CHAPTER 5

WATER MANAGEMENT STRATEGIES AND CONSERVATION RECOMMENDATIONS

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5 WATER MANAGEMENT STRATEGIES AND CONSERVATION RECOMMENDATIONS

The Plateau Water Planning Group (PWPG) has identified and evaluated a total of ~~67~~ 70 water management strategies for the ~~2021~~*2026 Plateau Region Water Plan*. Water management strategies are developed for entities where future water supply needs exist (as required by statute and administrative rules 31 TAC §357.34; 357.35). A need for water is identified when existing water supplies are less than projected water demands for that same WUG within any planning decade. In addition, water management strategies were developed for other entities requesting specific water supply projects, even though these entities did not have a projected water supply shortage.

5.1 IDENTIFICATION OF POTENTIALLY FEASIBLE WATER MANAGEMENT STRATEGIES

The first step in developing a list of recommended water management strategies is to take a "big picture" look at possible projects that could reasonably be expected to result in water-supply improvements. As required by TWC §16.053(e)(3), and 31 TAC §357.34(c) the Regional Water Planning Groups shall consider, but not be limited to considering, the following types of water management strategies for all identified water needs:

1. Conservation
2. Drought management
3. Reuse
4. Management of existing water supplies
5. Conjunctive use
6. Acquisition of available existing water supplies
7. Development of new water supplies
8. Developing regional water supply facilities or providing regional management of water supply facilities
9. 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)34
10. Developing large-scale desalination facilities for marine seawater that serve local or regional entities
11. 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
12. Emergency transfer of water under TWC §11.139
13. Interbasin transfers of surface water
14. System optimization
15. Reallocation of reservoir storage to new uses
16. Enhancements of yields
17. Improvements to water quality
18. New surface water supply
19. New groundwater supply
20. Brush control
21. Precipitation enhancement
22. Aquifer storage and recovery
23. Cancellation of water rights
24. Rainwater harvesting

Other potential projects considered for the initial list included:

- appropriate strategies from the ~~*2016*~~*2021 Plan*
- water-loss audits and line replacement
- projects suggested by municipalities through a survey
- projects that are currently or have recently applied to the TWDB for funding

The following process was used by the PWPG to identify *potentially feasible water management strategies*.

Needs Analysis

1. Receive a Needs Analysis Report from the TWDB, which provides a comparison of existing water supplies and projected water demands for each water user group (WUG) and wholesale water provider (WWP) in the Region. Based on this comparison, the report identifies WUGs and WWPs that are expected to experience needs for additional water supplies within the 50-year time frame of the regional water plan.

Identification and Selection Process

2. Review the potential infeasibility and implementation status identifying:

    - If strategy contemplates permitting and/or construction;
    - If strategy is near-term or necessitates significant time for implementation;
    - If the potential sponsor(s) have taken, or have indicated they will take, affirmative steps towards the strategy's implementation. Affirmative steps may include, but not be limited to:
        a. Spending money on the strategy or project;
        b. Voting to spend money on the strategy or project;
        c. Applying for a federal or state permit for the strategy or project

3. Review and consider recommended water management strategies adopted by the water planning group for the 2021 Plateau Water Plan.

4. Review and consider any issues identified in the most current TWDB Water Loss Audit Report, including leak detection and supply side analysis.

5. Solicit current water planning information, including specific water management strategies of interest from WUGs and WWPs with identified needs.

6. Review and consider the most recent Water Supply Management, Water Conservation, and/or Drought Contingency Plans, where available, from WUGs and WWPs with identified needs.

7. Consider potentially feasible water management strategies that may include, but are not limited to (Chapter 357 Subchapter C §357.34):

    - Extended use of existing supplies including:
        a. System optimization and conjunctive use of water resources
        b. Reallocation of reservoir storage to new uses
        c. Voluntary redistribution of water resources including contracts, water marketing, regional water banks, sales, leases, options, subordination agreements, and financing agreements
        d. Subordination of existing water rights through voluntary agreements
        e. Enhancement of yields of existing sources
        f. Improvement of water quality including control of naturally occurring chlorides

g. Drought management

- New supply development including:

a. Construction and improvement of surface water and groundwater resources
b. Brush control
c. Precipitation enhancement
d. Desalination
e. Water supply that could be made available by cancellation of water rights
f. Rainwater harvesting
g. Aquifer storage and recovery

- Conservation and drought management measures including demand management
- Reuse of wastewater
- Interbasin transfers of surface water
- Emergency transfers of surface water

8. Consider other *potentially feasible water management strategies* suggested by planning group members, stakeholders, and the public.

9. Based on the above reviews and considerations, establish a preliminary list of *potentially feasible water management strategies*. At a discussion level, consider the following feasibility concerns for each strategy:

- Water supply source availability during drought-of-record conditions
- Cost/benefit
- Water quality
- Threats to agriculture and natural resources
- Impacts to the environment, other water resources, and basin transfers
- Socio-economic impacts

10. Based on the above discussion level analysis, select a final list of *potentially feasible water management strategies* for further technical evaluation using detailed analysis criteria.

Using the above criteria and process, the PWPG selected the initial potentially feasible water management strategies listed in Table 5-1 for further detailed analysis. All strategy analyses recognize and protect existing water rights, water contracts, and option agreements. As the water management strategy analysis progressed, it became evident that the initial list would require modification of project descriptive names, and the possible addition of new strategies and the elimination or transfer of others. Much time was spent in communication with individual WUGs (municipalities, irrigation districts, etc.) to ensure that the strategies discussion met with their approval. The evaluation and final recommendation of water management strategies are provided in Appendix 5A. ~~at the end of this chapter.~~

Although these strategy types were considered by the PWPG, not all of them were considered viable options for addressing long-term needs in the region. The PWPG does not consider drought management as a feasible strategy to meet long-term growth in demands or current needs. This strategy is considered a temporary measure aimed at conserving available water supplies during times of drought or emergencies. Drought management is most adequately addressed in the Region through the implementation of local

drought contingency plans. The PWPG is supportive of the development and use of these plans during periods of drought or emergency water needs.

