667	$1,436,667	$1,436,667	$1,436,667	$1,436,667	**$71,833,330**
Donley	$161,691	$161,691	$161,691	$161,691	$161,691	$161,691	**$8,084,528**
Gray	$204,684	$204,684	$204,684	$204,684	$204,684	$204,684	**$10,234,181**
Hall	$151,951	$151,951	$151,951	$151,951	$151,951	$151,951	**$7,597,564**
Hansford	$981,599	$981,599	$981,599	$981,599	$981,599	$981,599	**$49,079,930**
Hartley	$1,834,479	$1,834,479	$1,834,479	$1,834,479	$1,834,479	$1,834,479	**$91,723,963**
Hemphill	$20,053	$20,053	$20,053	$20,053	$20,053	$20,053	**$1,002,632**
Hutchinson	$344,757	$344,757	$344,757	$344,757	$344,757	$344,757	**$17,237,829**
Lipscomb	$229,686	$229,686	$229,686	$229,686	$229,686	$229,686	**$11,484,276**
Moore	$1,067,788	$1,067,788	$1,067,788	$1,067,788	$1,067,788	$1,067,788	**$53,389,387**
Ochiltree	$476,234	$476,234	$476,234	$476,234	$476,234	$476,234	**$23,811,676**
Oldham	$26,977	$26,977	$26,977	$26,977	$26,977	$26,977	**$1,348,852**
Potter	$18,941	$18,941	$18,941	$18,941	$18,941	$18,941	**$947,034**
Randall	$102,582	$102,582	$102,582	$102,582	$102,582	$102,582	**$5,129,122**
Roberts	$50,549	$50,549	$50,549	$50,549	$50,549	$50,549	**$2,527,468**
Sherman	$1,355,533	$1,355,533	$1,355,533	$1,355,533	$1,355,533	$1,355,533	**$67,776,626**
Wheeler	$85,569	$85,569	$85,569	$85,569	$85,569	$85,569	**$4,278,462**
Total	**$9,436,907**	**$9,436,907**	**$9,436,907**	**$9,436,907**	**$9,436,907**	**$9,436,907**	**$471,845,351**

[1]The implementation cost was the estimated compensation rate required of $130.00 per acre.

Table B-8: Estimated Implementation Cost of Advances in Plant Breeding by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$11,619	$34,858	$39,506	$44,154	$44,154	$44,154	**$1,742,924**
Carson	$190,089	$570,268	$646,304	$722,340	$722,340	$722,340	**$28,513,418**
Childress	$28,620	$85,860	$97,308	$108,756	$108,756	$108,756	**$4,292,984**
Collingsworth	$72,979	$218,938	$248,130	$277,322	$277,322	$277,322	**$10,946,916**
Dallam	$496,711	$1,490,134	$1,688,819	$1,887,504	$1,887,504	$1,887,504	**$74,506,719**
Donley	$36,828	$110,483	$125,214	$139,945	$139,945	$139,945	**$5,524,134**
Gray	$59,525	$178,576	$202,386	$226,196	$226,196	$226,196	**$8,928,801**
Hall	$51,473	$154,419	$175,008	$195,597	$195,597	$195,597	**$7,720,926**
Hansford	$361,520	$1,084,560	$1,229,168	$1,373,776	$1,373,776	$1,373,776	**$54,227,993**
Hartley	$566,063	$1,698,189	$1,924,614	$2,151,040	$2,151,040	$2,151,040	**$84,909,458**
Hemphill	$2,898	$8,694	$9,853	$11,012	$11,012	$11,012	**$434,677**
Hutchinson	$123,038	$369,113	$418,328	$467,543	$467,543	$467,543	**$18,455,643**
Lipscomb	$34,754	$104,262	$118,164	$132,066	$132,066	$132,066	**$5,213,124**
Moore	$350,537	$1,051,612	$1,191,826	$1,332,041	$1,332,041	$1,332,041	**$52,580,576**
Ochiltree	$175,628	$526,885	$597,136	$667,388	$667,388	$667,388	**$26,344,244**
Oldham	$7,436	$22,307	$25,281	$28,255	$28,255	$28,255	**$1,115,345**
Potter	$3,810	$11,429	$12,953	$14,477	$14,477	$14,477	**$571,469**
Randall	$33,465	$100,395	$113,781	$127,167	$127,167	$127,167	**$5,019,742**
Roberts	$16,831	$50,494	$57,227	$63,960	$63,960	$63,960	**$2,524,720**
Sherman	$482,967	$1,448,900	$1,642,087	$1,835,273	$1,835,273	$1,835,273	**$72,445,003**
Wheeler	$24,873	$74,618	$84,567	$94,516	$94,516	$94,516	**$3,730,894**
Total	**$3,131,665**	**$9,394,994**	**$10,647,660**	**$11,900,326**	**$11,900,326**	**$11,900,326**	**$469,749,708**

[1]The implementation cost of this strategy was the additional operational cost of drought-tolerant seed estimated at $1 for every 1% reduction in water use.

Table B-9: Estimated Implementation Cost of Enhanced Education by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/decade.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$1,486	$1,486	$1,486	$1,486	$1,486	$1,486	**$74,284**
Carson	$22,103	$22,103	$22,103	$22,103	$22,103	$22,103	**$1,105,147**
Childress	$3,494	$3,494	$3,494	$3,494	$3,494	$3,494	**$174,702**
Collingsworth	$10,522	$10,522	$10,522	$10,522	$10,522	$10,522	**$526,080**
Dallam	$60,896	$60,896	$60,896	$60,896	$60,896	$60,896	**$3,044,783**
Donley	$6,854	$6,854	$6,854	$6,854	$6,854	$6,854	**$342,677**
Gray	$8,676	$8,676	$8,676	$8,676	$8,676	$8,676	**$433,794**
Hall	$6,441	$6,441	$6,441	$6,441	$6,441	$6,441	**$322,036**
Hansford	$41,607	$41,607	$41,607	$41,607	$41,607	$41,607	**$2,080,340**
Hartley	$77,758	$77,758	$77,758	$77,758	$77,758	$77,758	**$3,887,882**
Hemphill	$850	$850	$850	$850	$850	$850	**$42,498**
Hutchinson	$14,613	$14,613	$14,613	$14,613	$14,613	$14,613	**$730,656**
Lipscomb	$9,736	$9,736	$9,736	$9,736	$9,736	$9,736	**$486,781**
Moore	$45,260	$45,260	$45,260	$45,260	$45,260	$45,260	**$2,263,004**
Ochiltree	$20,186	$20,186	$20,186	$20,186	$20,186	$20,186	**$1,009,300**
Oldham	$1,143	$1,143	$1,143	$1,143	$1,143	$1,143	**$57,173**
Potter	$803	$803	$803	$803	$803	$803	**$40,142**
Randall	$4,348	$4,348	$4,348	$4,348	$4,348	$4,348	**$217,407**
Roberts	$2,143	$2,143	$2,143	$2,143	$2,143	$2,143	**$107,131**
Sherman	$57,457	$57,457	$57,457	$57,457	$57,457	$57,457	**$2,872,832**
Wheeler	$3,627	$3,627	$3,627	$3,627	$3,627	$3,627	**$181,350**
Total	**$400,000**	**$400,000**	**$400,000**	**$400,000**	**$400,000**	**$400,000**	**$20,000,000**

[1]The implementation cost was $400,000/year including $150,000 in operational cost and $250,000 in potential cost-share funds.

Table B-10: Estimated Implementation Cost of the Change in Crop Type, Irrigation Equipment Changes, and Irrigation Scheduling Combination by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$152,954	$284,663	$388,641	$492,620	$596,598	$684,399	**$1,915,476**
Carson	$3,202,194	$6,088,304	$8,561,860	$11,035,416	$13,508,972	$15,741,855	**$42,396,747**
Childress	$210,298	$370,629	$465,743	$560,857	$655,972	$713,040	**$2,263,498**
Collingsworth	$643,696	$1,136,928	$1,433,772	$1,730,617	$2,027,461	$2,209,739	**$6,972,474**
Dallam	$8,038,535	$15,206,229	$21,237,298	$27,268,368	$33,299,438	$38,667,430	**$105,049,867**
Donley	$592,875	$1,087,741	$1,454,684	$1,821,628	$2,188,571	$2,480,888	**$7,145,498**
Gray	$1,025,555	$1,927,040	$2,666,588	$3,406,137	$4,145,686	$4,790,765	**$13,171,006**
Hall	$388,319	$684,531	$860,527	$1,036,523	$1,212,519	$1,318,384	**$4,182,419**
Hansford	$6,321,616	$12,048,232	$16,998,253	$21,948,274	$26,898,294	$31,395,269	**$84,214,669**
Hartley	$9,702,733	$18,293,489	$25,432,889	$32,572,290	$39,711,691	$46,004,409	**$125,713,092**
Hemphill	$53,659	$95,162	$120,801	$146,440	$172,079	$188,463	**$588,141**
Hutchinson	$2,179,582	$4,150,189	$5,848,040	$7,545,891	$9,243,743	$10,782,475	**$28,967,445**
Lipscomb	$888,855	$1,638,484	$2,206,398	$2,774,311	$3,342,224	$3,804,129	**$10,850,272**
Moore	$5,479,022	$10,310,801	$14,297,795	$18,284,789	$22,271,783	$25,765,952	**$70,644,189**
Ochiltree	$2,845,215	$5,401,758	$7,581,528	$9,761,298	$11,941,067	$13,901,037	**$37,530,866**
Oldham	$101,037	$185,722	$249,064	$312,406	$375,748	$426,639	**$1,223,977**
Potter	$51,378	$91,276	$116,188	$141,100	$166,013	$182,183	**$565,955**
Randall	$415,825	$769,470	$1,041,956	$1,314,442	$1,586,928	$1,812,068	**$5,128,620**
Roberts	$267,674	$504,708	$701,749	$898,790	$1,095,832	$1,269,542	**$3,468,753**
Sherman	$8,389,644	$15,957,627	$22,453,175	$28,948,723	$35,444,271	$41,314,189	**$111,193,441**
Wheeler	$266,130	$480,391	$626,954	$773,517	$920,080	$1,027,149	**$3,067,071**
Total	**$51,216,795**	**$96,713,372**	**$134,743,904**	**$172,774,436**	**$210,804,968**	**$244,480,005**	**$666,253,476**

[1]The implementation costs were calculated as the sum of the implementation costs for change in crop type, irrigation equipment changes, and irrigation scheduling.

Table B-11: Estimated Implementation Cost of the Change in Crop Variety, Irrigation Equipment Changes, and Irrigation Scheduling Combination by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$165,433	$309,620	$426,077	$542,534	$658,992	$759,271	**$2,102,657**
Carson	$3,388,567	$6,461,050	$9,120,979	$11,780,908	$14,440,838	$16,860,093	**$45,192,343**
Childress	$210,796	$371,626	$467,239	$562,852	$658,465	$716,033	**$2,270,980**
Collingsworth	$659,123	$1,167,781	$1,480,053	$1,792,324	$2,104,595	$2,302,300	**$7,203,876**
Dallam	$8,593,707	$16,316,574	$22,902,816	$29,489,058	$36,075,300	$41,998,465	**$113,377,454**
Donley	$599,483	$1,100,957	$1,474,508	$1,848,060	$2,221,612	$2,520,537	**$7,244,620**
Gray	$1,101,840	$2,079,610	$2,895,444	$3,711,278	$4,527,112	$5,248,477	**$14,315,284**
Hall	$391,928	$691,750	$871,356	$1,050,961	$1,230,567	$1,340,041	**$4,236,563**
Hansford	$6,285,934	$11,976,868	$16,891,207	$21,805,546	$26,719,884	$31,181,178	**$83,679,439**
Hartley	$9,937,566	$18,763,155	$26,137,389	$33,511,623	$40,885,857	$47,413,408	**$129,235,590**
Hemphill	$56,262	$100,369	$128,611	$156,853	$185,095	$204,082	**$627,189**
Hutchinson	$2,187,577	$4,166,179	$5,872,025	$7,577,871	$9,283,717	$10,830,444	**$29,087,367**
Lipscomb	$918,311	$1,697,397	$2,294,766	$2,892,135	$3,489,505	$3,980,865	**$11,292,113**
Moore	$6,065,984	$11,484,724	$16,058,680	$20,632,635	$25,206,591	$29,287,722	**$79,448,614**
Ochiltree	$2,962,120	$5,635,568	$7,932,243	$10,228,918	$12,525,593	$14,602,468	**$39,284,443**
Oldham	$107,714	$199,076	$269,094	$339,113	$409,132	$466,700	**$1,324,129**
Potter	$55,117	$98,754	$127,405	$156,056	$184,708	$204,617	**$622,040**
Randall	$458,895	$855,609	$1,171,164	$1,486,720	$1,802,275	$2,070,485	**$5,774,662**
Roberts	$302,408	$574,175	$805,950	$1,037,725	$1,269,500	$1,477,945	**$3,989,758**
Sherman	$9,118,363	$17,415,065	$24,639,332	$31,863,598	$39,087,865	$45,686,502	**$122,124,223**
Wheeler	$273,041	$494,215	$647,690	$801,165	$954,639	$1,068,621	**$3,170,750**
Total	**$53,840,169**	**$101,960,122**	**$142,614,028**	**$183,267,935**	**$223,921,842**	**$260,220,253**	**$705,604,096**

[1]The implementation costs were calculated as the sum of the implementation costs for change in crop variety, irrigation equipment changes, and irrigation scheduling.

Table B-12: Estimated Implementation Cost of the Change in Crop Type, Advances in Plant Breeding, Irrigation Equipment Changes, Irrigation Scheduling, and Enhanced Education Combination by County for Selected Years and Cumulative over 50 years.[1]

County	Total Cost ($/yr.)						Cumulative cost over 50 years
	2030	2040	2050	2060	2070	2080	
Armstrong	$269,149	$633,248	$783,704	$934,160	$1,038,139	$1,125,940	**$3,658,401**
Carson	$5,103,089	$11,790,988	$15,024,902	$18,258,815	$20,732,371	$22,965,254	**$70,910,165**
Childress	$496,497	$1,229,225	$1,438,819	$1,648,413	$1,743,527	$1,800,596	**$6,556,482**
Collingsworth	$1,373,490	$3,326,311	$3,915,073	$4,503,835	$4,800,680	$4,982,958	**$17,919,390**
Dallam	$13,005,649	$30,107,573	$38,125,488	$46,143,403	$52,174,473	$57,542,466	**$179,556,586**
Donley	$961,151	$2,192,567	$2,706,821	$3,221,075	$3,588,018	$3,880,336	**$12,669,633**
Gray	$1,620,808	$3,712,800	$4,690,450	$5,668,100	$6,407,649	$7,052,728	**$22,099,807**
Hall	$903,047	$2,228,717	$2,610,604	$2,992,491	$3,168,487	$3,274,351	**$11,903,345**
Hansford	$9,936,815	$22,893,831	$29,289,931	$35,686,032	$40,636,052	$45,133,028	**$138,442,662**
Hartley	$15,363,363	$35,275,380	$44,679,033	$54,082,686	$61,222,087	$67,514,805	**$210,622,549**
Hemphill	$82,637	$182,098	$219,328	$256,558	$282,197	$298,581	**$1,022,817**
Hutchinson	$3,409,958	$7,841,318	$10,031,319	$12,221,321	$13,919,172	$15,457,905	**$47,423,088**
Lipscomb	$1,236,396	$2,681,109	$3,388,039	$4,094,969	$4,662,882	$5,124,787	**$16,063,395**
Moore	$8,984,394	$20,826,916	$26,216,058	$31,605,201	$35,592,195	$39,086,364	**$123,224,764**
Ochiltree	$4,601,497	$10,670,607	$13,552,890	$16,435,173	$18,614,943	$20,574,912	**$63,875,110**
Oldham	$175,393	$408,791	$501,876	$594,960	$658,302	$709,193	**$2,339,322**
Potter	$89,476	$205,570	$245,721	$285,873	$310,785	$326,955	**$1,137,424**
Randall	$750,475	$1,773,418	$2,179,764	$2,586,110	$2,858,596	$3,083,736	**$10,148,362**
Roberts	$435,989	$1,009,652	$1,274,019	$1,538,386	$1,735,427	$1,909,138	**$5,993,473**
Sherman	$13,219,311	$30,446,628	$38,874,042	$47,301,457	$53,797,005	$59,666,923	**$183,638,443**
Wheeler	$514,856	$1,226,570	$1,472,623	$1,718,677	$1,865,240	$1,972,309	**$6,797,966**
Total	**$86,533,442**	**$194,663,314**	**$245,220,505**	**$295,777,696**	**$333,808,228**	**$367,483,264**	**$1,156,003,184**

[1]The implementation costs were calculated as the sum of the implementation costs for change in crop type, advances in plant breeding, irrigation equipment changes, irrigation scheduling, and enhanced education.

APPENDIX D

COST ESTIMATES

Panhandle Regional Water Planning Area Cost Estimates

As part of the 2026 Panhandle Regional Water Plan, cost estimates were developed for each of the recommended water management strategies for the PWPA. In accordance with the Texas Water Development Board guidance the costs for water management strategies are reported in September 2023 dollars. The methodology used to develop the 2026 costs is described in the following sections. When detailed costs were provided by the sponsor, these costs were used, and where necessary, the costs were adjusted to September 2023 dollars using the Engineering News Record (ENR) Index for construction.

D.1 Introduction

1. The evaluation of water management strategies requires developing cost estimates. Guidance for cost estimates may be found in the TWDB's "Second Amended General Guidelines for Development of the 2026 Regional Water Plans (Exhibit C)", Section 2.5.2.12. Costs are to be reported in September 2023 dollars.
2. Standard unit costs for installed pipe, pump stations, standard treatment facilities, and well fields were developed and/or updated using the costing tool provided by the TWDB. The unit costs do not include engineering, contingency, financial and legal services, costs for land and rights-of-way, permits, environmental and archeological studies, or mitigation. The costs for these items are determined separately in the cost tables.
3. The information presented in this section is intended to be 'rule-of-thumb' guidance. Specific situations may call for alteration of the procedures and costs. Note that the costs in this memorandum provide a planning level estimate for comparison purposes.
4. It is important that when comparing alternatives that the cost estimates be similar and include similar items. If an existing reliable cost estimate is available for a project, it should be used where appropriate. All cost estimates must meet the requirements set forth in the TWDB's "Second Amended General Guidelines for Development of the 2026 Regional Water Plans (Exhibit C)"
5. The cost estimates have two components:
    - Initial Capital Costs: Including total construction cost of facilities, engineering and legal contingencies, environmental and archaeology studies and mitigation, land acquisition and surveying, and interest incurred during construction (3.5% annual interest rate less a 0.5% rate of return on investment of unspent funds).
    - Average Annual Costs: Including annual operation and maintenance costs, pumping energy costs, purchase of water and debt service.

TWDB does not require the consultant to determine life cycle or present value analysis. For most situations annual costs are sufficient for comparison purposes and a life-cycle analysis is not required.

D.2 Assumptions for Capital Costs

The unit cost and factors show in the **Table D-1**through **Table D-7**were developed directly from the TWDB Costing Tool. These costs are the basis of the capital costs developed for this plan. If applicable, other capital costs should include:

- Engineering, contingencies, financial, and legal services
- Permitting and mitigation activities, including, but not limited to archeological/historic resources, environmental and biological analyses, mitigation activities (evaluation, land acquisition, implementation, monitoring), and other activities.
- Land purchase costs not associated with mitigation.
- Easement costs. For pipelines, this includes a permanent easement plus a temporary construction easement as well as rights to enter easements for maintenance
- Purchases of water rights.

Conveyance Systems

Standard pipeline costs used for these cost estimates are shown in **Table D-1**. Pump station costs are based on required Horsepower capacity of capacity (MGD) and are listed in **Table D-2**. The power capacity is to be determined from the hydraulic analyses included in the TWDB costing tool (or detailed analysis if available). Pipelines and pump stations are to be sized for peak pumping capacity.

- Pump efficiency is assumed to be 70 percent.
- Peaking factor of 2 times the average demand is to be used for strategies when the water is pumped directly to a water treatment plant. (or historical peaking factor, if available)
- Peaking factor of 1.2 to 1.5 can be used if there are additional water sources and/or the water is transported to a terminal storage facility.
- The target flow velocity in pipes is 5 fps and the Hazen-Williams Factor is assumed to be 120.
- Ground storage is to be provided at each booster pump station along the transmission line unless there is a more detailed design.
- Ground storage tanks should provide sufficient storage for 2.5 to 4 hours of pumping at peak capacity. Costs for ground storage are shown in **Table D-3**. Covered storage tanks are used for all strategies transporting treated water.

Water Treatment Plants

Water treatment plants are to be sized for peak day capacity (assume peaking factor of 2 if no specific data is available). Costs estimated include six different treatment levels of varying degree. These levels are groundwater chlorine disinfection, iron and manganese removal, simple filtration, construction of a new conventional treatment plant, expansion of a conventional treatment plant, brackish desalination, and seawater desalination. Costs are also based upon a TDS factor that will increase or decrease the cost of treatment accordingly. These costs are summarized in **Table D-4**. All treatment plants are to be sized for finished water capacity.

Direct Reuse

Direct reuse refers to the introduction of reclaimed water directly from a water reclamation plant to a distribution system. The following assumptions were made for direct potable and non-potable reuse strategies.

Direct Potable Reuse

Direct potable reuse (DRP) is the use of reclaimed water that is transported directly from a wastewater treatment plant to a drinking water system. In the most recent version of the TWDB costing tool, cost estimation tables for advanced water treatment facilities (AWTF) were added for direct potable reuse strategies. These costs were adapted from TWDB DPR Resource Document and are summarized in **Table D-5**. There are two AWTF schemes listed for direct potable reuse. The primary difference between the two is the use of RO, which is included in Scheme 1, but not in Scheme 2. In order to utilize Scheme 2, nitrogen must be removed at the WWTP.

Direct Non-Potable Reuse

Non-potable reuse is the use of reclaimed water that is used directly for non-potable beneficial uses such as landscape irrigation. The TWDB costing tool currently does not have a direct non-potable reuse treatment plant improvements option, therefore the following assumptions were made.

- It was assumed that the cost of an iron and manganese removal plant would be an appropriate approximation of the improvements that would be needed at the Wastewater Treatment Plant. This cost was further refined by assuming that only upgrades to an existing facility would be required, and not construction of an entirely new plant.
- Approximately two miles of 6-inch pipeline was also included in the cost estimates for transport of the treated water to the destination. Since reuse is still relatively new, there is a lack of piping infrastructure for reuse water. It was also assumed that the pump station was included in the WWTP improvements.

New Groundwater Wells

Cost estimates required for water management strategies that include additional wells or well fields were determined through the TWDB costing tool (unless a more detailed design was available). The associated costs are shown in **Table D-6**. The costing tool differentiated the wells based upon purpose. The categories were Public Supply, Irrigation, and Aquifer Storage and Recovery (ASR). These cost relationships are “rule-of-thumb” in nature and are only appropriate in the broad context of the cost evaluations for the RWP process.

The cost relationships assume construction methods required for public water supply wells, including carbon steel surface casing and pipe-based, stainless steel, and wire-wrap screen. The cost estimates assume that wells would be gravel-packed in the screen sections and the surface casing cemented to their total depth. Estimates include the cost of drilling, completion, well development, well testing, pump, motor, motor controls, column pipe, installation and mobilization. The cost relationships do not include engineering, contingency, financial and legal services, land costs, or permits. A more detailed cost analysis should be completed prior to developing a project.