Table 5-1. Potentially Feasible Water Management Strategies

County	Water User Group	Strategy Source Basin	Water Management Strategy
Bandera	City of Bandera	San Antonio	Reuse treated wastewater effluent for irrigation use
			Promote, design & install rainwater harvesting systems
			Additional Lower Trinity well and lay necessary pipeline
			Additional Middle Trinity wells within city infrastructure
			Surface water acquisition, treatment, and ASR
	*Bandera County FWSD#1	San Antonio	Conservation
			New strategy - Additional groundwater well
	*Bandera County Other (Bandera River Ranch #1)	San Antonio	Water loss audit and main-line repair
	*Bandera County Other (Lake Medina Shores)	San Antonio	Conservation
			Additional groundwater wells
	*Bandera County Other (Medina WSC)	San Antonio	Conservation
			Additional groundwater well for the Town of Medina
	Bandera County Other	San Antonio	Drought management (BCRAGD)
			Additional groundwater well for Pebble Beach Subdivision
			Additional groundwater wells to provide emergency supply to VFD
			Water loss audit and main-line repair for Enchanted River Estates
			**Vegetative Management
		Nueces	Drought management (BCRAGD)
	*Bandera County Irrigation	San Antonio	Conservation
			Additional groundwater wells
	*Bandera County Livestock	*Guadalupe	Conservation
			Additional groundwater well
		*Nueces	Conservation
			Additional groundwater well
Edwards	*City of Rocksprings	*Nueces	Conservation
			Additional groundwater well
	Edwards County Other (Barksdale WSC)	Nueces	Additional groundwater well in the Nueces River Alluvium
	Edwards County Other	Nueces	**Vegetative Management
	*Edwards County Mining	*Nueces	Conservation
			Additional groundwater wells
		*Colorado	Conservation
			Additional groundwater wells
		*Rio Grande	Conservation
			Additional groundwater wells
Kerr	*City of Kerrville	Guadalupe	Increase wastewater reuse
			Water loss audit and main-line repair
			Explore and develop potable reuse

Table 5-1. (continued) Potentially Feasible Water Management Strategies

County	Water User Group	Strategy Source Basin	Water Management Strategy
Kerr	*City of Kerrville	Guadalupe	Explore and develop new Ellenburger Aquifer well supply
			Purchase Guadalupe River water rights
			Increased water treatment and ASR capacity
Kerr	Kerr County Other *(Center Point)	Guadalupe	*** EKCRWSP
	Kerr County Other (Center Point North WS)	Guadalupe	*** EKCRWSP
	Kerr County Other *(Center Point Taylor	Guadalupe	*** EKCRWSP
	Kerr County Other (Hills and Dales Estate)	Guadalupe	*** EKCRWSP
	Kerr County Other (Nickerson Farm WS)	Guadalupe	*** EKCRWSP
	Kerr County Other (Oak Forest South Water)	Guadalupe	*** EKCRWSP
	Kerr County Other (Park Place Subdivision)	Guadalupe	*** EKCRWSP
	Kerr County Other (Pecan Valley)	Guadalupe	*** EKCRWSP
	Kerr County Other (Rustic Hills Water)	Guadalupe	*** EKCRWSP
	Kerr County Other (Verde Park Estates)	Guadalupe	Water loss audit and main-line repair for Verde Park Estates
			*** EKCRWSP
	Kerr County Other (Westwood WS)	Guadalupe	*** EKCRWSP
	*Kerr County Other	*Nueces	Conservation: Public information and education - Water shortage met with Guadalupe Basin strategies
		Guadalupe	Water loss audit and main-line repair for Community Water Group WSC
			**Vegetative management - UGRA
	*Kerr County Irrigation	San Antonio	Conservation
			Additional groundwater well
	*Kerr County Livestock	*Colorado	Conservation
			Additional groundwater wells
		*Guadalupe	Conservation
			Additional groundwater wells
		*San Antonio	Conservation
			Additional groundwater well
		*Nueces	Conservation
			Additional groundwater well
	*Kerr County Mining	Colorado	Conservation
			Additional groundwater well
Kinney	City of Brackettville	Rio Grande	Increase supply to Spofford with new water line
			Increase storage facility
	Fort Clark Springs MUD	Rio Grande	Water loss audit and main-line repair

Table 5-1. (continued) Potentially Feasible Water Management Strategies

County	Water User Group	Strategy Source Basin	Water Management Strategy
Kinney	Fort Clark Springs MUD	Rio Grande	Increase storage facility
	Kinney County Other	Rio Grande	**Vegetative Management
		Nueces	**Vegetative Management
Real	*City of Camp Wood	Nueces	Conservation: Public information and education - Water shortage met with Guadalupe Basin strategies
			Additional groundwater wells
	*City of Leakey	Nueces	Conservation
			Additional groundwater well
			Develop interconnections between wells within the City
	Real County Other	Nueces	Water loss audit and main-line repair for Real WSC
			**Vegetative Management
			Additional groundwater well for Oakmont Saddle WSC
Val Verde	City of Del Rio	Rio Grande	Water loss audit and main-line repair
			Additional groundwater well
			Water treatment plant expansion
			Develop a wastewater reuse program
	Val Verde County Other	Rio Grande	Water loss audit and main-line repair for Val Verde County WCID Comstock
			Water loss audit and main-line repair for San Pedro Canyon Subdivision (Upper)
			Water loss audit and main-line repair for Tierra Del Lago
			**Vegetative Management
	*Val Verde County Mining	Rio Grande	Conservation
			Additional groundwater well

* WUG with a supply need.

** Vegetative Management has an availability of zero.

*** Eastern Kerr County Regional Water Supply Project Strategies		
East Kerr County Regional Water Supply Project	Guadalupe	UGRA acquisition of surface water rights
		KCCC acquisition of surface water rights
		Construction of an off-channel surface water storage
		Construction of surface water treatment facilities and main distribution transmission lines
		Construction of an ASR facility
		Construction of a wellfield for dense rural areas
		Construction of a brackish groundwater desalination facility
		Construction of an Ellenburger Aquifer water supply source
		Conservation

5.2 EVALUATION AND RECOMMENDATION OF WATER MANAGEMENT STRATEGIES

5.2.1 Strategy Evaluation Procedure

The strategy evaluation procedure is designed to provide a side-by-side comparison such that all strategies can be assessed based on the same quantifiable factors as shown in Tables 5-2, 5-3 and 5-4. An explanation of the qualitative and quantifiable rankings is provided in Appendix 5B. All strategy analyses recognize and protect existing water rights, water contracts, and option agreements. For planning purposes, it is assumed that all strategies experience a two percent water loss over the life of the strategy project. Specific factors considered in each Table were:

Table 5-2

- Quantity of new water supply produced
- Chemical quality
- Reliability of supply
- Impacts to water, agricultural, and natural resources

Table 5-3

- Financial cost (total capital cost, annual cost, and cost per acre-foot)

Table 5-4

- Environmental impacts
    - Environmental water needs
    - Wildlife habitat
    - Cultural resources
    - Environmental water quality
    - Inflows to bays and estuaries

Cost evaluations for all strategies include capital cost, debt service, and annual operating and maintenance (O&M) expenses. Capital costs are estimated based on September ~~2018~~2023 US dollars. Capital costs consider construction costs, engineering and feasibility studies, legal assistance, financing, bond counsel and contingencies, permitting and mitigation, land purchase not associated with mitigation, easement costs, and purchase of water rights. The length of debt service is 20 years unless otherwise stated. An annual unit cost is also calculated based on the O&M cost per acre-foot of water supplied. The TWDB Unified Costing Tool was used for all strategy evaluations except for when specific municipalities provided engineering design studies that included cost estimates.

Water quality is recognized as an important component in this 50-year water plan. To ensure that this *Plan* fully considers water quality, the Federal Clean Water Act and the State Clean Rivers Program were reviewed and considered when developing water management strategies and water quality impacts. Development of water management strategies were also guided by the principal that the designated water quality and related water uses described in the Water Quality Management Plans (WQMPs) of TCEQ and the Texas State Soil and Water Conservation Board (TSSWCB) were improved or maintained. TCEQ's

WQMP is tied to the State's water quality assessments that identify and direct planning for implementation measures that control and/or prevent priority water quality problems. Elements contained in the WQMP include effluent limitations of wastewater facilities, total maximum daily loads (TMDLs), nonpoint source management controls, identification of designated management agencies, and ground water and source water protection planning. TSSWCB's WQMP is a site-specific plan developed through and approved by soil and water conservation districts for agricultural or silvicultural lands. The plan includes appropriate land treatment practices, production practices, management measures, and technologies.

The PWPG relied on Management Supply Factors calculated and supplied by TWDB in the consideration of water-supply needs to be generated in the development of water management strategies. A Management Supply Factor is the combined total of existing and future supply divided by the total projected demand and may be used to consider uncertainties in population, water supply and demand, and other impactful conditions. Management Supply Factors are shown for all WUGs in a table provided in the Executive Summary. ~~Management Supply Factors for Del Rio Utilities, the lone Major Water Provider for this Region is as follows:~~

~~MWP Name~~	~~Management Supply Factor~~					
	~~2020~~	~~2030~~	~~2040~~	~~2050~~	~~2060~~	~~2070~~
~~Del Rio Utilities~~	~~1.6~~	~~1.6~~	~~1.5~~	~~1.4~~	~~1.4~~	~~1.3~~

The development of water management strategies is intended to assist entities with their future water supply needs based on drought-of-record conditions. Recommendations of the Drought Preparedness Council for the 2026 Plans consisted of three new recommendations: (1) The regional water plans and State water plan shall serve as water supply plans under drought of record conditions; (2) Drought Contingency Plans (DCP) encourages regional water planning groups to incorporate projected future reservoir evaporation rates in their assessments of future surface water availability; and (3) DCP encourages regional water planning groups to identify in their plans utilities within their boundaries that reported having less than 180 days of available water supply to the TCEQ. ~~are considered in this *Plan* and consist of four activities: (1) Drought Monitoring; (2) Impact Assessment; (3) Research and Educational Programs; and (4) Drought Mitigation Strategies.~~ Also, WUGs conservation and drought management plans (see Chapters 6 and 7) were reviewed to identify potential strategies that are currently under consideration by the entity.

Several strategies are considered integral or interconnected to the new supply goal for a specified WUG or cooperation between WUGs. Strategy J-~~45~~34 lists several projects that may serve the small communities and rural population of eastern Kerr County. ~~Strategies J-64 and J-65 combined will serve to produce a new water supply for the Spoford area of southern Kinney County.~~ These strategies are developed independently, and their interactions do not impact the water supply availability and yield associated with each individual strategy.

5.2.2 Emphasis on Conservation and Reuse

In terms of recommending strategies to meet future water needs, it is most practical and often most economical to consider potential conservation and reuse projects. Conservation generally includes best management practices that are undertaking either voluntarily by water customers or as mandated by a

water suppliers. Existing WUG conservation and drought management plans were reviewed, and conservation strategies selected for this *Plan* were often identified from these plans. Water conservation is discussed in further detail in Section 5.3 of this Chapter. The following paragraph is assigned to all Public Conservation Education strategies:

> "Public information programs, even though they may not be directly related to any equipment or operational change, can result in both short- and long-term water savings. Behavioral changes by customers will only occur if a reasonable, yet compelling cause can be presented with sufficient frequency to be recognized and absorbed by the customers. There are many resources that can be consulted to provide insight into implanting effective information programs. Like any marketing or public information program, to be effective, water conservation public information should be planned out and implemented in a consistent and continual manner. A more detailed description of conservation best management practices that might be encouraged is available in TWDB Report 362, Water Conservation Best Management Practices Guide. An updated version of this report is available on the TWDB's website and is titled Understanding Best Management Practices."