The costs associated with conveyance systems for multi-well systems can vary widely based on the distance between wells, terrain characteristics, well production, and distance to the treatment facility. These costs should be estimated using standard engineering approaches and site-specific information. For planning purposes, these costs were estimated using the TWDB costing tool's assumptions for conveyance. It is important to note that conveyance costs were not included for point of use water user groups such as mining.

Other Costs

- Engineering, contingency, construction management, financial and legal costs are to be estimated at 30 percent of construction cost for pipelines and 35 percent of construction costs for pump stations, treatment facilities and reservoir projects. (This is in accordance with TWDB guidance.)
- Permitting and mitigation for transmission and treatment projects are to be estimated at $30,000 per mile. For reservoirs, mitigation and permitting costs are assumed equal to the land purchase cost, unless site specific data is available.
- Right-of-way (ROW) costs for transmission lines are estimated through costs provided by the Texas A&M University Real Estate Center (https://www.recenter.tamu.edu/data/rural-land/) which gives current land costs based on county. The ROW width is assumed to be 20 ft. If a small pipeline follows existing right-of-ways (such as highways), no additional right-of-way cost may be assumed. Large pipelines will require ROW costs regardless of routing.

Interest during construction is the total of interest accrued at the end of the construction period using a 3.5 percent annual interest rate on total borrowed funds, less a 0.5 percent rate of return on investment of unspent funds. This is calculated assuming that the total estimated project cost (excluding interest during construction) would be drawn down at a constant rate per month during the construction period. Factors were determined for different lengths of time for project construction.

D.3 Assumptions for Annual Costs

Annual costs are to be estimated using the following assumptions:

- Debt service for all non-reservoir infrastructure (transmission and treatment facilities) is to be annualized over 20 years unless otherwise justified. For reservoirs, this period is 40 years, but not longer than the life of the project. [Note: uniform amortization periods should be used when evaluating similar projects for an entity.]
- Annual interest rate for debt service is 3.5 percent for both reservoir and non-reservoir projects.
- Water purchase costs are to be based on wholesale rates reported by the selling entity when possible. In lieu of known rates, a typical regional cost for treated water and raw water will be developed.
- Operation and Maintenance costs are to be calculated based on the construction cost of the capital improvement. Engineering, permitting, etc. should not be included as a basis for this calculation. Per the "Second Amended General Guidelines for Development of the 2026 Regional Water Plans (Exhibit C)", O&M should be calculated at:
    - 1 percent of the construction costs for pipelines
    - 1.5 percent for dams

- 2.5 percent of the construction costs for pump stations
- O&M Costs for the varying levels of water treatment plant and AWTF improvements were developed by the TWDB and are shown in **Table D-7**.

- Pumping costs are to be estimated using an electricity rate of $0.09 per Kilowatt Hour. If local data is available, this can be used.
- Power connection costs for pump stations are estimated to be $200 per HP.

Table D-1
Pipeline Costs

Diameter	Soil		Rock	
	Rural	Urban	Rural	Urban
(Inches)	($/Foot)	($/Foot)	($/Foot)	($/Foot)
6	141	212	153	236
8	165	248	198	287
10	189	284	244	337
12	214	321	289	388
14	238	356	335	436
16	262	393	381	484
18	286	430	427	532
20	310	465	470	582
24	358	538	562	678
30	432	646	698	823
36	590	1014	846	1204
42	750	1380	993	1586
48	909	1748	1141	1967
54	1020	1961	1289	2348
60	1130	2173	1436	2729
66	1242	2389	1584	3110
72	1353	2602	1731	3491
78	1464	2815	1879	3872
84	1820	3501	2303	4694
90	2122	4082	2654	5365
96	2426	4665	3007	6040
102	2728	5246	3358	6711
108	3030	5828	3709	7382
114	3333	6409	4060	8048
120	3636	6992	4413	8719
132	4049	7787	4884	9601
144	4655	8952	5588	10942

Table D-2
Pump Station Costs

Horsepower	Booster PS Cost ($ millions)	Intake PS cost ($ millions)
0	$0.00	$0.00
5	$0.58	$3.51
10	$0.62	$3.63
20	$0.71	$3.89
25	$0.75	$4.02
50	$0.95	$4.66
100	$1.37	$5.94
200	$2.21	$8.50
300	$3.05	$11.05
400	$3.88	$13.61
500	$4.72	$16.17
600	$5.56	$18.74
700	$6.40	$21.30
800	$7.23	$23.86
900	$8.07	$26.42
1,000	$8.91	$28.98
2,000	$17.27	$54.58
3,000	$25.63	$56.59
4,000	$33.99	$58.62
5,000	$42.36	$60.64
6,000	$44.01	$62.65
7,000	$45.66	$64.68
8,000	$47.31	$66.70
9,000	$48.96	$68.71
10,000	$50.61	$70.73
20,000	$67.09	$89.86
30,000	$83.58	$108.98
40,000	$100.05	$128.10
50,000	$116.53	$147.22
60,000	$133.02	$166.34
70,000	$149.50	$185.46

Table D-3
Ground Storage Tanks

Tank Volume (MG)	With Roof ($)	Without Roof ($)
0.05	1,061,624	604,482
0.1	1,099,666	632,123
0.5	1,404,011	852,945
1	1,784,442	1,128,898
1.5	2,164,873	1,404,851
2	2,545,304	1,680,954
2.5	2,925,735	1,956,907
3	3,306,166	2,233,010
3.5	3,686,597	2,508,963
4	4,067,028	2,784,915
5	4,827,890	3,336,971
6	5,588,752	3,889,027
7	6,349,614	4,441,083
8	7,110,476	4,993,139
10	8,632,200	6,498,937
12	10,153,924	8,004,735
14	11,675,648	9,510,684

Table D-4
Conventional Water Treatment Plant Costs

Capacity (MGD)	Level 0 Chlorine Disinfection (GW) Capital Cost ($)	Level 1 Iron & Manganese Removal Capital Cost ($)	Level 2 Simple Filtration Capital Cost ($)	Level 3 (new) Conventional Treatment Capital Cost ($)	Level 3 (exp) Conventional Treatment Capital Cost ($)	Level 4 Brackish Desalination Capital Cost ($)	Level 5 Seawater Desalination Capital Cost ($)
0	0	0	0	0	0	0	0
0.1	30,707	348,017	1,596,785	2,129,047	2,129,047	2,316,216	3,418,758
1	102,358	1,402,305	5,598,984	21,331,413	7,523,315	23,133,206	22,887,255
10	685,799	5,824,172	45,815,453	71,845,099	28,813,784	77,902,062	153,148,079
50	3,418,758	16,899,310	128,244,371	231,226,782	104,036,698	250,711,071	578,251,199
75	5,128,137	24,381,682	179,996,590	330,186,522	165,400,335	358,019,424	808,126,856
100	6,847,752	29,878,308	231,748,808	427,477,826	200,488,667	463,503,757	1,024,747,147
150	10,266,510	45,713,095	335,253,244	618,651,913	300,727,882	670,795,431	1,432,121,857
200	13,685,268	52,642,733	438,757,681	806,601,721	370,894,309	874,593,479	1,816,005,400

Note: Plant is sized for finished peak day capacity.

Table D-5
Advanced Water Treatment Facility Costs

Capacity (MGD)	Scheme 1 (includes RO)	Scheme 2
0	$0	$0
1	$11,975,889	$11,402,684
5	$42,724,240	$32,079,006
10	$74,004,853	$50,974,297
25	$183,824,780	$114,743,348

Table D-6
Cost Elements for Water Wells

Well Depth (ft)	Public Supply Well Costs Well Capacity (MGD)					
	100	175	350	700	1000	1800
50	$-	$-	$-			
150	$203,302	$308,626	$453,985	$667,043	$806,153	$1,010,256
300	$271,968	$388,528	$540,560	$760,986	$909,620	$1,126,561
500	$352,104	$485,660	$641,915	$909,028	$1,082,999	$1,311,028
700	$424,953	$573,078	$754,694	$1,044,083	$1,238,791	$1,487,701
1000	$558,509	$733,346	$937,703	$1,290,820	$1,527,758	$1,793,668
1500	$781,912	$1,002,888	$1,239,383	$1,703,778	$2,005,182	$2,299,176
2000	$1,005,314	$1,270,000	$1,532,046	$2,116,736	$2,485,121	$2,806,901
3000	$1,437,600	$1,816,101	$2,190,825	$3,026,934	$3,553,723	$4,013,868
Irrigation Well Costs						
150	$97,133	$149,922	$255,499	$293,508	$371,635	$536,338
300	$128,805	$192,153	$312,511	$369,524	$468,768	$654,585
500	$160,480	$240,718	$373,747	$451,874	$574,345	$791,837
700	$185,817	$276,615	$426,535	$521,557	$667,255	$910,084
1000	$242,830	$356,855	$536,338	$665,143	$850,960	$1,142,355
1500	$339,963	$494,107	$717,932	$903,749	$1,155,025	$1,526,661
2000	$434,983	$627,134	$899,526	$1,140,245	$1,461,202	$1,913,077
ASR Well Costs						
50	$-	$-	$-			
150	$264,293	$401,214	$590,181	$867,156	$1,047,999	$1,313,333
300	$353,559	$505,086	$702,728	$989,282	$1,182,506	$1,464,529
500	$457,736	$631,358	$834,489	$1,181,737	$1,407,899	$1,704,337
700	$552,438	$745,001	$981,102	$1,357,307	$1,610,428	$1,934,012
1000	$726,062	$953,350	$1,219,014	$1,678,066	$1,986,085	$2,331,768
1500	$1,016,486	$1,303,754	$1,611,198	$2,214,911	$2,606,737	$2,988,929
2000	$1,306,909	$1,651,000	$1,991,660	$2,751,757	$3,230,657	$3,648,971
3000	$1,868,880	$2,360,931	$2,848,073	$3,935,014	$4,619,840	$5,218,028

Table D-7
Annual Water Treatment Plant O&M Costs

Capacity (MGD)	Level 0 Chlorine Disinfection (GW)	Level 1 Iron & Manganese Removal	Level 2 Simple Filtration	Level 3 (New) Conventional Treatment	Level (Exp) Conventional Treatment	Level 4 Brackish Desalination	Level 5 Seawater Desalination
0	$-	$-	$-	$-	$-	$-	$-
0.1	$18,424.44	$114,845.71	$159,678.52	$212,904.70	$212,904.70	$421,130.17	$512,813.71
1	$61,414.82	$462,760.64	$559,898.41	$1,504,662.99	$752,331.50	$4,206,037.54	$3,433,088.21
10	$411,479.27	$1,921,976.66	$3,207,081.69	$5,029,156.92	$2,016,964.91	$14,164,011.26	$22,972,211.90
50	$2,051,254.85	$5,576,772.36	$8,977,106.00	$16,185,874.74	$7,282,568.87	$45,583,831.10	$86,737,679.92
75	$3,076,882.28	$8,045,955.04	$12,599,761.28	$23,113,056.55	$11,578,023.46	$65,094,440.77	$121,219,028.33
100	$4,108,651.19	$9,859,841.62	$16,222,416.56	$29,923,447.84	$14,034,206.66	$84,273,410.43	$153,712,072.07
150	$6,159,906.04	$15,085,321.24	$23,467,727.11	$43,305,633.88	$21,050,951.74	$121,962,805.62	$214,818,278.56
200	$8,211,160.89	$17,372,101.91	$30,713,037.66	$56,462,120.47	$25,962,601.65	$159,016,996.14	$272,400,809.99

Table D-1

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Amarillo - Amarillo Direct Potable Reuse*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Intake Pump Stations (0 MGD)	$1,616,000
Transmission Pipeline (12 in. dia., 7 miles)	$14,334,000
Two Water Treatment Plants (5 MGD and 5 MGD)	$64,748,000
Integration, Relocations, Backup Generator & Other	$23,000
TOTAL COST OF FACILITIES	**$80,721,000**
- Planning (3%)	$2,422,000
- Design (7%)	$5,650,000
- Construction Engineering (1%)	$807,000
Legal Assistance (2%)	$1,614,000
Fiscal Services (2%)	$1,614,000
Pipeline Contingency (15%)	$2,150,000
All Other Facilities Contingency (20%)	$13,277,000
Environmental & Archaeology Studies and Mitigation	$222,000
Land Acquisition and Surveying (44 acres)	$58,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$3,527,000
TOTAL COST OF PROJECT	**$112,062,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$7,883,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$144,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$40,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$10,090,000
Advanced Water Treatment Facility	$0
Pumping Energy Costs (374007 kW-hr @ 0.09 $/kW-hr)	$34,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$18,191,000**
Available Project Yield (acft/yr)	3,500
Annual Cost of Water ($ per acft), based on PF=1.5	$5,197
Annual Cost of Water After Debt Service ($ per acft), based on PF=1.5	$2,945
Annual Cost of Water ($ per 1,000 gallons), based on PF=1.5	$15.95
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1.5	$9.04
Aven Ault	*10/14/2024*

Table D-2

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Amarillo - Develop Phase II of the Potter/Carson County Well Field*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
CAPITAL COST	
Dam and Reservoir (Conservation Pool acft, acres)	$0
Off-Channel Storage/Ring Dike (Conservation Pool acft, acres)	$0
Terminal Storage (Conservation Pool acft, acres)	$0
Intake Pump Stations (0 MGD)	$4,700,000
Transmission Pipeline (36 in. dia., 5 miles)	$15,586,000
Transmission Pump Station(s) & Storage Tank(s)	$0
Well Fields (Wells, Pumps, and Piping)	$26,490,000
Storage Tanks (Other Than at Booster Pump Stations)	$0
Water Treatment Plant (0 MGD)	$0
Advanced Water Treatment Facility (MGD)	$0
Conservation (Leaking Pipe/Meter Replacement)	$0
Integration, Relocations, Backup Generator & Other	$58,000
TOTAL COST OF FACILITIES	**$46,834,000**
Engineering:	
- Planning (3%)	$1,405,000
- Design (7%)	$3,278,000
- Construction Engineering (1%)	$468,000
Legal Assistance (2%)	$937,000
Fiscal Services (2%)	$937,000
Pipeline Contingency (15%)	$2,338,000
All Other Facilities Contingency (20%)	$6,250,000
Environmental & Archaeology Studies and Mitigation	$603,000
Land Acquisition and Surveying (132 acres)	$53,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$2,049,000
TOTAL COST OF PROJECT	**$65,152,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$4,580,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$421,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$117,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (10733940 kW-hr @ 0.09 $/kW-hr)	$966,000

Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$6,084,000**
Available Project Yield (acft/yr)	10,000
Annual Cost of Water ($ per acft), based on PF=2	$608
Annual Cost of Water After Debt Service ($ per acft), based on PF=2	$150
Annual Cost of Water ($ per 1,000 gallons), based on PF=2	$1.87
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=2	$0.46
AJA	*10/14/2024*

Table D-3

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Amarillo (Roberts County) - ASR*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$20,783,000
TOTAL COST OF FACILITIES	**$20,783,000**
- Planning (3%)	$623,000
- Design (7%)	$1,455,000
- Construction Engineering (1%)	$208,000
Legal Assistance (2%)	$416,000
Fiscal Services (2%)	$416,000
All Other Facilities Contingency (20%)	$4,157,000
Environmental & Archaeology Studies and Mitigation	$180,000
Land Acquisition and Surveying (37 acres)	$42,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$920,000
TOTAL COST OF PROJECT	**$29,200,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$2,055,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$208,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (6597978 kW-hr @ 0.09 $/kW-hr)	$594,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$2,857,000**
Available Project Yield (acft/yr)	10,000
Annual Cost of Water ($ per acft), based on PF=0	$286
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$80
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$0.88
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.25
JP	*11/18/2024*

Table D-4

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Amarillo (Roberts County) - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$15,624,000
TOTAL COST OF FACILITIES	**$386,171,000**
- Planning (3%)	$11,585,000
- Design (7%)	$27,032,000
- Construction Engineering (1%)	$3,862,000
Legal Assistance (2%)	$7,723,000
Fiscal Services (2%)	$7,723,000
All Other Facilities Contingency (20%)	$19,253,000
Environmental & Archaeology Studies and Mitigation	$2,388,000
Land Acquisition and Surveying (495 acres)	$570,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$16,531,000
TOTAL COST OF PROJECT	**$526,324,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$36,951,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$3,118,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$1,860,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (22451632 kW-hr @ 0.09 $/kW-hr)	$2,021,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$43,950,000**
Available Project Yield (acft/yr)	11,210
Annual Cost of Water ($ per acft), based on PF=2	$3,921
Annual Cost of Water After Debt Service ($ per acft), based on PF=2	$624
Annual Cost of Water ($ per 1,000 gallons), based on PF=2	$12.03
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=2	$1.92
JP	*11/18/2024*

Table D-5

Cost Estimate Summary Water Supply Project Option September 2023 Prices Booker - Develop Additional Groundwater Well(s)	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$1,089,000
TOTAL COST OF FACILITIES	**$1,089,000**
- Planning (3%)	$33,000
- Design (7%)	$76,000
- Construction Engineering (1%)	$11,000
Legal Assistance (2%)	$22,000
Fiscal Services (2%)	$22,000
All Other Facilities Contingency (20%)	$218,000
Environmental & Archaeology Studies and Mitigation	$14,000
Land Acquisition and Surveying (3 acres)	$3,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$49,000
TOTAL COST OF PROJECT	**$1,537,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$108,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$11,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (229869 kW-hr @ 0.09 $/kW-hr)	$21,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$140,000**
Available Project Yield (acft/yr)	400
Annual Cost of Water ($ per acft), based on PF=0	$350
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$80
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.07
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.25
HK	*9/30/2024*

Table D-6

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *Borger - Acquisition of TCW Well Field and System*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Integration, Relocations, Backup Generator & Other	$20,000
TOTAL COST OF FACILITIES	**$20,000**
- Planning (3%)	$1,000
- Design (7%)	$1,000
All Other Facilities Contingency (20%)	$4,000
Environmental & Archaeology Studies and Mitigation	$0
TCW System Acquisition	$0
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$1,000
TOTAL COST OF PROJECT	**$27,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$2,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$0
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (0 kW-hr @ 0.09 $/kW-hr)	$0
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$2,000**
Available Project Yield (acft/yr)	805
Annual Cost of Water ($ per acft), based on PF=0	$2
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$0
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$0.01
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.00
Note: One or more cost element has been calculated externally	
KW	*11/13/2024*

Table D-7

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *Borger - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$10,725,000
TOTAL COST OF FACILITIES	**$10,725,000**
- Planning (3%)	$322,000
- Design (7%)	$751,000
- Construction Engineering (1%)	$107,000
Legal Assistance (2%)	$215,000
Fiscal Services (2%)	$215,000
All Other Facilities Contingency (20%)	$2,145,000
Environmental & Archaeology Studies and Mitigation	$108,000
Land Acquisition and Surveying (22 acres)	$26,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$475,000
TOTAL COST OF PROJECT	**$15,089,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$1,062,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$107,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (3830358 kW-hr @ 0.09 $/kW-hr)	$345,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$1,514,000**
Available Project Yield (acft/yr)	8,742
Annual Cost of Water ($ per acft), based on PF=0	$173
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$52
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$0.53
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.16
JP	*11/18/2024*

Table D-8

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Cactus - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$1,414,000
TOTAL COST OF FACILITIES	**$1,414,000**
- Planning (3%)	$42,000
- Design (7%)	$99,000
- Construction Engineering (1%)	$14,000
Legal Assistance (2%)	$28,000
Fiscal Services (2%)	$28,000
All Other Facilities Contingency (20%)	$283,000
Environmental & Archaeology Studies and Mitigation	$14,000
Land Acquisition and Surveying (3 acres)	$3,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$63,000
TOTAL COST OF PROJECT	**$1,988,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$140,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$14,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (651617 kW-hr @ 0.09 $/kW-hr)	$59,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$213,000**
Available Project Yield (acft/yr)	841
Annual Cost of Water ($ per acft), based on PF=0	$253
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$87
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$0.78
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.27
JP	*11/18/2024*

Table D-9

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *Canadian - Drill Additional Groundwater Well*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Transmission Pipeline (12 in. dia., 0.6 miles)	$465,000
Well Fields (Wells, Pumps, and Piping)	$1,043,000
TOTAL COST OF FACILITIES	**$1,508,000**
- Planning (3%)	$14,000
- Design (7%)	$33,000
- Construction Engineering (1%)	$5,000
- Well Field Engineering (Provided by Canadian)	$92,000
Legal Assistance (2%)	$9,000
Fiscal Services (2%)	$9,000
Pipeline Contingency (15%)	$70,000
Well Field Contingency (10% Provided by Canadian)	$104,000
Environmental & Archaeology Studies and Mitigation	$2,256,000
Water Right Acquisition and Surveying (Provided by Canadian)	$2,252,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$201,000
TOTAL COST OF PROJECT	**$6,553,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$447,000
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$15,000
TOTAL ANNUAL COST	**$462,000**
Available Project Yield (acft/yr)	725
Annual Cost of Water ($ per acft), based on PF=0	$637
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$21
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.96
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.06
Note: One or more cost element has been calculated externally	
KC	*1/27/2025*

Table D-10

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *CRMWA (Roberts County) - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$32,724,000
TOTAL COST OF FACILITIES	**$34,328,000**
- Planning (3%)	$1,030,000
- Design (7%)	$2,403,000
- Construction Engineering (1%)	$343,000
Legal Assistance (2%)	$687,000
Fiscal Services (2%)	$687,000
All Other Facilities Contingency (20%)	$6,866,000
Environmental & Archaeology Studies and Mitigation	$410,000
Land Acquisition and Surveying (89 acres)	$102,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$1,523,000
TOTAL COST OF PROJECT	**$48,379,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$3,403,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$327,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$40,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (2287493 kW-hr @ 0.09 $/kW-hr)	$206,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$3,976,000**
Available Project Yield (acft/yr)	10,000
Annual Cost of Water ($ per acft), based on PF=1.15	$398
Annual Cost of Water After Debt Service ($ per acft), based on PF=1.15	$57
Annual Cost of Water ($ per 1,000 gallons), based on PF=1.15	$1.22
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1.15	$0.18
JP	*11/27/2024*

Table D-11

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *CRMWA - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$11,988,000
TOTAL COST OF FACILITIES	**$11,988,000**
- Planning (3%)	$360,000
- Design (7%)	$839,000
- Construction Engineering (1%)	$120,000
Legal Assistance (2%)	$240,000
Fiscal Services (2%)	$240,000
All Other Facilities Contingency (20%)	$2,398,000
Environmental & Archaeology Studies and Mitigation	$283,000
Land Acquisition and Surveying (53 acres)	$61,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$538,000
TOTAL COST OF PROJECT	**$17,067,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$1,201,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$120,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (1399209 kW-hr @ 0.09 $/kW-hr)	$126,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$1,447,000**
Available Project Yield (acft/yr)	2,700
Annual Cost of Water ($ per acft), based on PF=0	$536
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$91
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.64
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.28
JP	*11/18/2024*