5.2.3 Water Loss Audit Strategies

In 2003, the 78th Texas Legislature, enacted House Bill 3338 to help conserve the State's water resources by reducing water loss occurring in the systems of drinking water utilities. This statute requires that retail public utilities providing water within Texas file a standardized water audit once every five years with the Texas Water Development Board (TWDB). See Section 1.6 in Chapter 1 of this Plan for a more detailed discussion. Entities that meet the key performance indicators discussed in Section 1.6 of Chapter 1 were selected to receive a water loss audit and line replacement strategy.

Across the Plateau Region, it is estimated that around 696 acre-feet of supply could be obtained through a water loss audits and leak repairs program in 2030. The reliability of this supply is low due to uncertainty associated with estimated savings and the extent to which this strategy relies on individual utilities to adopt a water loss audits and leak repairs program, which can be costly and time intensive, especially for smaller users. Due to the relatively high costs of implementing this strategy, especially for smaller or rural water user groups, this strategy may not be feasible.

System water audits and water loss programs are effective methods of accounting for all water usage by a public utility within its service area. The structured approach of a water audit allows a utility to reliably track water uses and provide the information to address unnecessary water and revenue losses. The resulting information from a water audit will be valuable in setting performance indicators and in establishing goals and priorities for cost-effectively reducing water losses. By adopting this Best Management Practice (BMP), utilities will more frequently implement water auditing and loss reduction techniques than required by HB 3338. The reliability of this water savings is contingent on the aggressive implementation of this BMP and the public's willingness to do their part.

~~Eleven entities reporting more than a 10 percent water loss were selected to receive a water loss audit and main line repair strategy. Volume of savings is calculated as percent total loss of the true real loss as shown in the graphic below:~~

Public Water System	Report Year	Reported Breaks Leaks	Unreported Loss	Total Real Losses	Cost of Real Losses	Total Loss Percent	Savings (ac-ft/yr.)
Bandera River Ranch 1	2015	364,487	4,426,897	4,791,384	3,656	27.9	4
City of Kerrville	2017	13,534,319	224,001,131	237,535,450	539,443	18.4	134
Community Water Group WSC	2015	1,252,104	663,788	1,915,892	1,341	20.3	-
Del Rio Utilities Commission	2016	1,540,400	33,261,796	34,802,196	144,777	11.4	12
Enchanted River Estates	2015	1,667,400	365,663	2,033,063	1,789	11.7	1
Fort Clark Springs MUD	2015	0	62,273,567	62,273,567	9,341	41.1	79
Real WSC	2015	100,000	1,533,416	1,633,416	1,111	32.3	2
San Pedro Canyon Subdivision - Upper	2016	0	5,394,010	5,394,010	2,551	40.0	7
Tierra Del Lago	2016	0	2,471,426	2,471,426	989	54.9	4
Val Verde County WCID Comstock	2015	20,000	1,534,206	1,554,206	894	16.4	1
Verde Park Estates	2015	32,000	630,140	662,140	2,715	15.5	0

5.2.4 Recommended Water Management Strategies

The strategy evaluation procedure, as described in Section 5.2.1 above, was followed on each of the potentially feasible strategies selected in Table 5-1. Some potential strategies were determined to not meet guideline standards and were thus eliminated. Also, several new strategies were introduced and were subsequently evaluated. Upon completion of the evaluation phase, the PWPG reviewed evaluation criteria and selected the final water management strategies listed in Table 5-2.

Seawater desalination, a major alternative water management solution for the coastal portion of Texas, was not selected for consideration in the Plateau Water Planning Region as the nearest direct point of origin for a seawater source is more than 150 miles from the easternmost border of the Plateau Region, and is thus not rationally economically feasible.

Third-party social and economic impacts resulting from voluntary redistributions of water, including impacts of moving water from rural and agricultural areas were considered; however, no strategies were recommended that resulted in moving water from such areas.

Table 5-2 provides a comparative listing of all the recommended water management strategies that the PWPG subsequently evaluated for inclusion in the ~~2021~~2026 *Plateau Region Water Plan*.

Table 5-3 provides a breakdown of the cost estimate for each strategy. Where applicable, capital costs, based on September ~~2018~~2023 US dollars, include the following:

- Construction, engineering and feasibility studies, legal assistance, financing, bond council, and contingencies;
- Environmental and archaeology studies and mitigation;
- Land acquisition and surveying; and
- Interest during construction

Error! Reference source not found.4 shows the potential impacts on the environment of enacting each strategy. Strategy evaluations are presented in Appendix 5A. The total capital cost for development of all water management strategies is $510,350,573. Appendix 5B provides a matrix procedure for measuring the quantitative and qualitative potential for each water management strategy.

Alternate water management strategies are projects that are not part of the package of Recommended strategies but can be substituted for any Recommended strategy that is later determined to be non-viable. Alternate water management strategies are evaluated in the same way as Recommended strategies based

on criteria specified in [31 TAC §357.7(a)(7-9, 12)] and are tabulated along with "Recommended" strategies in Tables 5-2, 5-3 and 5-4. Upon conclusion of a thorough evaluation process, the Plateau Water Planning Group identified ~~seven~~ five Alternate water management strategies.

5.2.5 Assessment of ASR Potential

Texas Water Code §16.053(e)(10) requires that "if a RWPA has significant identified water needs, the RWPG shall provide a specific assessment of the potential for aquifer storage and recovery (ASR) projects to meet those needs." The PWPG considers municipal utilities as the only WUGs in the Plateau Region that would have the resources available to initiate an ASR project; and that the threshold for "significant" identified water needs are defined by the PWPG as any municipal utility with greater than 800 acre-feet per year need over the 50-year planning horizon. This horizon only occurs with the City of Del Rio. All other municipal water needs are at a far less significant level. However, the PWPG has recommended ASR water management strategies for the Cities of Bandera and Kerrville, and the Eastern Kerr County Regional Project.

An assessment of ASR potential for Del Rio Utilities considers both source-supply availability and hydrologic capability of the underlying rock formations to perform the necessary storage function of the ASR process. Del Rio Utilities is primarily reliant on its water supply from San Felipe Creek, a tributary of the Rio Grande. The Utility captures its full permitted supply at San Felipe Springs, the principal headwaters of the Creek. Without acquiring additional water rights, the Utility is limited to its current supply availability. The Utility does not have access to water available in nearby Amistad Reservoir on the Rio Grande.