Table D-12

Cost Estimate Summary Water Supply Project Option September 2023 Prices CRMWA - Advanced Water Treatment of Lake Meredith Supplies	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	**Estimated Costs for Facilities**
CAPITAL COST	
Dam and Reservoir (Conservation Pool acft, acres)	$0
Off-Channel Storage/Ring Dike (Conservation Pool acft, acres)	$0
Terminal Storage (Conservation Pool acft, acres)	$0
Intake Pump Stations (0 MGD)	$2,710,000
Transmission Pipeline (14 in. dia., 10.4 miles)	$13,046,000
Transmission Pump Station(s) & Storage Tank(s)	$3,972,000
Well Fields (Wells, Pumps, and Piping)	$0
Storage Tanks (Other Than at Booster Pump Stations)	$0
Two Water Treatment Plants (11.9 MGD and 11.9 MGD)	$120,460,000
Advanced Water Treatment Facility (MGD)	$0
Conservation (Leaking Pipe/Meter Replacement)	$0
Integration, Relocations, Backup Generator & Other	$780,000
TOTAL COST OF FACILITIES	**$140,968,000**
Engineering:	
- Planning (3%)	$4,229,000
- Design (7%)	$9,868,000
- Construction Engineering (1%)	$1,410,000
Legal Assistance (2%)	$2,819,000
Fiscal Services (2%)	$2,819,000
Pipeline Contingency (15%)	$1,957,000
All Other Facilities Contingency (20%)	$25,584,000
Environmental & Archaeology Studies and Mitigation	$337,000
Land Acquisition and Surveying (22 acres)	$29,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$6,170,000
TOTAL COST OF PROJECT	**$196,190,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$13,792,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$151,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$136,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$18,905,000
Advanced Water Treatment Facility	$0
Pumping Energy Costs (2897292 kW-hr @ 0.09 $/kW-hr)	$261,000

Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$33,245,000**
Available Project Yield (acft/yr)	10,000
Annual Cost of Water ($ per acft), based on PF=1	$3,325
Annual Cost of Water After Debt Service ($ per acft), based on PF=1	$1,945
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$10.20
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$5.97
Note: One or more cost element has been calculated externally	

Aven Ault *10/15/2024*

Table D-13

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *CRMWA - Replace Capacity of Reoberts County Well Field (Ogallala Aquifer)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$25,538,000
TOTAL COST OF FACILITIES	**$25,538,000**
- Planning (3%)	$766,000
- Design (7%)	$1,788,000
- Construction Engineering (1%)	$255,000
Legal Assistance (2%)	$511,000
Fiscal Services (2%)	$511,000
All Other Facilities Contingency (20%)	$5,108,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$1,121,000
TOTAL COST OF PROJECT	**$35,598,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$2,505,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$255,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (0 kW-hr @ 0.09 $/kW-hr)	$0
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$2,760,000**
Available Project Yield (acft/yr)	25,000
Annual Cost of Water ($ per acft), based on PF=0	$110
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$10
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$0.34
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.03
Note: One or more cost element has been calculated externally	
Aven Ault	*10/14/2024*

Table D-14

Cost Estimate Summary Water Supply Project Option September 2023 Prices CRMWA - CRMWA II Expansion of Roberts County Wellfield	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	**Estimated Costs for Facilities**
Pump Station (66.7 MGD)	$136,562,000
Transmission Pipeline (72 in. dia., 67.1 miles)	$351,636,000
Pampa Pipeline and Tie-In (14 in. dia., 0.68 miles)	$950,000
Well Fields (Wells, Pumps, Deep Well Groundbed, and Piping)	$67,974,000
Amarillo Tie-In	$5,375,000
TOTAL COST OF FACILITIES	**$562,497,000**
- Planning (3%)	$16,875,000
- Design (7%)	$39,375,000
- Construction Engineering (1%)	$5,625,000
Legal Assistance (2%)	$11,250,000
Fiscal Services (2%)	$11,250,000
Pipeline Contingency (15%)	$52,888,000
All Other Facilities Contingency (20%)	$41,982,000
Environmental & Archaeology Studies and Mitigation	$2,014,000
Land Acquisition and Surveying (512 acres)	$0
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$24,015,000
TOTAL COST OF PROJECT	**$767,771,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$53,679,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$4,259,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$3,414,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (79787825 kW-hr @ 0.09 $/kW-hr)	$7,181,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$68,533,000**
Available Project Yield (acft/yr)	65,000
Annual Cost of Water ($ per acft), based on PF=1.15	$1,054
Annual Cost of Water After Debt Service ($ per acft), based on PF=1.15	$229
Annual Cost of Water ($ per 1,000 gallons), based on PF=1.15	$3.24
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1.15	$0.70
Note: One or more cost element has been calculated externally	
Kristal Copp	*12/9/2024*

Table D-15

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Canyon - Develop Additional Groundwater Well(s) - Dockum*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$3,311,000
Storage Tanks (Other Than at Booster Pump Stations)	$1,784,000
TOTAL COST OF FACILITIES	**$5,095,000**
- Planning (3%)	$153,000
- Design (7%)	$357,000
- Construction Engineering (1%)	$51,000
Legal Assistance (2%)	$102,000
Fiscal Services (2%)	$102,000
All Other Facilities Contingency (20%)	$1,019,000
Environmental & Archaeology Studies and Mitigation	$32,000
Land Acquisition and Surveying (4 acres)	$4,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$225,000
TOTAL COST OF PROJECT	**$7,140,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$502,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$51,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (738873 kW-hr @ 0.09 $/kW-hr)	$66,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$619,000**
Available Project Yield (acft/yr)	1,500
Annual Cost of Water ($ per acft), based on PF=0	$413
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$78
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.27
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.24
HK	*9/30/2024*

Table D-16

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Canyon - Develop Additional Groundwater Well(s) - Ogallala*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$3,412,000
Storage Tanks (Other Than at Booster Pump Stations)	$2,545,000
TOTAL COST OF FACILITIES	**$5,957,000**
- Planning (3%)	$179,000
- Design (7%)	$417,000
- Construction Engineering (1%)	$60,000
Legal Assistance (2%)	$119,000
Fiscal Services (2%)	$119,000
All Other Facilities Contingency (20%)	$1,191,000
Environmental & Archaeology Studies and Mitigation	$38,000
Land Acquisition and Surveying (4 acres)	$5,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$263,000
TOTAL COST OF PROJECT	**$8,348,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$587,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$60,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (572849 kW-hr @ 0.09 $/kW-hr)	$52,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$699,000**
Available Project Yield (acft/yr)	1,500
Annual Cost of Water ($ per acft), based on PF=0	$466
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$75
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.43
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.23
HK	*9/30/2024*

Table D-17

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Dumas - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$3,650,000
TOTAL COST OF FACILITIES	**$3,650,000**
- Planning (3%)	$109,000
- Design (7%)	$255,000
- Construction Engineering (1%)	$36,000
Legal Assistance (2%)	$73,000
Fiscal Services (2%)	$73,000
All Other Facilities Contingency (20%)	$730,000
Environmental & Archaeology Studies and Mitigation	$36,000
Land Acquisition and Surveying (7 acres)	$8,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$162,000
TOTAL COST OF PROJECT	**$5,132,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$361,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$36,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (1243195 kW-hr @ 0.09 $/kW-hr)	$112,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$509,000**
Available Project Yield (acft/yr)	1,900
Annual Cost of Water ($ per acft), based on PF=0	$268
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$78
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$0.82
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.24
HK	*9/30/2024*

Table D-18

Cost Estimate Summary
Water Supply Project Option
September 2023 Prices
City of Fritch - Develop Additional Groundwater Well(s)

Cost based on ENR CCI 13485.67 for September 2023 and
a PPI of 278.502 for September 2023

Item	*Estimated Costs for Facilities*
Well Fields (Wells, Pumps, and Piping)	$1,006,000
TOTAL COST OF FACILITIES	**$1,006,000**
- Planning (3%)	$30,000
- Design (7%)	$70,000
- Construction Engineering (1%)	$10,000
Legal Assistance (2%)	$20,000
Fiscal Services (2%)	$20,000
All Other Facilities Contingency (20%)	$201,000
Environmental & Archaeology Studies and Mitigation	$14,000
Land Acquisition and Surveying (3 acres)	$3,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$45,000
TOTAL COST OF PROJECT	**$1,419,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$100,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$10,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (46850 kW-hr @ 0.09 $/kW-hr)	$4,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$114,000**
Available Project Yield (acft/yr)	100
Annual Cost of Water ($ per acft), based on PF=0	$1,140
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$140
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$3.50
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.43
JP	*12/13/2024*

Table D-19

Cost Estimate Summary
Water Supply Project Option
September 2023 Prices
GMIWA - Greenbelt MIWA Groundwater WMS

Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023

Item	*Estimated Costs for Facilities*
Transmission Pipeline (None)	$187,000
Well Fields (Wells, Pumps, and Piping)	$21,340,000
TOTAL COST OF FACILITIES	**$21,527,000**
- Planning (3%)	$646,000
- Design (7%)	$1,507,000
- Construction Engineering (1%)	$215,000
Legal Assistance (2%)	$431,000
Fiscal Services (2%)	$431,000
Pipeline Contingency (15%)	$28,000
All Other Facilities Contingency (20%)	$4,268,000
Environmental & Archaeology Studies and Mitigation	$488,000
Land Acquisition and Surveying (168 acres)	$86,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$963,000
TOTAL COST OF PROJECT	**$30,590,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$2,152,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$215,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (11454093 kW-hr @ 0.09 $/kW-hr)	$1,031,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$3,398,000**
Available Project Yield (acft/yr)	2,692
Annual Cost of Water ($ per acft), based on PF=0	$1,262
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$463
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$3.87
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$1.42

Note: One or more cost element has been calculated externally

Aven Ault *9/16/2024*

Table D-20

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Gruver - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$733,000
TOTAL COST OF FACILITIES	**$733,000**
- Planning (3%)	$22,000
- Design (7%)	$51,000
- Construction Engineering (1%)	$7,000
Legal Assistance (2%)	$15,000
Fiscal Services (2%)	$15,000
All Other Facilities Contingency (20%)	$147,000
Environmental & Archaeology Studies and Mitigation	$14,000
Land Acquisition and Surveying (3 acres)	$3,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$33,000
TOTAL COST OF PROJECT	**$1,040,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$73,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$7,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (55036 kW-hr @ 0.09 $/kW-hr)	$5,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$85,000**
Available Project Yield (acft/yr)	110
Annual Cost of Water ($ per acft), based on PF=0	$773
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$109
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$2.37
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.33
HK	*9/30/2024*

Table D-21

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *Livestock, Hartley - Livestock, Hartley - Dockum Aquifer*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Transmission Pipeline (None)	$0
Well Fields (Wells, Pumps, and Piping)	$6,232,000
Integration, Relocations, Backup Generator & Other	$0
TOTAL COST OF FACILITIES	**$6,232,000**
- Planning (3%)	$187,000
- Design (7%)	$436,000
- Construction Engineering (1%)	$62,000
Legal Assistance (2%)	$125,000
Fiscal Services (2%)	$125,000
Pipeline Contingency (15%)	$0
All Other Facilities Contingency (20%)	$1,246,000
Environmental & Archaeology Studies and Mitigation	$187,000
Land Acquisition and Surveying (30 acres)	$85,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$283,000
TOTAL COST OF PROJECT	**$8,968,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$631,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$62,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (722330 kW-hr @ 0.09 $/kW-hr)	$65,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$758,000**
Available Project Yield (acft/yr)	1,200
Annual Cost of Water ($ per acft), based on PF=0	$632
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$106
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.94
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.32
Aven Ault	*1/17/2025*

Table D-22

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *Livestock, Hartley - Livestock, Hartley - Ogallala Aquifer*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Intake Pump Stations (0 MGD)	$0
Well Fields (Wells, Pumps, and Piping)	$1,789,000
Integration, Relocations, Backup Generator & Other	$0
TOTAL COST OF FACILITIES	**$1,789,000**
- Planning (3%)	$54,000
- Design (7%)	$125,000
- Construction Engineering (1%)	$18,000
Legal Assistance (2%)	$36,000
Fiscal Services (2%)	$36,000
All Other Facilities Contingency (20%)	$358,000
Environmental & Archaeology Studies and Mitigation	$31,000
Land Acquisition and Surveying (4 acres)	$11,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$80,000
TOTAL COST OF PROJECT	**$2,538,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$178,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$18,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (433362 kW-hr @ 0.09 $/kW-hr)	$39,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$235,000**
Available Project Yield (acft/yr)	1,200
Annual Cost of Water ($ per acft), based on PF=0	$196
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$48
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$0.60
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.15
Aven Ault	*1/17/2025*

Table D-23

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *Moore County Livestock - Develop Additional Groundwater Well(s) - Dockum Aquifer*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$2,766,000
TOTAL COST OF FACILITIES	**$2,766,000**
- Planning (3%)	$83,000
- Design (7%)	$194,000
- Construction Engineering (1%)	$28,000
Legal Assistance (2%)	$55,000
Fiscal Services (2%)	$55,000
All Other Facilities Contingency (20%)	$553,000
Environmental & Archaeology Studies and Mitigation	$78,000
Land Acquisition and Surveying (11 acres)	$33,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$125,000
TOTAL COST OF PROJECT	**$3,970,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$279,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$28,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (2971912 kW-hr @ 0.09 $/kW-hr)	$267,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$574,000**
Available Project Yield (acft/yr)	4,204
Annual Cost of Water ($ per acft), based on PF=0	$137
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$70
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$0.42
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.22
Aven Ault	*2/21/2025*

Table D-24

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *Livestock, Moore - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$6,484,000
TOTAL COST OF FACILITIES	**$6,484,000**
- Planning (3%)	$195,000
- Design (7%)	$454,000
- Construction Engineering (1%)	$65,000
Legal Assistance (2%)	$130,000
Fiscal Services (2%)	$130,000
All Other Facilities Contingency (20%)	$1,297,000
Environmental & Archaeology Studies and Mitigation	$44,000
Land Acquisition and Surveying (9 acres)	$11,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$287,000
TOTAL COST OF PROJECT	**$9,097,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$640,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$65,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (4155536 kW-hr @ 0.09 $/kW-hr)	$374,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$1,079,000**
Available Project Yield (acft/yr)	5,353
Annual Cost of Water ($ per acft), based on PF=0	$202
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$82
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$0.62
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.25
AJA	*1/27/2024*

Table D-25

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Miami - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$1,001,000
TOTAL COST OF FACILITIES	**$1,001,000**
- Planning (3%)	$30,000
- Design (7%)	$70,000
- Construction Engineering (1%)	$10,000
Legal Assistance (2%)	$20,000
Fiscal Services (2%)	$20,000
All Other Facilities Contingency (20%)	$200,000
Environmental & Archaeology Studies and Mitigation	$14,000
Land Acquisition and Surveying (3 acres)	$3,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$45,000
TOTAL COST OF PROJECT	**$1,413,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$100,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$10,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (32313 kW-hr @ 0.09 $/kW-hr)	$3,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$113,000**
Available Project Yield (acft/yr)	45
Annual Cost of Water ($ per acft), based on PF=0	$2,511
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$289
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$7.71
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.89
JP	*11/19/2024*

Table D-26

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *Moore County Manufacturing - Develop Additional Groundwater Well(s) - Dockum Aquifer*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$1,888,000
TOTAL COST OF FACILITIES	**$1,888,000**
- Planning (3%)	$57,000
- Design (7%)	$132,000
- Construction Engineering (1%)	$19,000
Legal Assistance (2%)	$38,000
Fiscal Services (2%)	$38,000
All Other Facilities Contingency (20%)	$378,000
Environmental & Archaeology Studies and Mitigation	$35,000
Land Acquisition and Surveying (5 acres)	$16,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$85,000
TOTAL COST OF PROJECT	**$2,686,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$189,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$19,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (516476 kW-hr @ 0.09 $/kW-hr)	$46,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$254,000**
Available Project Yield (acft/yr)	731
Annual Cost of Water ($ per acft), based on PF=0	$347
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$89
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.07
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.27
Aven Ault	*10/15/2024*

Table D-27

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *Moore County Manufacturing - Develop Additional Groundwater Well(s) - Ogallala Aquifer*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$1,534,000
TOTAL COST OF FACILITIES	**$1,534,000**
- Planning (3%)	$46,000
- Design (7%)	$107,000
- Construction Engineering (1%)	$15,000
Legal Assistance (2%)	$31,000
Fiscal Services (2%)	$31,000
All Other Facilities Contingency (20%)	$307,000
Environmental & Archaeology Studies and Mitigation	$35,000
Land Acquisition and Surveying (5 acres)	$16,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$69,000
TOTAL COST OF PROJECT	**$2,191,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$154,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$15,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (534401 kW-hr @ 0.09 $/kW-hr)	$48,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$217,000**
Available Project Yield (acft/yr)	767
Annual Cost of Water ($ per acft), based on PF=0	$283
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$82
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$0.87
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.25
Aven Ault	*10/15/2024*

Table D-28

Cost Estimate Summary
Water Supply Project Option
September 2023 Prices
City of Pampa - Aquifer Storage and Recovery Wells (ASR)

Cost based on ENR CCI 13485.67 for September 2023 and
a PPI of 278.502 for September 2023

Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$2,675,000
TOTAL COST OF FACILITIES	**$2,675,000**
- Planning (3%)	$80,000
- Design (7%)	$187,000
- Construction Engineering (1%)	$27,000
Legal Assistance (2%)	$53,000
Fiscal Services (2%)	$53,000
All Other Facilities Contingency (20%)	$535,000
Environmental & Archaeology Studies and Mitigation	$2,000
Land Acquisition and Surveying (1 acres)	$2,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$118,000
TOTAL COST OF PROJECT	**$3,732,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$263,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$27,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (0 kW-hr @ 0.09 $/kW-hr)	$0
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$290,000**
Available Project Yield (acft/yr)	500
Annual Cost of Water ($ per acft), based on PF=0	$580
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$54
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.78
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.17
Aven Ault	*10/15/2024*

Table D-29

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Panhandle - Develop Additional Groundwater Wells*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$1,766,000
TOTAL COST OF FACILITIES	**$1,766,000**
- Planning (3%)	$53,000
- Design (7%)	$124,000
- Construction Engineering (1%)	$18,000
Legal Assistance (2%)	$35,000
Fiscal Services (2%)	$35,000
All Other Facilities Contingency (20%)	$353,000
Environmental & Archaeology Studies and Mitigation	$3,000
Land Acquisition and Surveying (1 acres)	$2,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$78,000
TOTAL COST OF PROJECT	**$2,467,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$174,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$18,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (1164666 kW-hr @ 0.09 $/kW-hr)	$105,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$297,000**
Available Project Yield (acft/yr)	600
Annual Cost of Water ($ per acft), based on PF=0	$495
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$205
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.52
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.63
Kristal Copp	*1/15/2025*

Table D-30

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Perryton - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Intake Pump Stations (0 MGD)	$881,000
Transmission Pipeline (12 in. dia., 10 miles)	$11,287,000
Well Fields (Wells, Pumps, and Piping)	$1,113,000
Integration, Relocations, Backup Generator & Other	$8,000
TOTAL COST OF FACILITIES	**$13,289,000**
- Planning (3%)	$399,000
- Design (7%)	$930,000
- Construction Engineering (1%)	$133,000
Legal Assistance (2%)	$266,000
Fiscal Services (2%)	$266,000
Pipeline Contingency (15%)	$1,693,000
All Other Facilities Contingency (20%)	$401,000
Environmental & Archaeology Studies and Mitigation	$320,000
Land Acquisition and Surveying (68 acres)	$79,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$578,000
TOTAL COST OF PROJECT	**$18,354,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$1,291,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$124,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$22,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (539931 kW-hr @ 0.09 $/kW-hr)	$49,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$1,486,000**
Available Project Yield (acft/yr)	575
Annual Cost of Water ($ per acft), based on PF=1.2	$2,584
Annual Cost of Water After Debt Service ($ per acft), based on PF=1.2	$339
Annual Cost of Water ($ per 1,000 gallons), based on PF=1.2	$7.93
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1.2	$1.04
NL	*10/2/2024*

Table D-31

Cost Estimate Summary Water Supply Project Option September 2023 Prices City of Shamrock - Develop Additional Groundwater Well(s)	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	**Estimated Costs for Facilities**
Well Fields (Wells, Pumps, and Piping)	$703,000
TOTAL COST OF FACILITIES	**$703,000**
- Planning (3%)	$21,000
- Design (7%)	$49,000
- Construction Engineering (1%)	$7,000
Legal Assistance (2%)	$14,000
Fiscal Services (2%)	$14,000
All Other Facilities Contingency (20%)	$141,000
Environmental & Archaeology Studies and Mitigation	$14,000
Land Acquisition and Surveying (3 acres)	$3,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$32,000
TOTAL COST OF PROJECT	**$998,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$70,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$7,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (43661 kW-hr @ 0.09 $/kW-hr)	$4,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$81,000**
Available Project Yield (acft/yr)	127
Annual Cost of Water ($ per acft), based on PF=0	$638
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$87
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.96
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.27
JP	*11/20/2024*

Table D-32

Cost Estimate Summary ***Water Supply Project Option*** ***September 2023 Prices*** ***City of Stinnett - Develop Additional Groundwater Well(s)***	
Cost based on ENR CCI 13485.67 for September 2023 and ***a PPI of 278.502 for September 2023***	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$1,166,000
TOTAL COST OF FACILITIES	**$1,166,000**
- Planning (3%)	$35,000
- Design (7%)	$82,000
- Construction Engineering (1%)	$12,000
Legal Assistance (2%)	$23,000
Fiscal Services (2%)	$23,000
All Other Facilities Contingency (20%)	$233,000
Environmental & Archaeology Studies and Mitigation	$14,000
Land Acquisition and Surveying (3 acres)	$3,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$52,000
TOTAL COST OF PROJECT	**$1,643,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$116,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$12,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (33482 kW-hr @ 0.09 $/kW-hr)	$3,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$131,000**
Available Project Yield (acft/yr)	50
Annual Cost of Water ($ per acft), based on PF=0	$2,620
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$300
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$8.04
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.92
NL - Intera	*10/112024*

Table D-33

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Stratford - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Well Fields (Wells, Pumps, and Piping)	$1,108,000
TOTAL COST OF FACILITIES	**$1,108,000**
- Planning (3%)	$33,000
- Design (7%)	$78,000
- Construction Engineering (1%)	$11,000
Legal Assistance (2%)	$22,000
Fiscal Services (2%)	$22,000
All Other Facilities Contingency (20%)	$222,000
Environmental & Archaeology Studies and Mitigation	$14,000
Land Acquisition and Surveying (3 acres)	$3,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$50,000
TOTAL COST OF PROJECT	**$1,563,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$110,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$11,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (189956 kW-hr @ 0.09 $/kW-hr)	$17,000
Purchase of Water (0 acft/yr @ 500 $/acft)	$0
TOTAL ANNUAL COST	**$138,000**
Available Project Yield (acft/yr)	326
Annual Cost of Water ($ per acft), based on PF=0	$423
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$86
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$1.30
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$0.26
JP	*11/21/2024*

Table D-34

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Wellington - Wellington Nitrate Removal*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Storage Tanks (Other Than at Booster Pump Stations)	$687,000
Advanced Water Treatment Facility (0.2 MGD)	$2,395,000
TOTAL COST OF FACILITIES	**$3,082,000**
- Planning (3%)	$92,000
- Design (7%)	$216,000
- Construction Engineering (1%)	$31,000
Legal Assistance (2%)	$62,000
Fiscal Services (2%)	$62,000
All Other Facilities Contingency (20%)	$617,000
Environmental & Archaeology Studies and Mitigation	$5,000
Land Acquisition and Surveying (2 acres)	$6,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$136,000
TOTAL COST OF PROJECT	**$4,309,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$303,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$7,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$0
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$287,000
Pumping Energy Costs (0 kW-hr @ 0.09 $/kW-hr)	$0
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$597,000**
Available Project Yield (acft/yr)	174
Annual Cost of Water ($ per acft), based on PF=0	$3,431
Annual Cost of Water After Debt Service ($ per acft), based on PF=0	$1,690
Annual Cost of Water ($ per 1,000 gallons), based on PF=0	$10.53
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=0	$5.18
Kristal Copp	*1/15/2025*

Table D-35

Cost Estimate Summary *Water Supply Project Option* *September 2023 Prices* *City of Wheeler - Develop Additional Groundwater Well(s)*	
Cost based on ENR CCI 13485.67 for September 2023 and a PPI of 278.502 for September 2023	
Item	***Estimated Costs for Facilities***
Intake Pump Stations (0 MGD)	$679,000
Transmission Pipeline (6 in. dia., 2 miles)	$1,494,000
Well Fields (Wells, Pumps, and Piping)	$818,000
Integration, Relocations, Backup Generator & Other	$3,000
TOTAL COST OF FACILITIES	**$2,994,000**
- Planning (3%)	$90,000
- Design (7%)	$210,000
- Construction Engineering (1%)	$30,000
Legal Assistance (2%)	$60,000
Fiscal Services (2%)	$60,000
Pipeline Contingency (15%)	$224,000
All Other Facilities Contingency (20%)	$300,000
Environmental & Archaeology Studies and Mitigation	$80,000
Land Acquisition and Surveying (20 acres)	$23,000
Interest During Construction (3.5% for 1 years with a 0.5% ROI)	$133,000
TOTAL COST OF PROJECT	**$4,204,000**
ANNUAL COST	
Debt Service (3.5 percent, 20 years)	$295,000
Reservoir Debt Service (3.5 percent, 40 years)	$0
Operation and Maintenance	
Pipeline, Wells, and Storage Tanks (1% of Cost of Facilities)	$23,000
Intakes and Pump Stations (2.5% of Cost of Facilities)	$17,000
Dam and Reservoir (1.5% of Cost of Facilities)	$0
Water Treatment Plant	$0
Advanced Water Treatment Facility	$0
Pumping Energy Costs (122401 kW-hr @ 0.09 $/kW-hr)	$11,000
Purchase of Water (acft/yr @ $/acft)	$0
TOTAL ANNUAL COST	**$346,000**
Available Project Yield (acft/yr)	290
Annual Cost of Water ($ per acft), based on PF=1	$1,193
Annual Cost of Water After Debt Service ($ per acft), based on PF=1	$176
Annual Cost of Water ($ per 1,000 gallons), based on PF=1	$3.66
Annual Cost of Water After Debt Service ($ per 1,000 gallons), based on PF=1	$0.54
NL	*10/18/2024*

APPENDIX E

CONSISTENCY MATRIX

2026 IPP Review Item Number	Key Requirement Citation: TWC, 31 TAC Rule, or Contract Exhibit	Corresponding Contract Guidance and SOW Task *(if applicable)*	Requirement (see published rule and other contract documents for full context)	Location(s) in Regional Plan and/or Commentary
Header	**§ 357.22**		**General Considerations for Development of Regional Water Plans**	
1	**§ 357.22(a)**		RWPGs shall consider existing local, regional, and state water planning efforts, including water plans, information and relevant local, regional , state and federal programs and goals when developing the RWP. **The RWPGs shall also consider:**	Chapters 1 - 10 consider existing local, regional, and state water planning efforts, including water plans, information and relevant local, regional, state, and federal program goals
2	**§ 357.22(a)(1)**		**[The RWPGs shall also consider:]** water conservation plans;	Subchapter 5B, Chapter 7
3	**§ 357.22(a)(2)**		**[The RWPGs shall also consider:]** drought management and drought contingency plans;	Subchapter 5B, Chapter 7
4	**§ 357.22(a)(3)**	Exhibit C, Section 2.1	**[The RWPGs shall also consider:]** information compiled by the Board from water loss audits performed by retail public utilities pursuant to § 358.6 (relating to Water Loss Audits)	Chapter 1, Subchapter 5B
5	**§ 357.22(a)(4)**		**[The RWPGs shall also consider:]** publicly available plans for major agricultural, municipal, manufacturing and commercial water users;	Subchapter 5A
6	**§ 357.22(a)(5)**		**[The RWPGs shall also consider:]** local and regional water management plans;	Subchapter 5A
7	**§ 357.22(a)(6)**		**[The RWPGs shall also consider:]** water availability requirements promulgated by a county commissioners court in accordance with TWC § 35.019 (relating to Priority Groundwater Management Areas)	Chapter 3
8	**§ 357.22(a)(7)**		**[The RWPGs shall also consider:]** the Texas Clean Rivers Program;	Chapter 1, Subchapter 5A
9	**§ 357.22(a)(8)**		**[The RWPGs shall also consider:]** the U.S. Clean Water Act;	Chapter 1, Subchapter 5A
10	**§ 357.22(a)(9)**		**[The RWPGs shall also consider:]** water management plans;	Subchapter 5D
11	**§ 357.22(a)(10)**		**[The RWPGs shall also consider:]** other planning goals including, but not limited to, regionalization of water and wastewater services where appropriate	Subchapter 5A
12	**§ 357.22(a)(11)**		**[The RWPGs shall also consider:]** approved groundwater conservation district management plans and other plans submitted under Texas Water Code § 16.054 (relating to Local Water Planning);	Chapter 3
13	**§ 357.22(a)(12)**		**[The RWPGs shall also consider:]** approved groundwater regulatory plans;	Chapter 3
14	**§ 357.22(a)(13)**		**[The RWPGs shall also consider:]** potential impacts on public health, safety, or welfare;	Subchapter 5, Chapters 6 and 7
15	**§ 357.22(a)(14)**		**[The RWPGs shall also consider:]** water conservation best management practices available on the TWDB website; and	Subchapter 5B
16	**§ 357.22(a)(15)**		**[The RWPGs shall also consider:]** any other information available from existing local or regional water planning studies.	Subchapter 5A
17	**§ 357.22(b)**	Exhibit C, Section 1.6	The RWP shall contain a separate chapter for the contents of §§357.30, 357.31, 357.32, 357.33, 357.42, 357.43, 357.45, and 357.50 of this title and shall also contain a separate chapter for the contents of §357.34 and §§357.35, 357.40 and 357.41 of this title for a total of ten separate chapters	Chapters 1-10
Header	**§ 357.30**	**SOW Task 1**	**Description of the Regional Water Planning Area**	
18	**§ 357.30(1)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** social and economic aspects of a region such as information on current population, economic activity and economic sectors heavily dependent on water resources;	Chapter 1
19	**§ 357.30(2)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** current water use and major water demand centers;	Chapter 1
20	**§ 357.30(3)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** current groundwater, surface water, and reuse supplies including major springs that are important for water supply or protection of natural resources;	Chapter 1
21	**§ 357.30(4)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** major water providers;	Chapter 1
22	**§ 357.30(5)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** agricultural and natural resources;	Chapter 1
23	**§ 357.30(6)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** identified water quality problems;	Chapter 1
24	**§ 357.30(7)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** identified threats to agricultural and natural resources due to water quantity problems or water quality problems related to water supply;	Chapter 1

2026 IPP Review Item Number	Key Requirement Citation: TWC, 31 TAC Rule, or Contract Exhibit	Corresponding Contract Guidance and SOW Task *(if applicable)*	Requirement (see published rule and other contract documents for full context)	Location(s) in Regional Plan and/or Commentary
25	**§ 357.30(8)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their regional water planning area including the following:]** summary of existing local and regional water plans;	Chapter 1
26	**§ 357.30(9)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** the identified historic drought(s) of record within the planning area;	Chapter 1 and Chapter 7
27	**§ 357.30(10)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** current preparations for drought within the RWPA;	Chapter 1, Chapter 7, and http://www.panhandlewater.org/
28	**§ 357.30(11)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** information compiled by the Board from water loss audits performed by retail public utilities pursuant to § 358.6 of this title (relating to Water Loss Audits); and	Chapter 1
29	**§ 357.30(12)**	Exhibit C, Section 2.1; SOW Task 1	**[RWPGs shall describe their RWPA including the following:]** an identification of each threat to agricultural and natural resources and a discussion of how that threat will be addressed or affected by the water management strategies evaluated in the plan.	Chapter 1 and Chapter 6
Header	**§ 357.31**	**SOW Task 2A and 2B**	**Projected Population and Water Demands**	
30	**§ 357.31(a)**	Exhibit C, Section 2.2; SOW Task 2A and B	RWPs shall present projected population and Water Demands by WUG as defined in § 357.10 of this title (relating to Definitions and Acronyms). If a WUG lies in one or more counties or RWPA or river basins, data shall be reported for each river basin, RWPA, and county split.	Chapter 2, Attachment 2-1, Appendix J
31	**§ 357.31(b)**	Exhibit C, Section 2.2.3; SOW Task 2A and B	RWPs shall present projected Water Demands associated with MWPs by category of water use, including municipal, manufacturing, irrigation, steam electric power generation, mining, and livestock for the RWPA.	Chapter 2, Attachment 2-2
32	**§ 357.31(c)**	SOW Task 2A and B	RWPs shall evaluate the current contractual obligations of WUGs and WWPs to supply water in addition to any demands projected for the WUG or WWP. Information regarding obligations to supply water to other users must also be incorporated into the water supply analysis in § 357.32 of this title (relating to Water Supply Analysis) in order to determine net existing water supplies available for each WUG's own use. The evaluation of contractual obligations under this subsection is limited to determining the amount of water secured by the contract and the duration of the contract.	Chapter 2 and Chapter 3
33	**§ 357.31(d)**	Exhibit C, Section 2.2 and 2.5.5; SOW Task 2B	Municipal demands shall be adjusted to reflect water savings due to plumbing fixture requirements identified in the Texas Health and Safety Code, Chapter 372. RWPGs shall report how changes in plumbing fixtures would affect projected municipal Water Demands using projections with plumbing code savings provided by the Board or by methods approved by the EA.	Chapter 2, Attachment 2-1
34	**§ 357.31(e)(1)**	Exhibit C, Section 2.2; SOW Task 2A and B	**[Source of population and water demands. In developing RWPs, RWPGs shall use:]** Population and water demand projections developed by the EA that shall be contained in the next state water plan and adopted by the Board after consultation with the RWPGs, Commission, Texas Department of Agriculture, and the Texas Parks and Wildlife Department.	Chapter 2
35	**§ 357.31(f)**	Exhibit C, Section 2.2; SOW Task 2A and B	Population and Water Demand projections shall be presented for each Planning Decade for WUGs and MWPs.	Chapter 2, Attachment 2-1
Header	**§ 357.32**	**SOW Task 3**	**Water Supply Analysis**	
36	**§ 357.32(a)(1)**	Exhibit C, Section 2.3; SOW Task 3	**[RWPGs shall evaluate:]** source water Availability during Drought of Record conditions; and	Chapter 3 and Appendix B
37	**§ 357.32(a)(2)**	Exhibit C, Section 2.3; SOW Task 3	**[RWPGs shall evaluate:]** Existing Water Supplies that are legally and physically available to each WUG and WWP within the RWPA for use during the Drought of Record.	Chapter 3
38	**§ 357.32(b)**	Exhibit C, Section 2.3.6; SOW Task 3	Evaluations shall consider surface water and groundwater data from the state water plan, existing water rights, contracts and option agreements relating to water rights, other planning and water supply studies, and analysis of water supplies existing in and available to the RWPA during Drought of Record conditions.	Chapter 3

2026 IPP Review Item Number	Key Requirement Citation: TWC, 31 TAC Rule, or Contract Exhibit	Corresponding Contract Guidance and SOW Task *(if applicable)*	Requirement (see published rule and other contract documents for full context)	Location(s) in Regional Plan and/or Commentary
39	**§ 357.32(c)**	Exhibit C, Section 2.3.1; SOW Task 3	For surface water supply analyses, RWPGs shall use most current Water Availability Models from the Commission to evaluate the adequacy of surface water supplies. As the default approach for evaluating existing supplies, RWPGs shall assume full utilization of existing water rights and no return flows when using Water Availability Models. RWPGs may use better, more representative, water availability modeling assumptions or better site-specific information with written approval from the EA. Information available from the Commission shall be incorporated by RWPGs unless better site-specific information is available and approved in writing by the EA.	Chapter 3 and Appendix B
40	**§ 357.32(c)(1)**	Exhibit C, Section 2.3.1; SOW Task 3	Evaluation of existing stored surface water available during Drought of Record conditions shall be based on Firm Yield as defined in §357.10 of this title (relating to Definitions and Acronyms). The analysis may be based on justified operational procedures other than Firm Yield. The EA shall consider a written request from an RWPG to use procedures other than Firm Yield.	Chapter 3 and Appendix B
41	**§ 357.32(c)(2)**	Exhibit C, Section 2.3.1	Evaluation of existing run of river surface water available for municipal WUGs during Drought of Record conditions shall be based on the minimum monthly diversion amounts that are available 100 percent of the time, if those run of river supplies are the only supply for the municipal WUG.	Chapter 3 and Appendix B
42	**Contract Scope of Work Task 3**	Exhibit C, Section 2.3.1	Inclusion of sedimentation into the WAM RUN3 models (or other models) for major reservoirs is a necessary modification.	Appendix B
43	**Contract Exhibit C, Section 2.3.1**		The methodology used for calculating anticipated sedimentation rate and revising the area-capacity rating curve must be described in the IPP and final adopted RWP.	Appendix B
44	**Contract Exhibit C, Section 2.3.1**		For surface water withdrawals that do not require permits, such as for domestic and livestock uses, RWPGs will estimate these local annual water availability volumes under drought of record conditions based on the most current accessible information. RWPGs shall document the methodologies utilized for these availabilities in the Technical Memorandum, IPP, and final adopted RWP.	Chapter 3
45	**Contract Exhibit C, Section 2.3.2**	SOW Task 3	For planning purposes, availability for reservoirs operated as a system may be reported as a system in lieu of reporting individual reservoir availability. Such a relationship could include reservoirs owned and operated by the same entity, so long as the operations comply with the existing permit conditions. **The firm yield of the system should be the firm yield during drought of record conditions for the system as a whole.**	Chapter 3 and Appendix B
46	**Contract Exhibit C, Section 2.3.2**	SOW Task 3	System gain is the amount of permitted water a system creates that would otherwise be unavailable if the reservoirs were operated independently; and **for existing systems, this volume shall be reported separately in the RWPs in addition to the reservoir system firm yield**. For multi-reservoir systems, the minimum system gain during drought conditions may be considered additional water available, if it has already been permitted. Total existing water from a system shall not exceed the sum of the system gain plus the firm yields of individual reservoirs in that system. **To report system gain, system operations must produce a measurable system yield greater than the sum of the individual reservoir yields.** System gain for system operations that mask individual reservoir yields or that group reservoirs together without a permitted relationship shall not be allowed in the RWPs.	Chapter 3, Appendix B, DB27
47	**§ 357.32(d)**	Exhibit C, Section 2.3.4.1; SOW Task 3	RWPGs shall use modeled available groundwater volumes for groundwater Availability, as issued by the EA, and incorporate such information in its RWP unless no modeled available groundwater volumes are provided. Groundwater Availability used in the RWP must be consistent with the desired future conditions as of the most recent deadline for the Board to adopt the State Water Plan or, at the discretion of the RWPG, established subsequent to the adoption of the most recent State Water Plan.	Chapter 3

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48	**§ 357.32(d)(1)**	Exhibit C, Section 2.3.4.1; SOW Task 3	An RWP is consistent with a desired future condition if the groundwater Availability amount in the RWP and on which an Existing Water Supply or recommended WMS relies does not exceed the modeled available groundwater amount associated with the desired future condition for the relevant aquifers, in accordance with paragraph (2) of this subsection or as modified by paragraph (3) of this subsection, if applicable. The desired future condition must be either the desired future condition adopted as of the most recent deadline for the Board to adopt the State Water Plan or, at the option of the RWPG, a desired future condition adopted on a subsequent date.	Chapter 3
49	**§ 357.32(d)(2)**	Exhibit C, Section 2.3.4.3; SOW Task 3	If no groundwater conservation district exists within the RWPA, then the RWPG shall determine the Availability of groundwater for regional planning purposes. The Board shall review and consider approving the RWPG-Estimated Groundwater Availability, prior to inclusion in the IPP, including determining if the estimate is physically compatible with the desired future conditions for relevant aquifers in groundwater conservation districts in the co-located groundwater management area or areas. The EA shall use the Board's groundwater availability models as appropriate to conduct the compatibility review.	Chapter 3
50	**Contract Exhibit C, Section 2.3.4.3**	SOW Task 3	***[In relation to TWDB Board approved RWPG-estimated groundwater availability]*** , a copy of the TWDB Board approval memorandum as well as documentation of the request process should be included in the IPP and final adopted RWP. The TWDB Board approved RWPG-estimated groundwater availabilities will be used as the planning condition in the RWP and basis of analysis in DB27. The unmodified annual MAG volume(s) must also be reported in the IPP, and final adopted RWP	Chapter 3
51	**§ 357.32(d)(3)**	Exhibit C, Section 2.3.5.2; SOW Task 3	In RWPAs that have at least one groundwater conservation district, the EA shall consider a written request from an RWPG to apply a MAG Peak Factor in the form of a percentage (e.g., greater than 100 percent) applied to the modeled available groundwater value of any particular aquifer-region-county-basin split within the jurisdiction of a groundwater conservation district, or groundwater management area if no groundwater conservation district exists, to allow temporary increases in annual availability for planning purposes.	N/A, no MAG peaking factors
52	**Contract Exhibit C, Section 2.3.5.2**	SOW Task 3	***[In relation to approved MAG Peak Factor requests],*** a copy of the MAG peak factor approval letter as well as documentation of variance request process should be included in the IPP, and final adopted RWP. The unmodified annual MAG volume(s)must also be reported in the Technical Memorandum, IPP, and final adopted RWP.	N/A, no MAG peaking factors
53	**Contract Exhibit C, Section 2.3.4.2**	SOW Task 3	For groundwater sources where no DFC exists, RWPGs may determine the groundwater availability for planning purposes. These RWPG-estimated groundwater availabilities may be determined by using availability values presented in the local GCD management plan, TWDB GAMs, if available, or other means. RWPGs must include a table documenting the method(s) used for estimating RWPG-estimated groundwater availability in the Technical Memorandum, IPP, and final adopted RWP. **This table should include the aquifer, county, and methodology description(s).**	Chapter 3
54	**Contract Exhibit C, Section 2.3.5.2**		***[In relation to approved MAG Reallocation requests]*** , a copy of the MAG reallocation approval letter as well as documentation of variance request process should be included in the Technical Memorandum, IPP, and final adopted RWP. The unmodified annual MAG volume(s)must also be reported in the Technical Memorandum, IPP, and final adopted RWP.	N/A
55	**§ 357.32(e)**	SOW Task 3, Contract Exhibit C, Section 2.3.6	Water supplies based on contracted agreements shall be based on the terms of the contract, which may be assumed to renew upon contract termination if the contract contemplates renewal or extensions.	Chapter 3
56	**§ 357.32(f)**	SOW Task 3	Evaluation results shall be reported by WUG in accordance with § 357.31(a) of this title (relating to Projected Population and Water Demands) and MWP in accordance with § 357.31(b) of this title.	Chapter 3, Attachment 3-2

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57	**Contract Scope of Work, Task 3**	Contract Exhibit C, Section 2.12.2	In addition to submitting all electronic model input/output files used in determining water availability (in sufficient detail for another party to replicate the resulting availability estimates that are incorporated into the plan), the Technical Memorandum, IPP, and final RWP must include a table summarizing the details of any hydrologic models used, including the model name, version date, model input/output files used, date model run, and any relevant comments	Appendix B
58	**Contract Exhibit C, 2.3.5.1**		If the use of a hydrologic variance for an alternative surface water availability evaluation is approved by the Executive Administrator, a copy of the approved alternative hydrologic assumptions and methodologies as well as documentation of variance request process must be included in the IPP and final adopted RWP.	Appendix B
59	**Contract Exhibit C, Section 2.3.5.1. Table 2**		If the use of a hydrologic variance for an alternative surface water availability evaluation is approved by the Executive Administrator, the plan must include the additional yield information specified in Exhibit C, Section 2.3.5.1; Table 2, as a value reported in IPP and final RWP.	N/A
60	**Contract Exhibit C, Section 2.3.3**		Reuse is considered a stand-alone water source type and RWPGs will evaluate reuse availability and supplies separately from conservation, which is classified as a demand reduction associated with a WUG.	Chapter 3
61	**Contract Exhibit C, Section 2.3.3**		Reuse availability should be presented as a separate subsection within Chapter 3 of the IPP and final RWP. The subsection must describe the data sources and methodology used to calculate reuse availability.	Chapter 3
62	**Contract Exhibit C, Section 2.3.3**		RWPGs must classify reuse availability as either direct or indirect.	Chapter 3 and DB27
63	**Contract Exhibit C, Section 2.3.6**		For direct reuse [existing supplies], RWPGs shall base their drought of record existing direct reuse analyses on: currently installed wastewater reclamation infrastructure; and the amount of wastewater anticipated to be treated at the WWTP, based on associated decade populations/demands. These amounts shall not exceed the amounts of water available to utilities generating the wastewater.	Chapter 3
64	**Contract Exhibit C, Section 2.3.6**		For indirect reuse [existing supplies], RWPGs must base their drought of record existing indirect reuse analyses on currently installed wastewater treatment infrastructure; currently permitted wastewater discharge amounts; and the amount of wastewater anticipated to be treated at the WWTP, based on associated decade populations/demands. These amounts may not exceed the amounts of water available to utilities generating the wastewater.	N/A
65	**Contract Exhibit C, Section 2.3.6**		**[The following items must also be presented in the IPP and final adopted RWP:]** Water rights which are the basis for surface water existing supply volumes. RWPGs must also submit water rights data to the TWDB electronically using a TWDB provided spreadsheet.	Chapter 3 and electronic submittal
66	**Contract Exhibit C, Section 2.3.6**		**[The following items must also be presented in the IPP and final adopted RWP:]** For local surface water supply, plans must include a single table that lists each local surface water supply with a) an explanation for the basis of the supply itself, and b) the basis for the volume of supply. For unpermitted supplies, list the source as the sum of unpermitted surface water by county-basin split. Any unpermitted local surface water supplies must be listed individually as well with explanation and may be aggregated at the county-basin level when appropriate.	Chapter 3
67	**Contract Exhibit C, Section 2.3.6**		**[The following items must also be presented in the IPP and final adopted RWP:]** For local supplies, the plan must acknowledge whether the RWPG can confirm if the local supplies are firm. For any local supplies that cannot be confirmed as 'firm' under DOR, the RWP must include a summary of the number of WUGs for which this is true and the total associated volume of water associated with this uncertainty.	Chapter 3
68	**Contract Exhibit C, Section 2.3.6**		An RWPG may not set existing groundwater supplies equal to demands just for convenience. If a RWPG determines groundwater supply volumes are appropriate to equal demand values, then they must provide justification within the RWP.	Groundwater supplies were not set equal to demands for convenience.
Header	**§ 357.33**	**SOW Task 4A**	**Needs Analysis: Comparison of Water Supplies and Demands**	