The hydrogeologic nature of the underlying rock units of the Edwards Limestone is only partially understood in the Del Rio area. The upper portion of the formation is highly karstic resulting in the extensive flow paths leading to San Felipe Springs. An ASR reservoir would not likely be feasible in this upper horizon as stored water would not likely remain in place. Lower aquifer reservoirs have not adequately been tested for their ability to store and release injected water. Below the Edwards, the Trinity is likely brackish and probably far less permeable. Depth and reservoir capacity may thus limit the Trinity for its ASR function.

The PWPG considers that there is currently insufficient justification for designating an ASR water management strategy option for Del Rio Utilities in this ~~2021~~2026 Plan. However, the PWPG feels that ASR for the Del Rio area should remain as a research topic worthy of future consideration.

5.2.6 Unmet Needs

Sufficient water management strategy supplies are recommended to meet the identified projected needs of all water user groups (WUGs) in the Region except for Bandera County Irrigation, Edwards County Livestock, and Real County Manufacturing.

	WUG Unmet Needs (Acre-Feet per Year)					
Water User Group	**2030**	**2040**	**2050**	**2060**	**2070**	**2080**
Bandera County Irrigation	(806)	(806)	(806)	(806)	(806)	(806)
Edwards County Livestock	(2)	(2)	(2)	(2)	(2)	(2)
Real County Manufacturing	(1)	(1)	(1)	(1)	(1)	(1)

5.2.7 Unqualified Strategies

The TWDB requires that water management strategies listed in regional water plans develop "new" water supplies to be applicable for SWIFT funding. Projects that involve items such as replacing and/or repairing old infrastructure, and wastewater collection and treatment do not qualify. However, the TWDB offers many other types of financing options. Additional details pertaining to the different types of grants and loans offered can be accessed on the TWDB's Financial Assistance webpage.

5.2.8 Vegetative Management and Land Stewardship

Reduced rainfall during drought-of-record conditions certainly reduces aquifer recharge potential. However, some rainfall (and thus recharge) still does occur. Research studies have documented potential recharge impacts (see discussion below) resulting from vegetative management. Chapter 7, Section 7.1.1 defines drought-of-record conditions pertaining to rainfall in the Plateau Region as being an average of 20 percent (five inch) reduction in rainfall per year during the 1950's drought and an average 40 percent (10 inch) reduction during more current years. Assuming the worst-case scenario of 40 percent reduction in precipitation will likewise result in 40 percent reduction in average recharge potential, the PWPG strongly believes that strategies J-13, J-42, J-39, J-51, J-52, J-60, and J-68 produce a reliable amount of supply even during drought conditions. The PWPG recognizes that the concept of properly managing rural range lands is essential in maintaining natural spring flows in the headwaters of surface streams and rivers.

~~Vegetative management and land stewardship are not qualified as water management strategies under regional water planning guidelines as they are not considered to reduce demand. However, the PWPG strongly believes that the concept of properly managing rural range lands is essential in maintaining natural spring flows in the headwaters of surface streams and rivers.~~

Several invasive species have been recognized in the Plateau Region, as well as elsewhere in the State, that have a negative impact on surface water flow in springs, creeks and rivers, as well as recharge to underlying aquifers. Species of major concern are Giant River Cane (*Arundo donax*) and Elephant Ears (*Colocasia esculenta*) in watersheds, and the encroachment of woody species such as Ashe-juniper and Mesquite. The PWPG has selected vegetative management as an appropriate water management strategy for each river basin within each county in the Plateau Region.

Vegetative management of Ashe Juniper, also commonly known as "cedar" has become a significant source of discussion and debate as to its impact on water resources on the Edwards Plateau. Ashe Juniper is native to central Texas and was initially controlled through both man-made and natural fires and through foraging. As these events were reduced, cedar returned and has been expanding in the Region. Eradication methods have included controlled burns, use of heavy equipment to pull the plant up by its roots, mechanical cutting and chemical methods. There has been a great deal of debate regarding the impact on water resources by cedar with various groups calculating how much water cedar takes away from both groundwater and surface water sources. In a 2003, report done by A.A. McCole of the University of Texas Geology Department, it was noted that "in late summer and winter the Ashe Juniper obtains approximately between 72% and 100% of its water from groundwater. In contrast, during the wet periods of the year, spring and fall, mass balance calculations indicate that between 45% and 100% of Ashe Juniper's water is derived from soil water. This seasonal shift indicates the presence of Ashe Juniper can appreciably reduce groundwater resources both by lateral roots intercepting potential recharge during

the wet season and direct uptake of groundwater by deep roots during the dry season. Ashe Juniper will directly compete with grasses for soil water during the wet season, limiting herbaceous productivity."

In 2010, the USGS published a study, "Effects of Brush Management on the Hydrologic Budget and Water Quality in and Adjacent to Honey Creek State Park Natural Area, Comal County, Texas 2001-2010." The results of this study indicated that brush eradication did not increase runoff to streams but did suggest that clearing brush can result in more infiltration. The study found that before clearing potential groundwater recharge was 17% of the total water budget but increased to 24% after clearing. The study showed that prior to clearing a rainfall event produced a potential recharge of 5.91 inches of the rain that fell and after clearing, it increased to 7.09 inches; for a difference of 1.18 inches. In terms of actual water, the extra 1.18 inches amounts to approximately 32,042 gallons per acre. Thus, to obtain one acre foot of water, 10 acres will need to be cleared to gain an additional acre foot of water as infiltration. From these and other studies, brush eradication can have a positive impact on groundwater recharge and a limited impact on surface water runoff. However, with increased groundwater recharge it is reasonable to assume that a portion of this groundwater would percolate down to aquifers as well as provide base flow to surface water via springs.

Brush management is a difficult issue to deal with on a planning level since much of the work that needs to be done is on private property with landowners having varied interests. From literature on the subject many authors note that brush management includes both removing the brush, but also providing land management through replacement with other native species that will prevent erosion and hold moisture. However, as a strategy brush management does show potential for enhancing ground water supplies and subsequent base flow to surface water bodies.