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69	§ 357.33(a)	Exhibit C, Section 2.4; SOW Task 4A	RWPs shall include comparisons of existing water supplies and projected Water Demands to identify Water Needs.	Chapter 4
70	§ 357.33(b)+§ 357.33(c)	Exhibit C, Section 2.4; SOW Task 4A	RWPGs shall compare projected Water Demands, developed in accordance with § 357.31 of this title (relating to Projected Population and Water Demands), with existing water supplies available to WUGs and WWPs in a planning area, as developed in accordance with § 357.32 of this title (relating to Water Supply Analysis), to determine whether WUGs will experience water surpluses or needs for additional supplies.	Chapter 4, Attachment 4-1, and DB27
71	§ 357.33(c)	Exhibit C, Section 2.4; SOW Task 4A	Results of evaluations shall be reported by WUG in accordance with §357.31(a) of this title and by MWP in accordance with §357.31(b) of this title.	Chapter 4, Attachment 4-2
72	§ 357.33(d)	Exhibit C, Section 2.4; SOW Task 4A	RWPGs shall perform a secondary water needs analysis for all WUGs and WWPs for which conservation WMSs or direct Reuse WMSs are recommended. This secondary water needs analysis shall calculate the Water Needs that would remain after assuming all recommended conservation and direct Reuse WMSs are fully implemented. The resulting secondary water needs volumes shall be presented in the RWP by WUG and MWP and decade.	Chapter 4 and Appendix J
Header	**§ 357.34**	**SOW Task 5A-C**	**Identification and Evaluation of Potentially Feasible Water Management Strategies and Projects**	
73	§ 357.34(a)	Exhibit C, Section 2.5; SOW Task 5A and 5B	RWPGs shall identify and evaluate potentially feasible WMSs and the WMSPs required to implement those strategies for all WUGs and WWPs with identified Water Needs.	Chapter 5
74	§ 357.34(b)	Exhibit C, Section 2.5.1; SOW Task 5A	RWPGs shall identify potentially feasible WMSs to meet water supply needs identified in §357.33 of this title (relating to Needs Analysis: Comparison of Water Supplies and Demands) in accordance with the process in §357.12(b) of this title (relating to General Regional Water Planning Group Responsibilities and Procedures). Strategies shall be developed for WUGs and WWPs. WMS and WMSPs shall be developed for WUGs and WWPs that would provide water to meet water supply needs during Drought of Record conditions.	Chapter 5 and Attachment 5-1
75	TWC § 16.053(e)(5)+ 31 TAC § 357.34(c)(1-6)	Exhibit C, Section 2.5.1	**Potentially feasible WMSs may include, but are not limited to:** conservation; drought management; reuse; management of existing supplies; conjunctive use; acquisition of available existing supplies; development of new water supplies; developing regional water supply facilities or providing regional management of water supply facilities; developing large-scale desalination facilities for seawater or brackish groundwater that serve local or regional brackish groundwater production zones identified and designated under TWC, 16.060(b)(5); voluntary transfer of water within the region using, but not limited to, contracts, water marketing, regional water banks, sales, leases, options, subordination agreements, and financing agreements; emergency transfers of water under TWC, 11.139; interbasin transfers of surface water; system optimization; reallocation of reservoir storage to new uses; enhancements of yields; improvements to water quality; new surface water supply; new groundwater supply, brush control; precipitation enhancement; aquifer storage and recovery; cancellation of water rights; and rainwater harvesting.	Chapter 5 and Attachment 5-1
76	Contract Scope of Work Task 5A	Exhibit C, Section 2.5.1	The IPP and final adopted RWP must include the documented process used by the RWPG to identify potentially feasible WMS.	Chapter 5
77	Contract Scope of Work Task 5A	Exhibit C, Section 2.5.1	The IPP and final adopted RWP must include a list or table of all identified WMSs that were considered potentially feasible, to date, for meeting a need in the region per 31 TAC § 357.12(b). RWPGs must consider the potentially feasible WMSs listed in Exhibit C, Section 2.5.1.	Chapter 5
78	Contract Scope of Work, Task 5A	Exhibit C, Section 2.5.1	Identify those potentially feasible WMSs, if any, that, in addition to providing water supply, could potentially provide non-trivial flood mitigation benefits or that might be the best potential candidates for exploring ways that they might be combined with flood mitigation features to leverage planning efforts to achieve potential cost savings or other combined water supply and flood mitigation benefits. The work required to identify these WMSs will be based entirely on a high-level, qualitative assessment and should not require modeling or other additional technical analyses.	Chapter 5D

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79	**§ 357.34(d)**	Exhibit C, Section 2.5.2; SOW Task 5B	All recommended WMSs and WMSPs that are entered into the State Water Planning Database shall be designed to reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or develop, deliver or treat additional water supply volumes to WUGs or WWPs in at least one planning decade such that additional water is available during Drought of Record conditions. Any other RWPG recommendations regarding permit modifications, operational changes, and/or other infrastructure that are not designed to reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or develop, deliver or treat additional water supply volumes to WUGs or WWPs in at least one Planning Decade such that additional water is available during Drought of Record conditions shall be indicated as such and presented separately in the RWP and shall not be eligible for funding from the State Water Implementation Fund for Texas.	Chapter 5
80	**§ 357.34(e)(1)**	Exhibit C, Section 2.5.2; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include the following analyses:]** For the purpose of evaluating potentially feasible WMSs, the Commission's most current Water Availability Model with assumptions of no return flows and full utilization of senior water rights, is to be used. Alternative assumptions may be used with written approval from the EA who shall consider a written request from a RWPG to use assumptions other than no return flows and full utilization of senior water rights.	Appendix B
81	**Contract Exhibit C, Section 2.5.2.1**		For surface water WMSs, the RWP must clearly indicate which, if any, WMSs are assumed to rely on or to mutually exclude another WMS(s) and explain how the interaction may impact both the estimated future water availability and the future water supply associated with each WMS.	N/A
82	**Contract Exhibit C, Section 2.5.2.1**		Potential future operation of multiple reservoirs as a new system, or changes to current operational procedures for existing reservoir systems, in order to provide additional yield may be evaluated as a potential WMS. Such a WMS analysis shall adequately describe methods used to calculate these future system gains (to be permitted) and shall include discussion regarding any associated permit changes that would be required.	N/A
83	**§ 357.34(e)(2)**	SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include the following analyses:]** An equitable comparison between and consistent evaluation and application of all WMSs the RWPGs determine to be potentially feasible for each water supply need.	Chapter 5, Attachment 5-2
84	**§ 357.34(e)(3)(A)**	Exhibit C, Sections 2.5.2; 2.5.2.12; 2.5.2.14; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include: a quantitative reporting of]** The net quantity, reliability, and cost of water delivered and treated for the end user's requirements during Drought of Record conditions, taking into account and reporting anticipated strategy water losses, incorporating factors used in calculating infrastructure debt payments and may include present costs and discounted present value costs. Costs do not include costs of infrastructure associated with distribution of water within a WUG after treatment, except for specific, limited allowances for direct reuse and conservation WMSs.	Chapter 5, Attachment 5-2
85	**Contract Exhibit C, Section 2.5.2**		***[Related to § 357.34(e)(3)(A):]*** WMSs shown as providing a supply in a planning decade, must come online, with a reliable supply, in or prior to that initial decade year (31 TAC §357.10(21)).	WMSs are shown in the planning decade where they come online prior to the initial decade year
86	**Contract Exhibit C, Section 2.5.2**	SOW Task 5B	***[Related to § 357.34(e)(3)(A):]*** Water quantities produced by recommended WMSs and WMSPs must be based on water availability in accordance with Section 2.3 of Exhibit C, including firm yield under Drought of Record conditions.	Water quantities produced by recommended WMSs and WMSPs were based on water availability in accordance with Section 2.3 of Exhibit C
87	**Contract Exhibit C, Section 2.5.2.9**	SOW Task 5B	***[Related to § 357.34(e)(3)(A):]*** Estimated water losses associated with each WMS must be presented in the IPP and final adopted RWP. Water losses may be presented as a calculated percent water loss included in each strategy evaluation or a range of estimated losses by strategy type.	Losses were included when appropriate in for WMSs. Loss percentages are based on information provided by the sponsor, or based on estimates generally accepted by industry standards.

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88	§ 357.34(e)(3)(B)	Exhibit C, Section 2.5.2.10; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include: a quantitative reporting of]** PART I: Environmental factors including effects on environmental water needs, wildlife habitat, cultural resources, and effect of upstream development on bays, estuaries, and arms of the Gulf of Mexico.	Chapter 6, Chapter 5, and Attachment 5-2
89	§ 357.34(e)(3)(B)	Exhibit C, Section 2.5.2.10; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include: a quantitative reporting of]** PART II: Evaluations of effects on environmental flows shall include consideration of the Commission's adopted environmental flow standards under 30 Texas Administrative Code Chapter 298 (relating to Environmental Flow Standards for Surface Water). If environmental flow standards have not been established, then environmental information from existing site-specific studies, or in the absence of such information, state environmental planning criteria adopted by the Board for inclusion in the State Water Plan after coordinating with staff of the Commission and the Texas Parks and Wildlife Department to ensure that WMSs are adjusted to provide for environmental water needs including instream flows and bays and estuaries inflows.	Chapter 6, Chapter 5, and Attachment 5-2
90	§ 357.34(e)(3)(C)	Exhibit C, Section 2.5.2.10; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include: a quantitative reporting of]** impacts to agricultural resources.	Chapter 6, Chapter 5, and Attachment 5-2
91	§ 357.34(e)(4)	Exhibit C, Section 2.5.2.10; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include:]** Discussion of the plan's impact on other water resources of the state including other WMSs and groundwater and surface water interrelationships.	Chapter 6, Chapter 5, and Attachment 5-2
92	§ 357.34(e)(5)	Exhibit C, Section 2.5.2.10; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include:]** A discussion of each threat to agricultural or natural resources identified pursuant to § 357.30(7) of this title (relating to Description of the Regional Water Planning Area) including how that threat will be addressed or affected by the water management strategies evaluated.	Chapter 6, Chapter 5, and Attachment 5-2
93	§ 357.34(e)(6)	Exhibit C, Section 2.5.2.11; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include:]** If applicable, consideration and discussion of the provisions in Texas Water Code § 11.085(k)(1) for interbasin transfers of surface water. At minimum, this consideration shall include a summation of water needs in the basin of origin and in the receiving basin.	Chapter 5; There are no new interbasin strategies for PWPA
94	§ 357.34(e)(7)	Exhibit C, Section 2.5.2.10; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include:]** Consideration of third-party social and economic impacts resulting from voluntary redistributions of water including analysis of third-party impacts of moving water from rural and agricultural areas.	Chapter 6
95	§ 357.34(e)(8)	Exhibit C, Section 2.5.2.10; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include:]** A description of the major impacts of recommended WMSs on key parameters of water quality identified by RWPGs as important to the use of a water resource and comparing conditions with the recommended WMSs to current conditions using best available data.	Chapter 6
96	§ 357.34(e)(9)	Exhibit C, Section 2.5.2.10; SOW Task 5B	**[Evaluations of potentially feasible WMSs and associated projects shall include:]** Other factors as deemed relevant by the RWPG including recreational impacts.	Chapter 6, Chapter 5, and Attachment 5-2
97	§ 357.34(f)		RWPGs shall evaluate and present potentially feasible WMSs and WMSPs with sufficient specificity to allow state agencies to make financial or regulatory decisions to determine consistency of the proposed action before the state agency with an approved RWP.	Chapter 5, Attachment 5-1 and 5-2, and Appendix D
98	§ 357.34(g)(1)(A)	Exhibit C, Section 2.5.2.7; SOW Task 5B	Implementation of large recommended WMSs and associated WMSPs. **[For large recommended WMSs and associated WMSPs, RWPGs must include the following information:]** expenditures of sponsor money;	Subsection 5D, No recommended qualifying strategies in Region A
99	§ 357.34(g)(1)(B)	Exhibit C, Section 2.5.2.7; SOW Task 5B	**[For large recommended WMSs and associated WMSPs, RWPGs must include the following information:]** permit applications, including the status of a permit application; and	Subsection 5D, No recommended qualifying strategies in Region A
100	§ 357.34(g)(1)(C)	Exhibit C, Section 2.5.2.7; SOW Task 5B	**[For large recommended WMSs and associated WMSPs, RWPGs must include the following information:]** status updates on the phase of construction of a project.	Subsection 5D, No recommended qualifying strategies in Region A

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101	§ 357.34(g)(2)	Exhibit C, Section 2.5.2.7; SOW Task 5B	The implementation status must be provided for the following types of recommended WMSs with any online decade: • All reservoir strategies (including major and minor reservoirs) • All seawater desalination strategies • Direct potable reuse strategies that provide greater than 5,000 acre-feet per year (AFY) of supply in any planning decade • Brackish groundwater strategies that provide greater than 10,000 AFY of supply in any planning decade • Aquifer storage and recovery strategies that provide greater than 10,000 AFY in any decade • All water transfers from out of state • Any other innovative technology projects the RWPG considers appropriate	Subsection 5D, No recommended qualifying strategies in Region A
102	Contract Scope of Work, Task 5B	Exhibit C, Section 2.5.2.7; SOW Task 5B	Documentation of the implementation status addressing rule 357.34(g), must be included in a separate Chapter 5 subsection. The subsection must include 1) the implementation status in table format, using the TWDB provided table template, and 2) a simple, graphic, showing the full planning horizon, and displaying separate timeline/schedules for each project in accordance with Exhibit C, Section 2.5.2.7. **Planning groups are required to use the TWDB table template in the 2026 RWP Exhibit C Tables Excel file for this subsection.**	Subsection 5D, No recommended qualifying strategies in Region A
103	§ 357.34(h)	Exhibit C, Section 2.5.2.8; SOW Task 5B	If an RWPG does not recommend aquifer storage and recovery strategies, seawater desalination strategies, or brackish groundwater desalination strategies it must document the reason(s) in the RWP.	Subchapter 5A
104	§ 357.34(i)	Exhibit C, Section 2.5.2.4; SOW Task 5B	In instances where an RWPG has determined there are significant identified Water Needs in the RWPA, the RWP shall include an assessment of the potential for aquifer storage and recovery to meet those Water Needs. Each RWPG shall define the threshold to determine whether it has significant identified Water Needs. Each RWP shall include, at a minimum, a description of the methodology used to determine the threshold of significant needs. If a specific assessment is conducted, the assessment may be based on information from existing studies and shall include minimum parameters as defined in contract guidance.	Subchapter 5A
105	Contract Exhibit C, Section 2.5.2.4		Aquifer storage and recovery WMS evaluations must report the expected percent of recovery for the ASR projects and must present that expected, lesser volume as the net water supply yield for the project.	Subchapter 5C, 5D
106	§ 357.34(j)	Exhibit C, Section 2.5.2.5-6; SOW Task 5B and 5C	Conservation, Drought Management Measures, and Drought Contingency Plans shall be considered by RWPGs when developing the regional plans, particularly during the process of identifying, evaluating, and recommending WMSs. RWPs shall incorporate water conservation planning and drought contingency planning in the RWPA.	Subchapter 5B, Chapter 7
107	§ 357.34(j)(1)	Exhibit C, Section 2.5.2.6 and 2.5.2.8; SOW Task 5B	Drought Management Measures including water demand management. **RWPGs shall consider Drought Management Measures for each need identified in § 357.33 of this title and *shall include such measures* for each user group to which Texas Water Code § 11.1272 (relating to Drought Contingency Plans for Certain Applicants and Water Right Holders) applies**. Impacts of the Drought Management Measures on Water Needs must be consistent with guidance provided by the Commission in its administrative rules implementing Texas Water Code § 11.1272. **If an RWPG does not adopt a drought management strategy for a need it must document the reason in the RWP.** *Drought management measures are defined in 31 TAC §357.10(9) as demand management activities to be implemented during drought that may be evaluated and included as Water Management Strategies.*	Subchapter 5A and Chapter 7
108	§ 357.34(j)(2)	Exhibit C, Section 2.5.2.5; SOW Task 5B and 5C	Water conservation practices. RWPGs must consider water conservation practices, including potentially applicable best management practices, for each identified water need.	Subchapter 5B

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109	**§ 357.34(j)(2)(A)**	Exhibit C, Section 2.5.2.5; SOW Task 5B and 5C	**RWPGs shall include water conservation practices for each user group to which Texas Water Code § 11.1271 and § 13.146 (relating to Water Conservation Plans) apply.** The impact of these water conservation practices on water needs must be consistent with requirements in appropriate Commission administrative rules related to Texas Water Code § 11.1271 and § 13.146. *Water conservation measures (practices) are defined in 31 TAC §357.10(36) as practices, techniques, programs, and technologies that will protect water resources, reduce the consumption of water, reduce the loss or waste of water, or improve the efficiency in the use of water that may be presented as Water Management Strategies, so that a water supply is made available for future or alternative uses.*	Subchapter 5B
110	**§ 357.34(j)(2)(B)**	Exhibit C, Section 2.5.2.5 and 2.5.2.8; SOW Task 5B and 5C	RWPGs shall consider water conservation practices for each WUG beyond the minimum requirements of subparagraph (A) of this paragraph, whether or not the WUG is subject to Texas Water Code § 11.1271 and § 13.146. **If RWPGs do not adopt a water conservation strategy to meet an identified need, they shall document the reason in the RWP.**	Subchapter 5B
111	**§ 357.34(j)(2)(C)**	Exhibit C, Section 2.5.2.5 and Section 2.5.2.11; SOW Task 5B and Task 5C	For each WUG or WWP that is to obtain water from a proposed interbasin transfer to which Texas Water Code § 11.085 (relating to Interbasin Transfers) applies, RWPGs shall include a Water Conservation Strategy, pursuant to Texas Water Code § 11.085(l), that will result in the highest practicable level of water conservation and efficiency achievable. For these strategies, RWPGs shall determine and report projected water use savings in gallons per capita per day based on its determination of the highest practicable level of water conservation and efficiency achievable. RWPGs shall develop conservation strategies based on this determination. In preparing this evaluation, RWPGs shall seek the input of WUGs and WWPs as to what is the highest practicable level of conservation and efficiency achievable, in their opinion, and take that input into consideration. RWPGs shall develop water conservation strategies consistent with guidance provided by the Commission in its administrative rules that implement Texas Water Code § 11.085. When developing water conservation strategies, the RWPGs must consider potentially applicable best management practices. Strategy evaluation in accordance with this section shall include a quantitative description of the quantity, cost, and reliability of the water estimated to be conserved under the highest practicable level of water conservation and efficiency achievable.	N/A There are no new interbasin strategies for PWPA.
112	**§ 357.34(j)(2)(D)**	Exhibit C, Section 2.5.2.5; SOW Task 5A and 5C	RWPGs shall consider strategies to address any issues identified in the information compiled by the Board from the water loss audits performed by retail public utilities pursuant to § 358.6 of this title (relating to Water Loss Audits).	Subchapter 5B
113	**Contract Scope of Work, Task 5C**	Exhibit C, Section 2.5.2.5	RWPGs must develop water loss mitigation WMSs distinctly separate from water use reduction WMSs.	Subchapter 5B
114	**Contract Exhibit C, Section 2.5.2.14**		***[Related to § 357.34(e)(3)(A):]*** Regional and state water plans may not include the cost of distribution of water within a WUG service area. The exception regarding the inclusion of costs associated with Conservation - water loss mitigation projects may only include the costs specifically listed in Contract Exhibit C, Section 2.5.2.14.	The cost of distribution of water within a WUG service area was not included in the Region A Water Plan.
115	**Contract Exhibit C, Section 2.5.2.14**		If the distribution line replacement for the water conservation strategy is subject to adopted utility standard minimum size requirements that exceed two standard pipe diameters, the water management strategy evaluation must note the specific utility standard and include 1) a map of the proposed line replacement; and 2) detailed water loss calculations before and after the proposed line replacement.	N/A
116	**§ 357.34(j)(3)**	Exhibit C, Section 2.5.5; SOW Task 5C	RWPGs shall recommend Gallons Per Capita Per Day goal(s) for each municipal WUG or specified groupings of municipal WUGs. Goals must be recommended for each planning decade and may be a specific goal or a range of values. At a minimum, the RWPs shall include Gallons Per Capita Per Day goals based on drought conditions to align with guidance principles in §358.3 of this title (relating to Guidance Principles).	Subchapter 5B
117	**§ 357.34(k)**	Exhibit C, Section 2.5.5; SOW Task 5C	RWPs shall include a subchapter consolidating the RWPG's recommendations regarding water conservation. RWPGs shall include in the RWPs model water conservation plans pursuant to Texas Water Code § 11.1271.	Subchapter 5B

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118	**Contract Exhibit C, Section 2.5.2.3**		RWPGs must evaluate potential future sources of direct and/or indirect reuse that will require new permits and additional reclamation infrastructure as WMSs and must provide adequate justification to explain methods for estimating the amount of future direct and/or indirect reuse water available from such sources, including consideration of the population/demand projections for each decade associated with the WMS.	Subchapter 5C
119	**Contract Exhibit C, Section 2.5.2.14**		***[Related to § 357.34(e)(3)(A):]*** Regional and state water plans may not include the cost of distribution of water within a WUG service area. The exception regarding the inclusion of costs associated with direct reuse projects may only include the costs specifically listed in Contract Exhibit C, Section 2.5.2.14.	The cost of distribution of water within a WUG service area was not included in the Region A Water Plan.
120	**Contract Exhibit C, Section 2.5.2.13**	SOW Task 5B	RWPGs must utilize this WMSP costing tool for every cost estimate presented in the RWPs [in the absence of more accurate and detailed, project-specific cost estimates], including updating project cost estimates previously developed in the 2021 RWPs. RWPGs must present the costing tool's standardized, automated cost output report for each WMSP evaluated in the IPP and final adopted RWP. If a different format is utilized, the RWPG must apply the data and procedures used in the costing tool, and present the resulting output as analogous to the costing tool, for example breaking out capital cost estimates for each project component.	Subchapters 5B, 5C, 5D, Attachment 5-2, and Appendix D
121	**Contract Exhibit C, Section 2.5.2.12**		Costs of WMSPs must be prepared and presented separately and discretely for each separate WMSP and may not be aggregated and presented as a single capital cost representing multiple WMSPs that would actually be located in multiple locations and funded by separate sponsors or implemented separately. Each project with a capital cost should have an associated volume of water or annual capacity presented in the plan. RWPGs may not, in general, aggregate multiple facilities into a single cost estimate and then allocate shares of the resulting total cost, for example, pro rata across several entities or locations.	Subchapters 5B, 5C, 5D, Attachment 5-2, and Appendix D
122	**Contract Exhibit C, Section 2.5.2.12**		The plan must present the following capital costs for each WMSP, as applicable: construction costs, engineering and feasibility studies, legal assistance, financing, bond counsel and contingencies (30% total for pipeline projects, 35% for other unless more detailed info available); permitting and mitigation activities, land purchase costs not associated with mitigation; easement costs; and purchases of water rights.	Subchapters 5B, 5C, 5D, Attachment 5-2, and Appendix D
123	**Contract Exhibit C, Section 2.5.2.12**		Construction costs, if applicable, must be based on September 2023 price indices for commodities such as cement and steel as reported in the Engineering News Record (ENR) Construction Cost Index.	Subchapters 5B, 5C, 5D, Attachment 5-2, and Appendix D
124	**Contract Exhibit C, Section 2.5.2.12**		Capital costs and land areas associated with development of reservoirs must be broken out to show separate lines items for 1) the land area of the reservoir footprint (conservation pool only) alongside the estimated land purchase cost; 2) mitigation land area and associated estimate of purchase cost; and, 3) construction costs of embankment/dam facilities (separate from transmission facilities).	Subchapters 5B, 5C, 5D, Attachment 5-2, and Appendix D
125	**Contract Exhibit C, Section 2.5.2.12**		For WMSs other than reservoirs the length of debt service is 20 years unless otherwise justified. For reservoirs, the period is 40 years. Level debt service applies to all projects, and the annual interest rate for project financing is 3.5 percent. Terms of debt service must be reported in the evaluation of each project.	Appendix D
126	**Contract Exhibit C, Section 2.5.2.12**		Operations and maintenance unit costs shall be based on the associated quantity of water supplied. Unless more accurate, project-specific data are accessible, RWPGs shall calculate annual operating and maintenance costs as 1.0 percent of total estimated construction cost for pipelines, 2.5 percent of estimated construction costs for pump stations, and 1.5 percent of estimated construction costs for dams. Costs must include labor and materials required to maintain projects such as regular repair and/or replacement of equipment. Power costs shall be calculated on an annual basis using calculated horsepower input and a power purchase cost of $0.09 per kilowatt hour; however, **each RWPG may adjust this figure based on local and regional conditions if they specify and document their reasons**. RWPGs shall include costs of water if WMSs involve purchases of raw or treated water on an annual basis (e.g. leases of water rights).	Subchapters 5B, 5C, 5D, Attachment 5-2, and Appendix D