Vegetative management of Giant River Cane (*Arundo donax*) has become a significant problem throughout the Plateau Region. The problems with the Giant Cane are a direct result of its incredible growth potential. Individual shoots can grow upwards of four inches per day and a mature stand, or River Cane, can be approximately 30 feet tall. To support these high growth rates the plant requires significant amounts of water. When compared to native species, *Arundo donax* requires three times as much water minimum. USDA scientists have calculated that each acre of *Arundo donax* requires approximately 4.37-acre feet of water to support proper growth. Thus, 1,000 acres of *Arundo donax* will consume approximately 4,370-acre feet of water per year.

The eradication methods identified to control the *Arundo donax* are mechanical, chemical, and biological. Additionally, any combination of these three treatment protocols can be an effective treatment option. Mechanical control involves removing all portions of the living plant. Due to the plant's high silicon count, the plant is very flammable and highly susceptible to burning. This approach is not recommended as the burning does not affect the root structure.

Chemical control has proven to be the most effective, which uses glyphosate. Glyphosate interferes with the plant's synthesis of nutrients. Biologic control seems to hold promise for eradication. The USDA has been experimenting with using the asexual Arundo Wasp and has received permits to use this wasp in the eradication efforts. Due to the *Arundo donax* being highly invasive, the Texas Legislature passed legislation making it illegal to sell or distribute *Arundo donax* without a permit from the Texas Department of Agriculture.

An HDR consultant memo to the Brazos G Regional Water Plan (2014) provides projected water supply benefits from feasibility studies (Table 2). According to the memo, the increase in water yield referenced

is an increase in the average annual runoff from the treated watershed. ~~and should not be confused with a firm yield supply of water. Under most circumstances, the additional runoff or recharge attained from brush control projects are not sustained during a prolonged drought, and thus the supply benefit under these conditions will be zero. For the Bandera County / Edwards Aquifer / Medina River study, the estimated average annual volume of water supplied is 0.5166 acre-feet per acre.~~

Table 5-2. Summary of Recommended and Alternate Water Management Strategy Evaluation

County	Water User Group	Strategy Source Basin	Strategy	Source	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost	Quantity [a]	Quality [b]	Reliability [c]	Strategy Impacts[d]		
						2030	2040	2050	2060	2070	2080		(1-3)	(1-3)	(1-3)	Water Resources (1-5)	Agricultural Resources (1-5)	Natural Resources (1-5)
Bandera	City of Bandera	San Antonio	Water loss audit and main-line repair	Demand Reduction	J-1	5	5	5	5	5	5	$5,327,000	3	na	na	2	2	2
			Reuse treated wastewater effluent for irrigation of public spaces	Direct Non-Potable Reuse	J-2	0	310	310	310	310	310	$2,117,000	na	3	1	1	2	2
			Promote, design & install rainwater harvesting systems on public buildings	Rainwater Harvesting | Demand Reduction	J-3	0	1	1	1	1	1	$83,000	na	3	2	1	2	1
			Additional Lower Trinity well and lay necessary pipeline **ALTERNATE**	Lower Trinity Aquifer	J-4	0	403	403	403	403	403	$7,067,000	na	1	1	4	2	2
			Additional Middle Trinity wells within City water infrastructure area	Middle Trinity Aquifer	J-5	161	161	161	161	161	161	$1,115,000	na	1	1	3	2	3
			Surface water acquisition, treatment and ASR	Trinity Aquifer ASR	J-6	0	1,500	1,500	1,500	1,500	1,500	$50,501,000	na	2	2	3	2	2
	Bandera County FWSD #1	San Antonio	Public conservation education	Demand Reduction	J-7	4	4	4	4	4	4	$5,342	3	na	na	na	na	na
			Additional groundwater well	Lower Trinity Aquifer	J-8	100	100	100	100	100	100	$1,562,000	1	1	1	3	2	3
	Bandera County-Other (Bridlegate Subdivision)	San Antonio	Water loss audit and main-line repair	Demand Reduction	J-9	1	1	1	1	1	1	$2,130,000	3	na	na	2	2	2
	Bandera County-Other (Flying L Ranch PUD)	San Antonio	Water loss audit and main-line repair	Demand Reduction	J-10	2	2	2	2	2	2	$1,065,000	3	na	na	2	2	2
	Bandera County-Other (Medina WSC)	San Antonio	Additional groundwater well	Lower Trinity Aquifer	J-11	55	55	55	55	55	55	$2,129,000	1	1	1	3	2	3
	Bandera County-Other (BCRAGD)	San Antonio	Drought management	Demand Reduction	J-12	441	491	516	525	533	537	$0	na	na	na	2	2	2
	***Bandera County-Other	San Antonio	Vegetative Management	Demand Reduction	J-13	1,388	1,388	1,388	1,388	1,388	1,388	$0	3	na	na	2	2	2
	Bandera County-Other (Volunteer Fire Dept.)	San Antonio	Additional groundwater wells to provide emergency supply **ALTERNATE**	Trinity Aquifer	J-14	189	189	189	189	189	189	$7,527,000	na	1	2	3	2	3
	Bandera County-Other (BCRAGD)	Nueces	Drought management	Demand Reduction	J-15	23	26	27	28	28	28	$0	na	na	na	2	2	2
	**Bandera County Irrigation	San Antonio	Irrigation scheduling	Demand Reduction	J-16	76	76	76	76	76	76	$0	3	na	na	2	2	2
			Additional groundwater wells	Trinity Aquifer	J-17	75	75	75	75	75	75	$399,000	1	3	1	2	2	3
	*Bandera County Livestock	Nueces	Livestock conservation	Demand Reduction	J-18	13	13	13	13	13	13	$0	3	na	na	2	2	2
			Additional groundwater wells	Middle Trinity Aquifer	J-19	8	8	8	8	8	8	$671,000	1	1	1	3	2	3
Edwards	City of Rocksprings	Nueces	Public conservation education	Demand Reduction	J-20	2	2	2	2	2	2	$5,555	na	na	na	na	na	na
			Water loss audit and main-line repair	Demand Reduction	J-21	5	5	5	5	5	5	$2,130,000	3	na	na	2	2	2
			Additional groundwater wells	Edwards-Trinity (Plateau) Aquifer	J-22	121	121	121	121	121	121	$1,020,000	na	1	1	2	2	3
	Edwards County-Other (Barksdale WSC)	Nueces	Additional well in the Nueces River Alluvium Aquifer and RO wellhead treatment	Nueces River Alluvium	J-23	54	54	54	54	54	54	$317,000	na	1	2	3	2	3
	***Edwards County-Other	Nueces	Vegetative Management	Demand Reduction	J-24	87	87	87	87	87	87	$0	3	na	na	2	2	2
	*Edwards County Irrigation	Rio Grande	Irrigation Scheduling	Demand Reduction	J-25	3,806	3,806	3,806	3,806	3,806	3,806	$0	3	na	na	2	2	2
	**Edwards County Livestock	Nueces	Livestock conservation	Demand Reduction	J-26	51	51	51	51	51	51	$0	3	na	na	2	2	2
	*Edwards County Mining	Nueces	Mining Conservation	Demand Reduction	J-27	2	2	2	2	2	2	$0	3	na	na	2	2	2
			Additional groundwater well	Edwards-Trinity (Plateau) Aquifer	J-28	16	16	16	16	16	16	$154,000	1	1	1	3	2	3