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127	**Contract Exhibit C, Section 2.5.2.12**		At a minimum, annual costs should be presented by debt service, operation and maintenance cost as a percentage of total construction cost, power costs, and cost of purchasing water (if applicable). If precise information on the cost of purchasing water is not available, the plan should include a best estimate (e.g., as a percent markup) or an estimated range of the raw or treated water cost and the water management strategy evaluation can state the average cost is an estimate.	Subchapters 5B, 5C, 5D, Attachment 5-2, and Appendix D
128	**Contract Exhibit C, Section 2.5.2.12**		The RWP must present the unit costs of the net volume of water anticipated to be delivered to water users (after water losses) in dollars per acre-foot. Unit costs of WMSs must be evaluated, compared, and presented in an 'apples-to-apples' manner.	Subchapters 5B, 5C, 5D, Attachment 5-2, and Appendix D
129	**Contract Exhibit C, Section 2.5.2.15**		If an infrastructure component is not required to increase the treated water supply volume delivered to an entity either as new supply or through demand reduction, then the component and its costs may not be included in the RWP. **Infrastructure costs that may not be included in RWP are listed in Exhibit C, Section 2.5.2.15.**	Project components or costs that do not increase treated water supplies were not included in the Region A Water Plan.
130	**Contract Scope of Work, Task 5B**	**Contract Exhibit C, Section 2.5.2**	***[Related to technical evaluations:]*** WMS and WMSP documentation must include a strategy description, discussion of associated facilities, project map, and technical evaluation addressing all considerations and factors required under 31 TAC §357.34(e)-(i) and §357.35. If an identified potentially feasible WMS is, at any point, determined to be not potentially feasible by the planning group and therefore not evaluated, the plan must provide documentation of why the WMS was not evaluated.	Subchapters 5B and 5C
131	**Contract Scope of Work, Task 5B**	**Contract Exhibit C, Section 2.5.4**	[If applicable] Alternative water management strategies must be fully evaluated in accordance with 31 TAC §357.34(e)-(i). Technical evaluations of alternative WMSs must be included in the plans and the data associated with alternative WMS must be entered into DB27. Technical evaluations of each alternative WMS must have a generally defined delivery point for the water.	N/A. Region A had no alternative water management strategies this round.
132	**Contract Scope of Work, Task 5B**		RWPGs must evaluate all WMSs that were scoped by the RWPG under Task 5B. Analyses of each of those potentially feasible WMSs must be presented in the plan; even if a WMS analysis is brief (i.e., ended up not being fully evaluated for reasons of ultimately being found infeasible.) This includes technical evaluations of all WMSs that were evaluated but not recommended.	Subchapter 5B
Header	**§ 357.35**	**SOW Task 5B**	**Recommended and Alternative Water Management Strategies and Projects**	
133	**§ 357.35(a)**	Contract Exhibit C, Section 2.5.4; Scope of Work, Task 5B	RWPGs shall recommend WMSs and the WMSPs required to implement those WMSs to be used during a Drought of Record based on the potentially feasible WMSs evaluated under § 357.34 of this title (relating to Identification and Evaluation of Potentially Feasible Water Management Strategies and Water Management Strategy Projects).	Chapter 5, Attachment 5-2
134	**§ 357.35(b)**	Contract Exhibit C, Section 2.5.4; Scope of Work, Task 5B	RWPGs shall recommend specific water management strategies based upon the identification, analysis, and comparison of water management strategies by the RWPG that the RWPG determines are potentially feasible so that the cost effective water management strategies that are environmentally sensitive are considered and adopted unless a RWPG demonstrates that adoption of such strategies is inappropriate. To determine cost-effectiveness and environmental sensitivity, RWPGs shall follow processes described in § 357.34 of this title. The RWP may include alternative water management strategies evaluated by the processes described in § 357.34 of this title.	Chapter 5, Attachment 5-2
135	**§ 357.35(c)**	Contract Exhibit C, Section 2.5.4	Strategies shall be selected by the RWPGs so that cost effective water management strategies, which are consistent with long-term protection of the state's water resources, agricultural resources, and natural resources are adopted.	Chapter 5, Attachment 5-2
136	**§ 357.35(d)**	Contract Exhibit C, Section 2.5.1	RWPGs shall identify and recommend water management strategies for all WUGs and WWPs with identified water needs and that meet all water needs during the drought of record except in cases where:	Chapter 5
137	**§ 357.35(d)(1)**	Contract Exhibit C, Section 2.5.1	**[Except in cases where:]** no WMS is feasible. In such cases, RWPGs must explain why no WMS are feasible; or	Chapter 5

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138	**§ 357.35(d)(2)**	Contract Exhibit C, Section 2.5.1	**[Except in cases where:]** a political subdivision that provides water supply other than water supply corporations, counties, or river authorities explicitly does not participate in the regional water planning process for needs located within its boundaries or extraterritorial jurisdiction.	Chapter 5
139	**§ 357.35(e)**		Specific recommendations of WMSs to meet an identified need shall not be shown as meeting a need for a political subdivision if the political subdivision in question objects to inclusion of the strategy for the political subdivision and specifies its reasons for such objection. This does not prevent the inclusion of the strategy to meet other needs.	Chapter 5
140	**§ 357.35(f)**	Contract Exhibit C, Section 2.5.2	Recommended strategies shall protect existing water rights, water contracts, and option agreements, but may consider potential amendments of water rights, contracts and agreements, which would require the eventual consent of the owner.	Chapter 5
141	**§ 357.35(g)(1)**	Contract Exhibit C, Section 2.5.2	**[RWPGs shall report:]** Recommended WMSs, recommended WMSPs, and the associated results of all the potentially feasible WMS evaluations by WUG and MWP. If a WUG lies in one or more counties or RWPAs or river basins, data shall be reported for each river basin, RWPA, and county.	Chapter 5
142	**§ 357.35(g)(2)**	Contract Exhibit C, Section 2.5.4.1	**[RWPGs shall report:]** Calculated planning management supply factors for each WUG and MWP included in the RWP assuming all recommended WMSs are implemented. This calculation shall be based on the sum of: the total existing water supplies, plus all water supplies from recommended WMSs for each entity; divided by that entity's total projected Water Demand, within the Planning Decade. The resulting calculated management supply factor shall be presented in the plan by entity and decade for every WUG and MWP. Calculating planning management supply factors is for reporting purposes only.	Appendix J
143	**Contract Exhibit C, Section 2.5.4.1**		RWPGs must provide an explanation for any predetermined management supply factors and may present these factors based, for example, on sizes of water users, types of water use, water availability conditions, types of WMSs, or any other factors the RWPG considers relevant at the project or water user level.	N/A, no predetermined management supply factors
144	**§ 357.35(g)(3)**		**[RWPGs shall report:]** Fully evaluated Alternative WMSs and associated WMSPs included in the adopted RWP shall be presented together in one place in the RWP.	N/A. Region A had no alternative water management strategies this round.
145	**Contract Scope of Work, Task 5B**	Contract Exhibit C, Section 2.5.4	The IPP and final adopted RWP must include documentation of the RWPG's process for selecting recommended WMSs and associated WMSPs including development of WMS evaluations matrices and other tools required to assist the RWPG in comparing and selecting recommended WMSs and WMSPs.	Chapter 5, Attachment 5-2
146	**Contract Exhibit C, Section 2.5.3**		For any recommended water management strategies where the strategy supply volume remains 100 percent unallocated to water user groups, the RWPG must explain in the RWP why the strategy is recommended but not assigned to any beneficiaries.	Appendix I
147	**Contract Exhibit C, Section 2.5.4**		RWPGs must recommend WMSs separately from WMSPs although they are often interrelated.	Appendix J
Header	**§ 357.40**	**SOW Task 6**	**Impacts of Regional Water Plan**	
148	**§ 357.40(a)**	Exhibit C, Section 2.6.4; SOW Task 6	RWPs shall include a quantitative description of the socioeconomic impacts of not meeting the identified Water Needs pursuant to § 357.33(c) of this title (relating to Needs Analysis: Comparison of Water Supplies and Demands).	Chapter 6, Appendix F
149	**§ 357.40(b)(1)**	Exhibit C, Section 2.6.1; SOW Task 6	**[RWPs shall include a description of the impacts of the RWP regarding:]** Agricultural resources pursuant to § 357.34(e)(3)(C) of this title (relating to Identification and Evaluation of Potentially Feasible Water Management Strategies);	Chapter 6, Attachment 5-2
150	**§ 357.40(b)(2)**	Exhibit C, Section 2.6.1; SOW Task 6	**[RWPs shall include a description of the impacts of the RWP regarding:]** Other water resources of the state including other water management strategies and groundwater and surface water interrelationships pursuant to § 357.34(e)(4) of this title;	Chapter 6, Attachment 5-2
151	**§ 357.40(b)(3)**	Exhibit C, Section 2.6.1; SOW Task 6	**[RWPs shall include a description of the impacts of the RWP regarding:]** Threats to agricultural and natural resources identified pursuant to § 357.34(e)(5) of this title;	Chapter 6, Attachment 5-2

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152	§ 357.40(b)(4)	Exhibit C, Section 2.6.1; SOW Task 6	**[RWPs shall include a description of the impacts of the RWP regarding:]** Third-party social and economic impacts resulting from voluntary redistributions of water including analysis of third-party impacts of moving water from rural and agricultural areas pursuant to § 357.34(e)(7) of this title;	Chapter 6
153	§ 357.40(b)(5)	Exhibit C, Section 2.6.1; SOW Task 6	**[RWPs shall include a description of the impacts of the RWP regarding:]** Major impacts of recommended water management strategies on key parameters of water quality pursuant to § 357.34(e)(8) of this title; and	Chapter 6
154	§ 357.40(b)(6)	Exhibit C, Section 2.6.1; SOW Task 6	**[RWPs shall include a description of the impacts of the RWP regarding:]** Effects on navigation.	Chapter 6
155	§ 357.40(c)	Exhibit C, Section 2.6.3; SOW Task 6	RWPs shall include a summary of the identified water needs that remain unmet by the RWP.	Subchapter 5D
156	§ 357.50(j)	Contract Exhibit C, Section 2.6.3	The RWPGs must provide adequate justification of any unmet municipal needs. **For each municipal WUG with unmet needs, the RWPG shall include**: 1. documentation that all potentially feasible WMS were considered to meet the need, including drought management WMS; 2. explanations as to why additional conservation and/or drought management WMS were not recommended to address the need; 3. descriptions of how, in the event of a repeat of the drought of record, the WUG associated with the unmet need shall ensure the public health, safety, and welfare in each planning decade with an unmet need; and, 4. explanation as to whether there may be occasion, prior to the development of the next IPP, to amend the RWP to address all or a portion of the unmet municipal need.	Chapter 6
Header	**§ 357.41**	**SOW Task 6**	**Consistency with Long-Term Protection of Water Resources, Agricultural Resources, and Natural Resources**	
157	§ 357.41	Exhibit C, Section 2.6.2, SOW Task 6	RWPGs shall describe how RWPs are consistent with the long-term protection of the state's water resources, agricultural resources, and natural resources as embodied in the guidance principles in § 358.3(4) and (8) of this title (relating to Guidance Principles).	Chapter 6
Header	**§ 357.42**	**SOW Task 7**	**Drought Response Information, Activities, and Recommendations**	
158	§ 357.42(a)	Exhibit C, Section 2.7; SOW Task 7	RWPs shall consolidate and present information on current and planned preparations for, and responses to, drought conditions in the region including, but not limited to, drought of record conditions based on the following subsections.	Chapter 7
159	Contract Exhibit C, Section 2.7.1	Exhibit C, Section 2.7.1; SOW Task 7	The RWP must present and summarize information regarding the current Drought(s) of Record for the region and any other relevant sub-regional or basin-specific drought of record periods that impact the existing RWPA water supplies. This summary may include relevant sub-regional, basin-based, and/or sub-basin droughts of record.	Chapter 7
160	§ 357.42(b)(1)	Exhibit C, Section 2.7.3; SOW Task 7	**[RWPGs shall conduct an assessment of current preparations for drought within the RWPA. This may include information from local Drought Contingency Plans. The assessment shall include]:** A description of how water suppliers in the RWPA identify and respond to the onset of drought; and	Chapter 7
161	§ 357.42(b)(2)	Exhibit C, Section 2.7.3; SOW Task 7	**[RWPGs shall conduct an assessment of current preparations for drought within the RWPA. This may include information from local Drought Contingency Plans. The assessment shall include]:** Identification of unnecessary or counterproductive variations in drought response strategies among water suppliers that may confuse the public or impede drought response efforts. At a minimum, RWPGs shall review and summarize drought response efforts for neighboring communities including the differences in the implementation of outdoor watering restrictions.	Chapter 7
162	§ 357.42(c)(1); § 357.42(c)(3)	Exhibit C, Section 2.7.4; SOW Task 7	**[RWPGs shall identify drought response triggers and actions regarding the management of existing groundwater and surface water sources in the RWPA designated in accordance with § 357.32, including:]** Factors specific to each source of water supply to be considered in determining whether to initiate a drought response for each water source including specific recommended drought response triggers. *Triggers and actions developed in paragraphs (1) and (2) of this subsection may consider existing triggers and actions associated with existing drought contingency plans.*	Chapter 7

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163	**§ 357.42(c)(2); § 357.42(c)(3)**	Exhibit C, Section 2.7.4; SOW Task 7	**[RWPGs shall identify drought response triggers and actions regarding the management of existing groundwater and surface water sources in the RWPA designated in accordance with § 357.32, including:]** Actions to be taken as part of the drought response by the manager of each water source and the entities relying on each source, including the number of drought stages. *Triggers and actions developed in paragraphs (1) and (2) of this subsection may consider existing triggers and actions associated with existing drought contingency plans.*	Chapter 7, Attachment 7-1
164	**§ 357.42(d)**	Exhibit C, Section 2.7.5; SOW Task 7	RWPGs shall collect information on existing major water infrastructure facilities that may be used for interconnections in event of an emergency shortage of water. **At a minimum, the RWP shall include a general description of the methodology used to collect the information, the number of existing and potential emergency interconnects in the RWPA, and a list of which entities are connected to each other.** In accordance with Texas Water Code §16.053(r), certain information regarding water infrastructure facilities is excepted from the Public Information Act, Texas Government Code, Chapter 552. Any excepted information collected shall be submitted separately to the EA in accordance with guidance to be provided by EA.	Chapter 7, no confidential information received
165	**§ 357.42(e)**	Exhibit C, Section 2.7.5; SOW Task 7	RWPGs may provide general descriptions of local Drought Contingency Plans that involve making emergency connections between water systems or WWP systems that do not include locations or descriptions of facilities that are disallowed under subsection (d) of this section.	Chapter 7
166	**§ 357.42(f)(1)**	Exhibit C, Section 2.7.6; SOW Task 7	**[RWPGs may designate recommended and alternative drought management water management strategies and other recommended drought measures in the RWP, including:]** List and description of the recommended drought management water management strategies and associated WUGs and WWPs, if any, that are recommended by the RWPG. Information to include associated triggers to initiate each of the recommended drought management water management strategies;	Chapter 7
167	**§ 357.42(f)(2)**	Exhibit C, Section 2.7.6; SOW Task 7	**[RWPGs may designate recommended and alternative drought management water management strategies and other recommended drought measures in the RWP, including:]** List and description of alternative drought management water management strategies and associated WUGs and WWPs, if any, that are included in the plan. Information to include associated triggers to initiate each of the alternative drought management water management strategies;	N/A, there are no drought water management strategies in Region A
168	**§ 357.42(f)(3)**	Exhibit C, Section 2.7.6; SOW Task 7	**[RWPGs may designate recommended and alternative drought management water management strategies and other recommended drought measures in the RWP, including:]** List of all potentially feasible drought management water management strategies that were considered or evaluated by the RWPG but not recommended; and	N/A, there are no drought water management strategies in Region A
169	**§ 357.42(f)(4)**	Exhibit C, Section 2.7.8; SOW Task 7	**[RWPGs may designate recommended and alternative drought management water management strategies and other recommended drought measures in the RWP, including:]** List and summary of any other recommended drought management measures, if any, that are included in the RWP, including associated triggers if applicable.	N/A, there are no drought water management strategies in Region A
170	**§ 357.42(g)**	Exhibit C, Section 2.7.7; SOW Task 7	The RWPGs shall evaluate potential emergency responses to local drought conditions or loss of existing water supplies; the evaluation shall include identification of potential alternative water sources that may be considered for temporary emergency use by WUGs and WWPs in the event that the existing water supply sources become temporarily unavailable to the WUGs and WWPs due to unforeseeable hydrologic conditions such as emergency water right curtailment, unanticipated loss of reservoir conservation storage, or other localized drought impacts. **RWPGs shall evaluate, at a minimum, municipal WUGs that:**	Chapter 7
171	**§ 357.42(g)(1)**	Exhibit C, Section 2.7.7	**[Evaluation includes municipal WUGS that:]** have existing populations less than 7,500;	Chapter 7

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172	**§ 357.42(g)(2)**	Exhibit C, Section 2.7.7	**[Evaluation includes municipal WUGS that:]** rely on a sole source for its water supply regardless of whether the water is provided by a WWP; and	Chapter 7
173	**§ 357.42(g)(3)**	Exhibit C, Section 2.7.7	**[Evaluation includes municipal WUGS that:]** all county-other WUGs.	Chapter 7
174	**Contract Exhibit C, Section 2.7.7**		For the purpose of this [emergency responses to local drought conditions or loss of municipal supply] analysis, it will be assumed that the entities being evaluated have approximately 180 days or less of water supply remaining.	Chapter 7
175	**§ 357.42(h)**	Exhibit C, Section 2.7.8	RWPGs shall consider any relevant recommendations from the Drought Preparedness Council.	Chapter 7
176	**§ 357.42(i)(1)**	Exhibit C, Section 2.7.8	**[RWPGs may make drought preparation and response recommendations regarding:]** Development of, content contained within, and implementation of local drought contingency plans required by the Commission;	Chapter 7, Attachment 7-1
177	**§ 357.42(i)(2)(A)**	Exhibit C, Section 2.7.8	**[RWPGs may make drought preparation and response recommendations regarding:]** Current drought management preparation in the RWPA including: drought response triggers; and	Chapter 7, Attachment 7-1
178	**§ 357.42(i)(2)(B)**	Exhibit C, Section 2.7.8	**[RWPGs may make drought preparation and response recommendations regarding:]** Current drought management preparation in the RWPA including: responses to drought conditions;	Chapter 7, Attachment 7-1
179	**§ 357.42(i)(3)**	Exhibit C, Section 2.7.8	**[RWPGs may make drought preparation and response recommendations regarding:]** The Drought Preparedness Council and the State Drought Preparedness Plan; and	Chapter 7
180	**§ 357.42(i)(4)**	Exhibit C, Section 2.7.8	**[RWPGs may make drought preparation and response recommendations regarding:]** Any other general recommendations regarding drought management in the region or state.	Chapter 7
181	**§ 357.42(j)**	Exhibit C, Section 2.7.9; SOW Task 7	The RWPGs shall develop region-specific model drought contingency plans.	Chapter 7, http://www.panhandlewater.org/
182	**Contract Exhibit C, Section 2.7.9**	SOW Task 7	At a minimum, **two model plans must be developed** and may be based, for example, on different water use categories, user sizes, and/or types of water source. Model plans for municipal users must address triggers for and responses to severe and critical/emergency drought conditions. It is at the discretion of the RWPG on the type of models plans developed but is recommended that RWPGs develop plans that would be of use to the types of water users within the RWPA.	Chapter 7, https://www.panhandlewater.org/region-a-pwpg
183	**Contract Scope of Work, Task 7**	Exhibit C, Section 2.7.2	Include a separate Chapter 7 subsection that provides documentation of how the planning group addressed uncertainties in the RWP (if applicable), how the planning group addressed a drought worse than the DOR in the RWP (if applicable), and potential measures and responses that would likely be available to users in the region, in the event of a drought worse than the DOR.	Chapter 7
184	**Contract Exhibit C, Section 2.7.2**		Summarize, in general, how the region incorporated planning for uncertainty in its RWP and the region's basis, or policy, for inclusion. This could include general discussion on planning factors, any drivers of uncertainty associated with those factors, and how the RWPG made planning decisions to acknowledge or address that uncertainty. If the RWP does not include any measures to address uncertainty, this subsection must include a statement to that effect.	Chapter 7
185	**Contract Exhibit C, Section 2.7.2**		Summarize, in general, the key assumptions, analyses, strategies, and projects that are already included in the 2026 RWP calculations and recommendations (if applicable) that go beyond just meeting identified water needs anticipated under a DOR (i.e., those things that will provide some additional measure of protection to withstand a DWDOR such as use of safe-yield or inclusion of strategies that provide water volumes in excess of the identified water need, such as management supply factor, etc.). The summary should include describing which water users in the region, in general, are associated with those additional measures of protection (e.g., list of WUGs and WWPs and their associated water supplies to which these assumptions apply). If the RWP does not include any planning measures to address a DWDOR, this subsection must include a statement to that effect.	Chapter 7, Attachment 7-2