Table 5-2. (continued) Summary of Recommended and Alternate Water Management Strategy Evaluation

County	Water User Group	Strategy Source Basin	Strategy	Source	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost	Quantity [a]	Quality [b]	Reliability [c]	Strategy Impacts[d]		
						2030	2040	2050	2060	2070	2080		(1-3)	(1-3)	(1-3)	Water Resources (1-5)	Agricultural Resources (1-5)	Natural Resources (1-5)
Kerr	*City of Kerrville	Guadalupe	Increase wastewater reuse	Treated wastewater reuse	J-29	2,500	2,500	2,500	2,500	2,500	2,500	$23,355,000	3	3	1	1	2	2
			Water loss audit and main-line repair	Conservation	J-30	42	42	42	42	42	42	$28,757,000	3	na	na	2	2	2
			Additional groundwater well	Ellenburger-San Saba Aquifer	J-31	1,156	1,156	1,156	1,156	1,156	1,156	$38,542,000	1	1	1	2	2	2
			Increased water treatment and ASR capacity	Trinity Aquifer ASR	J-32	0	3,360	3,360	3,360	3,360	3,360	$21,621,000	1	2	2	2	2	2
	*Kerrville South Water	Guadalupe	Additional groundwater wells	Lower Trinity Aquifer	J-33	200	200	200	200	200	200	$2,209,000	1	1	1	3	2	3
	Kerr County-Other (Eastern Kerr County Regional Water Supply Project)	Guadalupe	Project 1. Construction of an Ellenburger Aquifer water supply well	Ellenburger-San Saba Aquifer	J-34	0	108	108	108	108	108	$906,000	1	1	1	2	2	2
			Project 2. Construction of off-channel surface water storage	Guadalupe River		0	1,121	1,121	1,121	1,121	1,121	$39,053,000	na	na	na	2	2	1
			Project 2. Construction of surface water treatment facilities and transmission lines	Guadalupe River								$48,626,000	na	na	na	2	2	2
			Project 3. Construction of ASR facility	Trinity Aquifer		0	1,124	1,124	1,124	1,124	1,124	$1,881,000	na	na	na	2	2	2
			Project 4. Construction of Trinity Aquifer wellfield for dense, rural areas	Trinity Aquifer		0	860	860	860	860	860	$13,067,000	na	na	na	4	2	2
			Project 4. Construction of desalination plant	Trinity Aquifer								$52,888,000	na	na	na	na	na	na
	Kerr County-Other (Center Point)	Guadalupe	Purchase water from EKCRWSP	Guadalupe River and Trinity Aquifer	J-35	0	11	11	11	11	11	$0	1	1	1	na	na	na
	Kerr County-Other (Center Point Taylor System)	Guadalupe	Purchase water from EKCRWSP	Guadalupe River and Trinity Aquifer	J-36	0	43	43	43	43	43	$0	1	1	1	na	na	na
	Kerr County-Other (Community Water Group WSC)	Nueces	Water loss audit and main-line repair	Demand Reduction	J-37	1	1	1	1	1	1	$1,065,000	3	na	na	2	2	2
	*Kerr County-Other	Colorado	Purchase water from EKCRWSP	Guadalupe River and Trinity Aquifer	J-38	102	102	102	102	102	102	$0	1	1	1	na	na	na
	***Kerr County-Other	Guadalupe	Vegetative Management	Demand Reduction	J-39	131	131	131	131	131	131	$0	3	na	na	2	2	2
	*Kerr County Irrigation	Colorado	Irrigation scheduling	Demand Reduction	J-40	1,941	1,941	1,941	1,941	1,941	1,941	$0	3	na	na	2	2	2
	*Kerr County Irrigation	San Antonio	Irrigation scheduling	Demand Reduction	J-41	1,941	1,941	1,941	1,941	1,941	1,941	$0	3	na	na	2	2	2
	*Kerr County Livestock	Colorado	Livestock conservation	Demand Reduction	J-42	6	6	6	6	6	6	$0	3	na	na	2	2	2
			Additional groundwater wells **ALTERNATE**	Trinity Aquifer	J-43	24	24	24	24	24	24	$318,000	1	3	1	3	2	3
	*Kerr County Livestock	San Antonio	Livestock conservation	Demand Reduction	J-44	9	9	9	9	9	9	$0	3	na	na	2	2	2
			Additional groundwater wells **ALTERNATE**	Trinity Aquifer	J-45	54	54	54	54	54	54	$255,000	1	3	1	3	2	3
	*Kerr County Mining	Guadalupe	Mining Conservation	Demand Reduction	J-46	30	30	30	30	30	30	$0	3	na	na	2	2	2
			Additional groundwater wells **ALTERNATE**	Edwards-Trinity (Plateau) Aquifer	J-47	48	48	48	48	48	48	$360,000	1	1	1	3	2	3
Kinney	City of Brackettville	Rio Grande	Increase supply to Spofford with new water line	Edwards-Trinity (Plateau) Aquifer	J-48	0	3	3	3	3	3	$13,196,000	na	1	1	2	2	2
			Increase storage facility	Edwards-Trinity (Plateau) Aquifer	J-49	0	3	3	3	3	3	$1,438,000	na	na	na	na	2	2
	Fort Clark Springs MUD	Rio Grande	Increase storage facility	Edwards-Trinity (Plateau) Aquifer	J-50	0	620	620	620	620	620	$2,499,000	na	na	na	na	2	2
	Kinney County Other	Nueces	Vegetative Management	Demand Reduction	J-51	87	87	87	87	87	87	$0	3	na	na	2	2	2
	Kinney County Other	Rio Grande	Vegetative Management	Demand Reduction	J-52	87	87	87	87	87	87	$0	3	na	na	2	2	2