2026 IPP Review Item Number	Key Requirement Citation: TWC, 31 TAC Rule, or Contract Exhibit	Corresponding Contract Guidance and SOW Task *(if applicable)*	Requirement (see published rule and other contract documents for full context)	Location(s) in Regional Plan and/or Commentary
186	Contract Exhibit C, Section 2.7.2		Summarize, in general, the potential additional types of measures and responses, that are not part of the recommendations in the 2026 RWP, but that would likely be available to certain water providers/users in the event of the near-term onset of a DWDOR and that would be capable of providing additional, potential capacity for those water providers and users to withstand a DWDOR (i.e., additional or deeper drought management measures - if not a recommended WMS - that could be employed). The summary should include describing which water providers/users in the region, in general, the additional measures and responses would be associated with (e.g., list of WUGs and WWPs and their associated water supplies to which these assumptions apply). This information may be presented at a high-level as provided in the examples in the 2026 RWP Exhibit C Tables Excel file.	Chapter 7
Header	**§ 357.43**	**SOW Task 8**	**Regulatory, Administrative, or Legislative Recommendations**	
187	§ 357.43(a)	Exhibit C, Section 2.8.3; SOW Task 8	The RWPs shall contain any regulatory, administrative, or legislative recommendations developed by the RWPGs.	Chapter 8
188	§ 357.43(b)	SOW Task 8; Exhibit C, Section 2.8.1	Ecologically Unique River and Stream Segments. RWPGs may include in adopted RWPs recommendations for all or parts of river and stream segments of unique ecological value located within the RWPA by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by supporting literature and data. The recommendation package shall address each of the criteria for designation of river and stream segments of ecological value found in this subsection. The RWPG shall forward the recommendation package to the Texas Parks and Wildlife Department and allow the Texas Parks and Wildlife Department 30 days for its written evaluation of the recommendation. The adopted RWP shall include, if available, Texas Parks and Wildlife Department's written evaluation of each river and stream segment recommended as a river or stream segment of unique ecological value.	Chapter 8
189	§ 357.43(b)(1)	SOW Task 8; Exhibit C, Section 2.8.1	An RWPG may recommend a river or stream segment as being of unique ecological value based upon the criteria set forth in § 358.2 of this title (relating to Definitions).	Chapter 8
190	Contract Scope of Work, Task 8	Exhibit C, Section 2.8.1	An updated Texas Parks and Wildlife Department evaluation must be included in each RWP, even for those stream segments that have been recommended in previous plans but not designated by the Legislature.	Chapter 8
191	Contract Exhibit C, Section 2.8.1		If a river or stream segment has been recommended in a previous plan, the planning group may incorporate references of supporting materials developed for the previous plan into the current plan. References must be precise and include a summary of the information presented in the previous plan.	Chapter 8 - Region A WPG does not recommend the designation of any ecologically unique stream segments
192	Contract Exhibit C, Section 2.8.1		Recommendations regarding unique river or stream segments presented in the RWPs must be specific as to a) which unique river or stream segments have been previously designated by the legislature and b) which are being recommended for designation by the planning group.	Chapter 8
193	§ 357.43(b)(2)	Exhibit C, Section 2.8.1; SOW Task 8	For every river and stream segment that has been designated as a unique river or stream segment by the legislature, including during a session that ends not less than one year before the required date of submittal of an adopted RWP to the Board, or recommended as a unique river or stream segment in the RWP, the RWPG shall assess the impact of the RWP on these segments. The assessment shall be a quantitative analysis of the impact of the plan on the flows important to the river or stream segment, as determined by the RWPG, comparing current conditions to conditions with implementation of all recommended water management strategies. The assessment shall also describe the impact of the plan on the unique features cited in the region's recommendation of that segment.	Chapter 8
194	§ 357.43(c)	Exhibit C, Section 2.8.2; SOW Task 8	Unique Sites for Reservoir Construction. A RWPG may recommend sites of unique value for construction of reservoirs by including descriptions of the sites, reasons for the unique designation and expected beneficiaries of the water supply to be developed at the site. The criteria at § 358.2 of this title shall be used to determine if a site is unique for reservoir construction.	Chapter 8
195	Contract Exhibit C, Section 2.8.2		For recommendations regarding unique reservoir sites, the RWP must be specific as to a) which unique reservoir sites have been previously designated by the legislature; b) which are being recommended for designation by the RWPG; and c) whether the RWPG is recommending that the legislature re-designate a previously designated unique reservoir site.	Chapter 8

2026 IPP Review Item Number	Key Requirement Citation: TWC, 31 TAC Rule, or Contract Exhibit	Corresponding Contract Guidance and SOW Task *(if applicable)*	Requirement (see published rule and other contract documents for full context)	Location(s) in Regional Plan and/or Commentary
196	§ 357.43(d)	Exhibit C, Section 2.8.3; SOW Task 8	Any other recommendations that the RWPG believes are needed and desirable to achieve the stated goals of state and regional water planning including to facilitate the orderly development, management, and conservation of water resources and prepare for and respond to drought conditions. This may include recommendations that the RWPG believes would improve the state and regional water planning process.	Chapter 8
197	§ 357.43(e)	Exhibit C, Section 2.8.3	RWPGs may develop information as to the potential impacts of any proposed changes in law prior to or after changes are enacted.	Chapter 8
198	§ 357.43(f)	Exhibit C, Section 2.8.3	RWPGs should consider making legislative recommendations to facilitate more voluntary water transfers in the region.	Chapter 8
199	Contract Scope of Work, Task 8	Exhibit C, Section 2.8.3	Receive and consider recommendations from the Interregional Planning Council to the RWPGs.	Chapter 8
Header	**§ 357.45**	**SOW Task 9**	**Implementation and Comparison to Previous RWP**	
200	§ 357.45(a)	Exhibit C, Section 2.9.1; SOW Task 9	RWPGs shall describe the level of implementation of previously recommended WMSs and associated impediments to implementation in accordance with guidance provided by the board. Information on the progress of implementation of all WMSs that were recommended in the previous RWP, including conservation and Drought Management WMSs; and the implementation of WMSPs that have affected progress in meeting the state's future water needs.	Chapter 9
201	§ 357.45(b)(1)	Exhibit C, Section 2.9.2; SOW Task 9	**[RWPGs shall assess the progress of the RWPA in encouraging cooperation between WUGs for the purpose of achieving economies of scale and otherwise incentivizing WMSs that benefit the entire RWPA. This assessment of regionalization shall include:]** The number of recommended WMSs in the previously adopted and current RWPs that serve more than one WUG;	Chapter 9
202	§ 357.45(b)(2)	Exhibit C, Section 2.9.2; SOW Task 9	**[RWPGs shall assess the progress of the RWPA in encouraging cooperation between WUGs for the purpose of achieving economies of scale and otherwise incentivizing WMSs that benefit the entire RWPA. This assessment of regionalization shall include:]** The number of recommended WMSs in the previously adopted RWP that serve more than one WUG and have been implemented since the previously adopted RWP; and	Chapter 9
203	§ 357.45(b)(3)	Exhibit C, Section 2.9.2; SOW Task 9	**[RWPGs shall assess the progress of the RWPA in encouraging cooperation between WUGs for the purpose of achieving economies of scale and otherwise incentivizing WMSs that benefit the entire RWPA. This assessment of regionalization shall include:]** A description of efforts the RWPG has made to encourage WMSs and WMSPs that serve more than one WUG, and that benefit the entire region.	Chapter 9
204	§ 357.45(c)(1)	Exhibit C, Section 2.9.3, SOW Task 9	**[RWPGs shall provide a brief summary of how the RWP differs from the previously adopted RWP with regards to:]** Water demand projections;	Chapter 9
205	§ 357.45(c)(2)	Exhibit C, Section 2.9.3, SOW Task 9	**[RWPGs shall provide a brief summary of how the RWP differs from the previously adopted RWP with regards to:]** Drought of Record and hydrologic and modeling assumptions used in planning for the region;	Chapter 9
206	§ 357.45(c)(3)	Exhibit C, Section 2.9.3, SOW Task 9	**[RWPGs shall provide a brief summary of how the RWP differs from the previously adopted RWP with regards to:]** Groundwater and surface water availability, existing water supplies, and identified water needs for WUGs and WWPs; and	Chapter 9
207	§ 357.45(c)(4)	Exhibit C, Section 2.9.3, SOW Task 9	**[RWPGs shall provide a brief summary of how the RWP differs from the previously adopted RWP with regards to:]** Recommended and Alternative Water Management Strategies and Projects	Chapter 9
Header	**§ 357.50**	**SOW Task 10**	**Adoption, Submittal, and Approval of Regional Water Plans - Includes Public Participation and Notice Items relevant to IPP review**	
208	§ 357.12(i), § 357.21(a), and § 357.21(j)	Contract Exhibit C, Section 2.12.2	Each RWPG and any committee or subcommittee of an RWPG are subject to Chapters 551 and 552, Government Code. A copy of all materials presented or discussed at an open meeting shall be made available for public inspection prior to and following the meetings and shall meet the additional notice requirements when specifically referenced as required under other subsections. **Plan includes a statement confirming that the planning group met all requirements under the Texas Open Meetings Act and Public Information Act in accordance with 31 TAC §§357.12 and 357.21**.	Chapter 10

2026 IPP Review Item Number	Key Requirement Citation: TWC, 31 TAC Rule, or Contract Exhibit	Corresponding Contract Guidance and SOW Task *(if applicable)*	Requirement (see published rule and other contract documents for full context)	Location(s) in Regional Plan and/or Commentary
209	§ 357.50(b)		Prior to the adoption of the RWP, the RWPGs shall submit concurrently to the EA and the public an IPP. The IPP submitted to the EA must be in the electronic and paper format specified by the EA. Each RWPG must certify that the IPP is complete and adopted by the RWPG. **In the instance of a recommended WMS proposed to be supplied from a different RWPA, the RWPG recommending such strategy shall submit, concurrently with the submission of the IPP to the EA, a copy of the IPP, or a letter identifying the WMS in the other region along with an internet link to the IPP, to the RWPG associated with the location of such strategy.**	Chapter 10
210	§ 357.50(c)		The RWPGs shall distribute the IPP in accordance with §357.21(h)(7) of this title (relating to Notice and Public Participation).	Chapter 10
211	§ 357.50(g)(1)(A)	Contract Exhibit C, Section 2.12.2; SOW, Task 10	**[RWPs shall include:]** The technical report and data prepared in accordance with this chapter and the EA's specifications;	The technical report and data were prepared in accordance with Chapter 10 and the EA specifications
212	§ 357.50(g)(1)(B)	Contract Exhibit C, Section 2.12.2; SOW, Task 10	**[RWPs shall include:]** An executive summary that documents key RWP findings and recommendations;	Executive Summary, Attachments ES-1, ES-2
213	§ 357.50(g)(1)(C)	Contract Exhibit C, Section 2.10, Section 2.12.2; SOW, Task 10	**[RWPs shall include:]** Documentation of the RWPG's interregional coordination efforts;	Chapter 10
214	Contract Exhibit C, Section 2.13.2		In the 2026 RWPs, the required DB27 data reports must be included in the IPP and final RWP via reference to the TWDB Database Reports application in lieu of including electronic versions of the reports as an appendix to the plan. **Each Executive Summary of the IPP and RWP must include a section that lists the DB27 reports that will be available through the TWDB Database Reports application and instructions on how the public can access the reports, including a direct hyperlink to the TWDB Database Reports application.** The DB27 reports that will be accessible in the application are listed in Contract Exhibit C, Table 3. Section 2.13.2 of Exhibit C lists the required instructions to include in the IPP and final plans. *Please note that regions may include the DB27 reports as appendices, should they choose to, but at minimum, each Executive Summary must include the SARA access information and the report list as specified in guidance.*	Executive Summary
215	Contract Scope of Work, Task 10	Contract Exhibit C, Section 2.10	Conduct and/or enhance existing outreach specifically to rural entities in the planning area to collect and evaluate information to support plan development, including keeping track of which rural entities were contacted by the RWPG/Consultant, which entities were not responsive to RWPG contact efforts, and including a summary of the region's rural outreach efforts in Chapter 10 of the IPP and final RWP.	Appendix H
216	§ 357.50(g)(2)(B)	Contract Exhibit C, Section 2.13.2	**[RWPGs shall submit RWPs to the EA according to the following schedule:]** Prior to submission of the IPP, the RWPGs shall upload all required data, metadata and all other relevant digital information supporting the plan to the Board's State Water Planning Database. All changes and corrections to this information must be entered into the Board's State Water Planning Database prior to submittal of a final adopted plan.	All required data has been uploaded
Header	**§ 357.60**		**Consistency of Regional Water Plans - Items relevant to IPP review**	
217	§ 357.60(a)		RWPGs shall submit to the development Board a RWP that is consistent with the guidance principles and guidelines outlined in § 357.20 of this title (relating to Guidance Principles for State and Regional Water Planning). Information provided shall be based on data provided or approved by the Board in a format consistent with the guidelines of Subchapters C and D of this chapter and guidance by the EA.	A RWP consistent with the required guidance principles and guidelines has been submitted to the Development Board.
218	§ 357.60(c)		Relation to state and local plans. RWPs shall be consistent with Chapter 358 of this title (relating to State Water Planning Guidelines) and this chapter. RWPGs shall consider and use as a guide the state water plan and local water plans provided for in the Texas Water Code § 16.054 (relating to Local Water Planning).	Region A considered and used as a guide the state water plan and local water plans
Header	**§ 358.3**		**State Water Plan Guidance Principles**	
219	§ 358.3(1)		The state water plan shall provide for the preparation for and response to drought conditions.	Chapters 1, 2, 3, 5 and 7

2026 IPP Review Item Number	Key Requirement Citation: TWC, 31 TAC Rule, or Contract Exhibit	Corresponding Contract Guidance and SOW Task *(if applicable)*	Requirement (see published rule and other contract documents for full context)	Location(s) in Regional Plan and/or Commentary
220	§ 358.3(2)		The regional water plans and state water plan shall serve as water supply plans under drought of record conditions. RWPGs may, at their discretion, plan for drought conditions worse than the drought of record.	Chapters 1, 2, 3, 5 and 7
221	§ 358.3(3)		Consideration shall be given to the construction and improvement of surface water resources and the application of principles that result in voluntary redistribution of water resources.	Chapter 5
222	§ 358.3(4)		Regional water plans shall provide for the orderly development, management, and conservation of water resources and preparation for and response to drought conditions so that sufficient water will be available at a reasonable cost to satisfy a reasonable projected use of water to ensure public health, safety, and welfare; further economic development; and protect the agricultural and natural resources of the affected regional water planning areas and the state.	Chapters 5, 6 and 7
223	§ 358.3(5)		Regional water plans shall include identification of those policies and action that may be needed to meet Texas' water supply needs and prepare for and respond to drought conditions.	Chapters 5 and 7
224	§ 358.3(6)		RWPG decision-making shall be open to and accountable to the public with decisions based on accurate, objective and reliable information with full dissemination of planning results except for those matters made confidential by law.	Chapter 10
225	§ 358.3(7)		The RWPG shall establish terms of participation in its water planning efforts that shall be equitable and shall not unduly hinder participation.	Chapter 10
226	§ 358.3(8)		Consideration of the effect of policies or water management strategies on the public interest of the state, water supply, and those entities involved in providing this supply throughout the entire state.	Chapters 5 and 8
227	§ 358.3(9)		Consideration of all water management strategies the RWPG determined to be potentially feasible when developing plans to meet future water needs and to respond to drought so that cost effective water management strategies and water management strategy projects which are consistent with long-term protection of the state's water resources, agricultural resources, and natural resources are considered and approved.	Chapters 5 and 6
228	§ 358.3(10)		Consideration of opportunities that encourage and result in voluntary transfers of water resources, including but not limited to regional water banks, sales, leases, options, subordination agreements, and financing agreements.	Chapter 5
229	§ 358.3(11)		Consideration of a balance of economic, social, aesthetic, and ecological viability.	Chapter 5, Attachment 5-2
230	§ 358.3(12)		For regional water planning areas without approved regional water plans or water providers for which revised plans are not developed through the regional water planning process, the use of information from the adopted state water plan and other completed studies that are sufficient for water planning shall represent the water supply plan for that area or water provider.	N/A
231	§ 358.3(13)		All surface waters are held in trust by the state, their use is subject to rights granted and administered by the Commission, and the use of surface water is governed by the prior appropriation doctrine, unless adjudicated otherwise.	Chapter 3, Appendix B
232	§ 358.3(14)		Existing water rights, water contracts, and option agreements shall be protected. However, potential amendments of water rights, contracts and agreements may be considered and evaluated. Any amendments will require the eventual consent of the owner.	Chapters 3 and 5
233	§ 358.3(15)		The production and use of groundwater in Texas is governed by the rule of capture doctrine unless and to the extent that such production and use is regulated by a groundwater conservation district, as codified by the legislature at Texas Water Code § 36.002 (relating to Ownership of Groundwater).	Chapters 3 and 5
234	§ 358.3(16)		Consideration of recommendations of river and stream segments of unique ecological value to the legislature for potential protection.	Chapter 8
235	§ 358.3(17)		Consideration of recommendation of sites of unique value for the construction of reservoirs to the legislature for potential protection.	Chapter 8
236	§ 358.3(18)		Consideration of water planning and management activities of local, regional, state, and federal agencies, along with existing local, regional, and state water plans and information and existing state and federal programs and goals.	Chapters 1 and 5
237	§ 358.3(19)		Designated water quality and related water uses as shown in the state water quality management plan shall be improved or maintained.	Chapter 6

2026 IPP Review Item Number	Key Requirement Citation: TWC, 31 TAC Rule, or Contract Exhibit	Corresponding Contract Guidance and SOW Task *(if applicable)*	Requirement (see published rule and other contract documents for full context)	Location(s) in Regional Plan and/or Commentary
238	**§ 358.3(20)**		RWPGs shall actively coordinate water planning and management activities to identify common needs, issues, and opportunities for interregional water management strategies and water management strategy projects to achieve efficient use of water supplies. The Board will support RWPGs coordination to identify common needs, issues, and opportunities while working with RWPGs to resolve conflicts in a fair, equitable, and efficient manner.	Entire RWP
239	**§ 358.3(21)**		The water management strategies and water management strategy projects identified in approved RWPs to meet needs shall be described in sufficient detail to allow a state agency making a financial or regulatory decision to determine if a proposed action before the state agency is consistent with an approved RWP. (also see § 357.34(f))	Chapter 5, Appendices C and D
240	**§ 358.3(22)**		The evaluation of water management strategies and water management strategy projects shall use environmental information in accordance with the Commission's adopted environmental flow standards under 30 TAC Chapter 298 (relating to Environmental Flow Standards for Surface Water) where applicable or, in basins where standards are not available or have not been adopted, information from existing site-specific studies or state consensus environmental planning criteria.	No new appropriations are recommended.
241	**§ 358.3(23)**		Consideration of environmental water needs including instream flows and bay and estuary inflows, including adjustments by the RWPGs to water management strategies to provide for environmental water needs including instream flows and bay and estuary needs. Consideration shall be consistent with the Commission's adopted environmental flow standards under 30 TAC Chapter 298 in basins where standards have been adopted.	No new appropriations are recommended. Existing instream regulations considered.
242	**§ 358.3(24)**		Planning shall be consistent with all laws applicable to water use for the state and regional water planning area.	Entire RWP
243	**§ 358.3(25)**		The inclusion of ongoing water development projects that have been permitted by the Commission or a predecessor agency.	None in PWPA
244	**§ 358.3(26)**		Specific recommendations of water management strategies shall be based upon identification, analysis, and comparison of all water management strategies the RWPG determines to be potentially feasible so that the cost effective water management strategies which are environmentally sensitive are considered and adopted unless the RWPG demonstrates that adoption of such strategies is not appropriate. To determine cost-effectiveness, the RWPGs will use the process described in § 357.34(e)(3)(A) of this title (relating to Identification and Evaluation of Potentially Feasible Water Management Strategies) and, to determine environmental sensitivity, the RWPGs shall use the process described in § 357.34(e)(3)(B) of this title.	Chapter 5, Attachment 5-2, Appendix D
245	**§ 358.3(27)**		RWPGs shall conduct their planning to achieve efficient use of existing water supplies, explore opportunities for and the benefits of developing regional water supply facilities or providing regional management of water facilities, coordinate the actions of local and regional water resource management agencies, provide substantial involvement by the public in the decision-making process, and provide full dissemination of planning results.	Chapters 5 and 10
246	**§ 358.3(28)**		RWPGs must consider existing regional water planning efforts when developing their plans.	Chapters 1, 5 and 10

APPENDIX F

SOCIO-ECONOMIC MATRIX

APPENDIX G

IMPLEMENTATION SURVEY

Planning Region	WMS or WMS Project Name	Database Online Decade	Related Sponsor Entity and/or Benefitting WUGs	Implementation Survey Record Type	Database ID	Has the sponsor taken affirmative vote or actions? (TWC 16.053(h)(10))	What is the status of the WMS project or WMS recommended in the 2022 SWP?	If the project has not been started or no longer is being pursued, please explain why by adding information in this column.	Please select one or more project impediments. If an impediment is not listed, select "Other" and provide information in Column K.	If you selected "Other" in Column J, please provide information about project impediments not shown in the impediment list provided.	What funding type(s) are being used for the project? (Select all that apply)	Optional Comments
A	Advanced Metering Infrastructure - Amarillo	2020	Project Sponsor(s): Amarillo	Recommended WMS Project	3882	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Advanced Treatment (Nitrate Removal) - Wellington	2020	Project Sponsor(s): Wellington Municipal Water System	Recommended WMS Project	899	No	Project/WMS not started	Delay project start	Shift in timeline	N/A	Unknown	None
A	Amarillo Wellfield fo CRMWA 2 Transmission Pipeline - Amarillo	2070	Project Sponsor(s): Amarillo	Recommended WMS Project	3858	No	Project/WMS not started	Unknown	Other	Not recommended until later in the planning horizon.	Unknown	None
A	Aquifer Storage and Recovery - Amarillo	2030	Project Sponsor(s): Amarillo	Recommended WMS Project	3875	No	Project/WMS not started	Delay project start	Shift in timeline	N/A	Unknown	None
A	Aquifer Storage and Recovery - CRMWA	2030	Project Sponsor(s): Canadian River Municipal Water Authority	Recommended WMS Project	3906	No	Project/WMS not started	Delay project start	Shift in timeline	N/A	Unknown	None
A	Aquifer Storage and Recovery - Pampa	2030	Project Sponsor(s): Pampa Municipal Water System	Recommended WMS Project	3905	No	Project/WMS not started	Delay project start	Shift in timeline	N/A	Unknown	None
A	CRMWA 2 CRMWA Pipeline	2030	Project Sponsor(s): Canadian River Municipal Water Authority	Recommended WMS Project	3912	Yes	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	CRMWA 2 Shared Pipeline	2030	Project Sponsor(s): Canadian River Municipal Water Authority	Recommended WMS Project	3863	No	Project/WMS not started	Shared pipeline no longer recommended - project being pursued seperately.	Other	No longer being pursued.	Unknown	None
A	Develop Dockum Aquifer Supplies - Canyon	2030	Project Sponsor(s): Canyon	Recommended WMS Project	735	No	Project/WMS not started	Unknown	N/A	N/A	Unknown	None
A	Develop Dockum Aquifer Supplies - Moore County Manufacturing	2050	Project Sponsor(s): Manufacturing (Moore)	Recommended WMS Project	3880	No	Project/WMS not started	Delay project start	Shift in timeline	N/A	Unknown	None
A	Develop New Well Field (Ogallala Aquifer) - Cactus	2020	Project Sponsor(s): Cactus Municipal Water System	Recommended WMS Project	945	No	Project/WMS not started	Delay project start	Shift in timeline	N/A	Unknown	None
A	Develop Ogalalla Aquifer Supplies - Booker	2040	Project Sponsor(s): Booker	Recommended WMS Project	769	No	Project/WMS not started	Unknown	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer in Donley County - Greenbelt MIWA	2030	Project Sponsor(s): Greenbelt Municipal and Industrial Water Authority	Recommended WMS Project	895	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Canyon	2060	Project Sponsor(s): Canyon	Recommended WMS Project	3868	No	Project/WMS not started	Unknown	Other	Not recommended until later in the planning horizon.	Unknown	None
A	Develop Ogallala Aquifer Supplies - Dalhart	2020	Project Sponsor(s): Dalhart	Recommended WMS Project	831	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Dumas	2030	Project Sponsor(s): Dumas	Recommended WMS Project	766	No	Project/WMS not started	Unknown	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Gruver	2030	Project Sponsor(s): Gruver	Recommended WMS Project	773	No	Project/WMS not started	Unknown	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - McLean	2030	Project Sponsor(s): McLean Municipal Water Supply	Recommended WMS Project	829	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Memphis	2030	Project Sponsor(s): Memphis	Recommended WMS Project	900	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Moore County Manufacturing	2050	Project Sponsor(s): Manufacturing (Moore)	Recommended WMS Project	3879	No	Project/WMS not started	Unknown	Project sponsor not identified	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Pampa	2040	Project Sponsor(s): Pampa Municipal Water System	Recommended WMS Project	828	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Panhandle	2030	Project Sponsor(s): Panhandle Municipal Water System	Recommended WMS Project	897	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Perryton	2050	Project Sponsor(s): Perryton Municipal Water System	Recommended WMS Project	736	No	Project/WMS not started	Unknown	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Potter County Manufacturing	2040	Project Sponsor(s): Manufacturing (Potter)	Recommended WMS Project	3876	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Randall County Manufacturing	2030	Project Sponsor(s): Manufacturing (Randall)	Recommended WMS Project	731	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Spearman	2050	Project Sponsor(s): Spearman Municipal Water System	Recommended WMS Project	772	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Stinnett	2050	Project Sponsor(s): Stinnett	Recommended WMS Project	771	No	Project/WMS not started	Unknown	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Sunray	2030	Project Sponsor(s): Sunray	Recommended WMS Project	739	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - TCW Supply	2030	Project Sponsor(s): TCW Supply	Recommended WMS Project	770	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Texline	2050	Project Sponsor(s): Texline	Recommended WMS Project	830	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Develop Ogallala Aquifer Supplies - Wheeler	2050	Project Sponsor(s): Wheeler	Recommended WMS Project	730	No	Project/WMS not started	Unknown	N/A	N/A	Unknown	None
A	Develop Potter/Carson County Well Field Phase 1 (Ogallala Aquifer) - Amarillo	2030	Project Sponsor(s): Amarillo	Recommended WMS Project	882	No	Project/WMS not started	Delay project start	Shift in timeline	N/A	Unknown	None
A	Develop Potter/Carson County Well Field Phase 2 (Ogallala Aquifer) - Amarillo	2050	Project Sponsor(s): Amarillo	Recommended WMS Project	3854	No	Project/WMS not started	Unknown	N/A	Not recommended until later in the planning horizon.	Unknown	None
A	Develop Roberts County Well Field (Ogallala Aquifer) - Amarillo	2070	Project Sponsor(s): Amarillo	Recommended WMS Project	883	No	Project/WMS not started	Unknown	Other	Not recommended until later in the planning horizon.	Unknown	None
A	Develop Seymour Aquifer Supplies - Wellington	2030	Project Sponsor(s): Wellington Municipal Water System	Recommended WMS Project	898	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Direct Potable Reuse - Amarillo	2040	Project Sponsor(s): Amarillo	Recommended WMS Project	884	No	Project/WMS not started	Unknown	N/A	N/A	Unknown	None
A	Expansion of Roberts County Well Field (Ogallala Aquifer) in 2024 - CRMWA2	2030	Project Sponsor(s): Canadian River Municipal Water Authority	Recommended WMS Project	887	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Irrigation Conservation - Armstrong County	2020	Project Sponsor(s): Irrigation (Armstrong)	Recommended WMS Project	709	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Carson County	2020	Project Sponsor(s): Irrigation (Carson)	Recommended WMS Project	710	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Childress County	2020	Project Sponsor(s): Irrigation (Childress)	Recommended WMS Project	711	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Collingsworth County	2020	Project Sponsor(s): Irrigation (Collingsworth)	Recommended WMS Project	712	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Dallam County	2020	Project Sponsor(s): Irrigation (Dallam)	Recommended WMS Project	713	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Donley County	2020	Project Sponsor(s): Irrigation (Donley)	Recommended WMS Project	714	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Gray County	2020	Project Sponsor(s): Irrigation (Gray)	Recommended WMS Project	715	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Hall County	2020	Project Sponsor(s): Irrigation (Hall)	Recommended WMS Project	716	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Hansford County	2020	Project Sponsor(s): Irrigation (Hansford)	Recommended WMS Project	717	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Hartley County	2020	Project Sponsor(s): Irrigation (Hartley)	Recommended WMS Project	718	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Hemphill County	2020	Project Sponsor(s): Irrigation (Hemphill)	Recommended WMS Project	719	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Hutchinson County	2020	Project Sponsor(s): Irrigation (Hutchinson)	Recommended WMS Project	720	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Lipscomb County	2020	Project Sponsor(s): Irrigation (Lipscomb)	Recommended WMS Project	721	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Moore County	2020	Project Sponsor(s): Irrigation (Moore)	Recommended WMS Project	722	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Ochiltree County	2020	Project Sponsor(s): Irrigation (Ochiltree)	Recommended WMS Project	723	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Oldham County	2020	Project Sponsor(s): Irrigation (Oldham)	Recommended WMS Project	724	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Potter County	2020	Project Sponsor(s): Irrigation (Potter)	Recommended WMS Project	725	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Randall County	2020	Project Sponsor(s): Irrigation (Randall)	Recommended WMS Project	726	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Roberts County	2020	Project Sponsor(s): Irrigation (Roberts)	Recommended WMS Project	727	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Sherman County	2020	Project Sponsor(s): Irrigation (Sherman)	Recommended WMS Project	728	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Irrigation Conservation - Wheeler County	2020	Project Sponsor(s): Irrigation (Wheeler)	Recommended WMS Project	729	No	Project/WMS started	N/A	Project sponsor not identified	N/A	Unknown	None
A	Municipal Conservation - Amarillo	2020	WUG Reducing Demand: Amarillo	Recommended Demand Reduction Strategy Without WMS Project	1613	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Booker	2020	WUG Reducing Demand: Booker	Recommended Demand Reduction Strategy Without WMS Project	2591	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Borger	2020	WUG Reducing Demand: Borger	Recommended Demand Reduction Strategy Without WMS Project	2601	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Cactus	2020	WUG Reducing Demand: Cactus Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	2609	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Canadian	2020	WUG Reducing Demand: Canadian	Recommended Demand Reduction Strategy Without WMS Project	1637	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Canyon	2020	WUG Reducing Demand: Canyon	Recommended Demand Reduction Strategy Without WMS Project	2613	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Childress	2020	WUG Reducing Demand: Childress	Recommended Demand Reduction Strategy Without WMS Project	1667	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Clarendon	2020	WUG Reducing Demand: Clarendon	Recommended Demand Reduction Strategy Without WMS Project	2617	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Claude	2020	WUG Reducing Demand: Claude Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	1699	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Dalhart	2020	WUG Reducing Demand: Dalhart	Recommended Demand Reduction Strategy Without WMS Project	2629	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Darrouzett	2020	WUG Reducing Demand: Darrouzett	Recommended Demand Reduction Strategy Without WMS Project	23082	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Dumas	2020	WUG Reducing Demand: Dumas	Recommended Demand Reduction Strategy Without WMS Project	2635	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Follett	2020	WUG Reducing Demand: Follett	Recommended Demand Reduction Strategy Without WMS Project	23087	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Fritch	2020	WUG Reducing Demand: Fritch	Recommended Demand Reduction Strategy Without WMS Project	1741	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Groom	2020	WUG Reducing Demand: Groom Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	2639	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Gruver	2020	WUG Reducing Demand: Gruver	Recommended Demand Reduction Strategy Without WMS Project	1747	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None

A	Municipal Conservation - Hartley	2020	WUG Reducing Demand: Hartley WSC	Recommended Demand Reduction Strategy Without WMS Project	23092	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Higgins	2020	WUG Reducing Demand: Higgins Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	23097	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Lake Tanglewood	2020	WUG Reducing Demand: Lake Tanglewood	Recommended Demand Reduction Strategy Without WMS Project	1757	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - McLean	2020	WUG Reducing Demand: McLean Municipal Water Supply	Recommended Demand Reduction Strategy Without WMS Project	1761	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Memphis	2020	WUG Reducing Demand: Memphis	Recommended Demand Reduction Strategy Without WMS Project	1865	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Miami	2020	WUG Reducing Demand: Miami	Recommended Demand Reduction Strategy Without WMS Project	1877	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Moore County Other	2020	WUG Reducing Demand: County-Other, Moore	Recommended Demand Reduction Strategy Without WMS Project	2621	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Pampa	2020	WUG Reducing Demand: Pampa Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	2643	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Panhandle	2020	WUG Reducing Demand: Panhandle Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	1891	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Perryton	2020	WUG Reducing Demand: Perryton Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	2647	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Shamrock	2020	WUG Reducing Demand: Shamrock Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	1901	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Spearman	2020	WUG Reducing Demand: Spearman Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	2651	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Stinnett	2020	WUG Reducing Demand: Stinnett	Recommended Demand Reduction Strategy Without WMS Project	1921	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Stratford	2020	WUG Reducing Demand: Stratford	Recommended Demand Reduction Strategy Without WMS Project	1937	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Sunray	2020	WUG Reducing Demand: Sunray	Recommended Demand Reduction Strategy Without WMS Project	1947	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - TCW Supply	2020	WUG Reducing Demand: TCW Supply	Recommended Demand Reduction Strategy Without WMS Project	1957	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Texhoma	2020	WUG Reducing Demand: Texhoma	Recommended Demand Reduction Strategy Without WMS Project	23102	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Texline	2020	WUG Reducing Demand: Texline	Recommended Demand Reduction Strategy Without WMS Project	1961	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Turkey	2020	WUG Reducing Demand: Turkey Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	23107	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Vega	2020	WUG Reducing Demand: Vega	Recommended Demand Reduction Strategy Without WMS Project	1971	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Wellington	2020	WUG Reducing Demand: Wellington Municipal Water System	Recommended Demand Reduction Strategy Without WMS Project	1981	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - Wheeler	2020	WUG Reducing Demand: Wheeler	Recommended Demand Reduction Strategy Without WMS Project	2655	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Municipal Conservation - White Deer	2020	WUG Reducing Demand: White Deer	Recommended Demand Reduction Strategy Without WMS Project	1991	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	New Groundwater Source - Turkey	2030	Project Sponsor(s): Turkey Municipal Water System	Recommended WMS Project	909	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Replace Capacity of Roberts County Well Field (Ogallala Aquifer) in 2040 - CRMWA	2040	Project Sponsor(s): Canadian River Municipal Water Authority	Recommended WMS Project	886	No	Project/WMS not started	Unknown	N/A	N/A	Unknown	None
A	Water Audit and Leak Repair - Amarillo	2020	Project Sponsor(s): Amarillo	Recommended WMS Project	2890	Yes	Project/WMS started	N/A	N/A	N/A	Unknown	None
A	Water Audit and Leak Repair - Canyon	2020	Project Sponsor(s): Canyon	Recommended WMS Project	2891	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Water Audit and Leak Repair - Dumas	2020	Project Sponsor(s): Dumas	Recommended WMS Project	2892	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None
A	Water Audit and Leak Repair - Higgins	2020	Project Sponsor(s): Higgins Municipal Water System	Recommended WMS Project	2894	No	Project/WMS not started	Unknown	N/A	N/A	Unknown	None
A	Water Audit and Leak Repair - Turkey	2020	Project Sponsor(s): Turkey Municipal Water System	Recommended WMS Project	2895	No	Project/WMS not started	No longer needed	N/A	N/A	Unknown	None

APPENDIX H

RURAL OUTREACH

For the 2026 Regional Water Plans, planning groups were asked to do additional rural outreach in support of plan development. TWDB provided a list of 70 entities which qualify as rural political subdivisions per definition per Texas Water Code 15.001(14) in Region A. Forty-nine of these entities are already named water user groups (WUGs) and Region A had attempted surveying and/or calls as part of standard outreach procedures for plan development. In accordance with TWDB guidelines, outreach for the remaining entities was prioritized for those entities which have:

1. Self-reported water use restriction to TCEQ due to water supply issues during the current planning cycle,
2. self-report to TCEQ having less than 180 days of water supply remaining during the current planning cycle,
3. have not previously engaged in the regional planning process, and
4. have already been identified as facing significant near-term shortages under drought conditions in previous regional water plans.

Table H-1 documents each entity provided by TWDB and if they meet any of the four criteria for prioritization. If an entity was found to have all four criteria, it was given a 'very high' priority for outreach. If an entity met three of the criteria, it was considered 'high' priority. If an entity met two criteria, it was classified as 'moderate' priority. If an entity met a single criterion, it was assigned a priority of 'low'. If an entity met none of the criteria provided by TWDB, it was ranked as 'very low' priority for outreach. If an entity was not reached out to as part of the standard planning process as a WUG, Region A consultants attempted to reach them by phone as documented in **Table H-1**. If an entity is provided for by a separate Region A WUG, then no contact was attempted, and it was assumed the entity had been planned for through their provider.

Table H-1
Region A Rural Outreach Prioritization and Documentation

WUG Related Planning Region(s)	Water User Group Name	PWS Name	1. Entity has self-reported water use restrictions to TCEQ due to water supply issues during the current planning cycle	2. Entity has self-reported having less than 180 days of water supply remaining during the current planning cycle	3. Entity has not previously engaged in the regional planning process	4. Entity has identified as facing significant near-term shortages under drought conditions in previous regional water plans	Priority for Outreach	Outreach Measures Performed	Response Received from Entity
A	Booker	CITY OF BOOKER	no	no	yes	no	low	Survey sent	Yes
A	Borger	BORGER MUNICIPAL WATER SYSTEM	no	no	no	no	very low	Survey sent	Yes
A	Cactus Municipal Water System	CITY OF CACTUS	no	no	no	yes	low	Survey sent, called, emailed	No
A	Canadian	CANADIAN MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	Yes
A	Childress	CITY OF CHILDRESS	no	no	yes	no	low	Survey sent	No
A	Clarendon	CITY OF CLARENDON	no	no	yes	no	low	Survey sent	Yes
A	Claude Municipal Water System	CLAUDE MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	No
A	County-Other, Armstrong	WASHBURN COMMUNITY WSC	no	no	yes	no	low	Phone, number disconnected	No
A	County-Other, Carson	SKELLYTOWN MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Phone, emailed survey	No
A	County-Other, Collingsworth	CITY OF DODSON	no	no	yes	no	low	Phone, number disconnected	No
A	County-Other, Donley	HEDLEY MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent to water provider, discuss with water provider	No
A	County-Other, Gray	LEFORS MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Phone, emailed survey	Yes
A	County-Other, Hall	BRICE LESLEY WSC	no	no	no	no	very low	Phone, emailed survey	Yes
A	County-Other, Hall	LAKEVIEW WSC	no	no	yes	no	low	No phone or email available	No
A	County-Other, Hansford	MORSE WSC	no	no	yes	no	low	Phone, did not answer	No
A	County-Other, Hartley	CHANNING WATER WORKS	no	no	yes	no	low	Phone, number disconnected	No
A	County-Other, Hutchinson	SANFORD MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Phone, number disconnected	No
A	County-Other, Moore	MOORTEX WSC	no	no	yes	no	low	Survey sent to water provider, discuss with water provider	No
A	County-Other, Ochiltree	FARNSWORTH WSC	no	no	yes	no	low	Phone, number disconnected	No
A	County-Other, Ochiltree	WAKA WSC	no	no	yes	no	low	Phone, no answer	No
A	County-Other, Oldham	CAL FARLEYS BOYS RANCH	no	no	yes	no	low	No phone or email available	No
A	County-Other, Oldham	ADRIAN MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Phone, disconnected	No
A	County-Other, Oldham	WILDORADO WSC	no	no	yes	no	low	Phone, left message	No
A	County-Other, Potter	BUSHLAND WSC	no	no	yes	no	low	Phone, no answer	No
A	County-Other, Randall	SUNDAY CANYON WSC	no	no	yes	no	low	Survey sent to water provider, discuss with water provider	No
A	County-Other, Randall	UMBARGER COMMUNITY WATER SUPPLY	no	no	yes	no	low	Survey sent to water provider, discuss with water provider	No

WUG Related Planning Region(s)	Water User Group Name	PWS Name	1. Entity has self-reported water use restrictions to TCEQ due to water supply issues during the current planning cycle	2. Entity has self-reported having less than 180 days of water supply remaining during the current planning cycle	3. Entity has not previously engaged in the regional planning process	4. Entity has identified as facing significant near-term shortages under drought conditions in previous regional water plans	Priority for Outreach	Outreach Measures Performed	Response Received from Entity
A	County-Other, Wheeler	MOBEETIE CITY WATER WORKS	no	no	yes	no	low	Phone, no answer	No
A	County-Other, Wheeler	FORT ELLIOTT CISD BRISCOE	no	no	yes	no	low	No phone or email available	No
A	Dalhart	DALHART MUNICIPAL WATER SYSTEM	no	no	no	yes	low	Survey sent & called	Yes
A	Darrouzett	DARROUZETT MUNICIPAL WATER SYSTEM	yes	no	yes	no	moderate	Survey sent & called	Yes
A	Dumas	CITY OF DUMAS	no	no	yes	no	low	Survey sent & called	Yes
A	Follett	FOLLETT MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent - undelivered & called	No
A	Fritch	FRITCH MUNICIPAL WATER SUPPLY	no	no	no	no	very low	Survey sent	No
A	Groom Municipal Water System	GROOM MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	Yes
A	Gruver	GRUVER MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	No
A	Hartley WSC	HARTLEY WSC	no	no	no	no	very low	Survey sent - undelivered & called	No
A	Higgins Municipal Water System	HIGGINS MUNICIPAL WATER SYSTEM	no	no	no	no	very low	Survey sent	Yes
A	McLean Municipal Water Supply	MCLEAN MUNICIPAL WATER SUPPLY	no	no	yes	no	low	Survey sent	No
A	Memphis	CITY OF MEMPHIS	no	no	yes	no	low	Survey sent	Yes
A	Miami	CITY OF MIAMI	no	no	yes	no	low	Survey sent	Yes
A	Pampa Municipal Water System	CITY OF PAMPA	no	no	yes	no	low	Survey sent	Yes
A	Pampa Municipal Water System	TDCJ BATEN & JORDAN UNITS	no	no	yes	no	low	Survey sent	No
A	Panhandle Municipal Water System	PANHANDLE MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	Yes
A	Perryton Municipal Water System	PERRYTON MUNICIPAL WATER SYSTEM	no	no	no	no	very low	Survey sent & called	No
A	Red River Authority of Texas	RRA NORTHEAST CHILDRESS	yes	no	yes	no	moderate	Survey sent	Yes
A	Red River Authority of Texas	RRA GARDEN VALLEY WS	no	no	yes	no	low	Survey sent	Yes
A	Red River Authority of Texas	RRA SAIED WS	no	no	yes	no	low	Survey sent	Yes
A	Red River Authority of Texas	RRA SAMNORWOOD WATER SYSTEM	no	no	yes	no	low	Survey sent	Yes
A	Red River Authority of Texas	RRA DODSON WATER SYSTEM	no	no	yes	no	low	Survey sent	Yes

WUG Related Planning Region(s)	Water User Group Name	PWS Name	1. Entity has self-reported water use restrictions to TCEQ due to water supply issues during the current planning cycle	2. Entity has self-reported having less than 180 days of water supply remaining during the current planning cycle	3. Entity has not previously engaged in the regional planning process	4. Entity has identified as facing significant near-term shortages under drought conditions in previous regional water plans	Priority for Outreach	Outreach Measures Performed	Response Received from Entity
A	Red River Authority of Texas	RRA HOWARDWICK	no	no	yes	no	low	Survey sent	Yes
A	Red River Authority of Texas	RRA GREENBELT LAKE LOTS	no	no	yes	no	low	Survey sent	Yes
A	Red River Authority of Texas	RRA ESTELLINE TURKEY WATER SYSTEM	no	no	yes	no	low	Survey sent	Yes
A	Red River Authority of Texas	RRA NEWLIN WATER SYSTEM	no	no	yes	no	low	Survey sent	Yes
A	Red River Authority of Texas	RRA CLUB LAKE WATER SYSTEM	no	no	yes	no	low	Survey sent	Yes
A	Shamrock Municipal Water System	SHAMROCK MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	Yes
A	Spearman Municipal Water System	SPEARMAN MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	No
A	Stinnett	CITY OF STINNETT	no	no	yes	no	low	Survey sent	No
A	Stratford	STRATFORD MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	No
A	Sunray	CITY OF SUNRAY	no	no	no	no	very low	Survey sent	No
A	Texhoma	TEXHOMA CITY MUNICIPAL WATER SYSTEM	no	no	no	no	very low	Survey sent	No
A	Texline	TEXLINE MUNICIPAL WATER SYSTEM	no	no	no	no	very low	Survey sent	No
A	Turkey Municipal Water System	TURKEY MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	No
A	Vega	VEGA MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	No
A	Wellington Municipal Water System	WELLINGTON MUNICIPAL WATER SYSTEM	no	no	no	yes	low	Survey sent	No
A	Wheeler	WHEELER MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Survey sent	Yes
A	White Deer	WHITE DEER MUNICIPAL WATER SYSTEM	no	no	no	no	very low	Survey sent	No
A; B	Red River Authority of Texas	RRA KIRKLAND LAZARE WS	no	no	yes	no	low	Survey sent	Yes
A; B	Red River Authority of Texas	RRA TELL CEE VEE WS	no	no	yes	no	low	Survey sent	Yes
A; O	Happy	HAPPY MUNICIPAL WATER SYSTEM	no	no	yes	no	low	Region O primary WUG	No
A; O	Red River Authority of Texas	RRA CAREY NORTHFIELD WS	no	no	yes	no	low	Survey sent	Yes

APPENDIX I

DATABASE REPORTS (DB27)

Region A's required database (DB27) reports can be accessed through the TWDB Database Reports application at https://www3.twdb.texas.gov/apps/SARA/reports/list and following the steps below.

1. Enter '2026 Regional Water Plan' into the "Report Name" field to filter to all DB27 reports associated with the 2026 Regional Water Plans
2. Click on the report name hyperlink to load the desired report
3. Enter the planning region letter parameter, click view report

The tables available for access in DB27 are listed below.

1. WUG Population
2. WUG Water Demand
3. Source Availability
4. WUG Existing Water Supply
5. WUG Needs/Surplus
6. WUG Second-Tier Identified Water Need
7. WUG Data Comparison to 2021 RWP
8. Source Data Comparison to 2021 RWP
9. WUG Unmet Needs
10. Recommended WUG Water Management Strategies
11. Recommended Projects Associated with Water Management Strategies
12. Alternative WUG Water Management Strategies
13. Alternative Projects Associated with Water Management Strategies
14. WUG Management Supply Factor
15. Recommended water Management Strategy Supply Associated with a new or amended IBT Permit
16. WUG Recommended WMS Supply Associated with a new or amended IBT Permit and Total Recommended conservation WMS Supply
17. Sponsored Recommended WMS Supplies Unallocated to WUGs
18. MWP Existing sales and Transfers
19. MWP WMS Summary

In Region A, there are several strategies which are recommended but fully allocated in DB27 to 'Unassigned Volumes'. This occurs when a wholesale water provider plans to develop supplies beyond the exact projected needs of their customers (a management supply factor of greater than 1). This is prudent planning given uncertainty in growth of existing and potential future customers and the potential for a drought worse than the drought of record. In these cases, the strategy is still recommended. However, it is not allocated out to customers as surpluses because this water is not owned by the individual water user group (WUG). This is a surplus that the wholesale provider keeps as a margin of safety against a worse potential drought, unanticipated growth, or new customers. Since it is unknown which of these factors it will be used for, it is left on the wholesale water provider. In the database it is allocated to 'unassigned volumes.'

APPENDIX J

COMMENTS RECEIVED ON THE IPP AND RESPONSES

(To be included in Final Report)