Table 5-2. (continued) Summary of Recommended and Alternate Water Management Strategy Evaluation

County	Water User Group	Strategy Source Basin	Strategy	Source	Strategy ID	Strategy Supply (Acre-Feet Per Year)						Total Capital Cost	Quantity [a]	Quality [b]	Reliability [c]	Strategy Impacts[d]		
						2030	2040	2050	2060	2070	2080		(1-3)	(1-3)	(1-3)	Water Resources (1-5)	Agricultural Resources (1-5)	Natural Resources (1-5)
Real	*City of Camp Wood	Nueces	Public conservation education	Demand Reduction	J-53	1	1	1	1	1	1	$4,697	3	na	na	na	na	na
			Additional groundwater wells	Edwards-Trinity (Plateau) Aquifer	J-54	258	258	258	258	258	258	$2,531,000	1	1 or 2	1 or 2	3	2	3
	City of Leakey	Nueces	Public conservation education	Demand Reduction	J-55	1	1	1	1	1	1	$5,979						
			Additional groundwater well	Lower Trinity Aquifer	J-56	91	91	91	91	91	91	$646,000	na	1 or 2	1 or 2	3	2	3
			Develop interconnections between wells within the City	Frio River Alluvium Aquifer	J-57	0	81	81	81	81	81	$791,000	na	na	na	na	2	2
	Real County Other - Real WSC	Nueces	Water loss audit and main-line repair	Demand Reduction	J-58	1	1	1	1	1	1	$1,065,000	3	na	na	2	2	2
	Real County Other - Oakmont Saddle Mountain WSC	Nueces	Additional groundwater well	Frio River Alluvium Aquifer	J-59	54	54	54	54	54	54	$615,000	na	1	1	2	2	3
	Real County Other	Nueces	Vegetative Management	Demand Reduction	J-60	0	0	0	0	0	0	$0						
	**Real County Manufacturing	Nueces	Manufacturing Conservation	Demand Reduction	J-61	1	1	1	1	1	1	$0						
Val Verde	*City of Del Rio	Rio Grande	Water loss audit and main-line repair	Demand Reduction	J-62	631	631	631	631	631	631	$89,466,000	3	na	na	na	na	na
			Additional groundwater well	Edwards-Trinity (Plateau) Aquifer	J-63	7,191	7,191	7,191	7,191	7,191	7,191	$19,764,000	1	1	1	3	2	3
			Water treatment plant expansion	Direct Non-Potable Reuse	J-64	0	943	943	943	943	943	$10,489,000	3	2	1	3	2	2
			Develop a wastewater reuse program	Direct Non-Potable Reuse	J-65	0	3,092	3,092	3,092	3,092	3,092	$11,451,000	3	3	1	1	2	2
	Val Verde County Other - San Pedro Canyon Upper Subdivision	Rio Grande	Water loss audit and main-line repair	Demand Reduction	J-66	3	3	3	3	3	3	$1,065,000	3	na	na	2	2	2
	Val Verde County Other - Tierra Del Lago	Rio Grande	Water loss audit and main-line repair	Demand Reduction	J-67	5	5	5	5	5	5	$1,065,000	3	na	na	2	2	2
	Val Verde County Other	Rio Grande	Vegetative Management	Demand Reduction	J-68	0	0	0	0	0	0	$0						
	*Val Verde County Mining	Rio Grande	Mining Conservation	Demand Reduction	J-69	15	16	17	18	19	21	$0						
			Additional groundwater wells	Edwards-Trinity (Plateau) Aquifer	J-70	242	242	242	242	242	242	$1,348,000	2	3	1	3	2	3

See Appendix 5B for quantification description of impact ranges.

* WUGs with a projected future supply deficit. *(See Table 4-1 for list of shortages)*

** WUGs with a projected future unmet need

*** Potential Supplies for Vegetative Management under 40% Reduction of Average Rainfall (see table below)

a Quantity Range: 1 = Meets 100% of shortage; 2 = Meets 50 to 99% of shortage; 3 = Meets <50% of shortage *(See Table 4-1 for list of shortages)*

b Quality Range: 1 = Meets safe drinking-water standards; 2 = Must be treated or mixed to meet safe drinking-water standards; 3 = Usable for intended use

c Reliability Range: 1 = Sustainable; 2 = Provides firm supply, but may be partially impacted during drought conditions; 3 = Non-sustainable

d Strategy Impact Range: 1 = Positive, 2 = No New; 3 = Minimal Negative; 4 = Moderate Negative; 5 = Significant Negative

2026 Strategy ID	Water Management Strategy	Average Rainfall Supply in all Decades (ac-ft/yr.)	DOR Rainfall Supply in all Decades (ac-ft/yr.)
J-13	Vegetative Management	2,314	1,388
J-24	Vegetative Management	145	87
J-39	Vegetative Management	218	131
J-51	Vegetative Management	145	87
J-52	Vegetative Management	145	87
J-60 & 68	Vegetative Management	145	87

Table 5-3. Summary of Recommended and Alternate Water Management Strategy Cost

County	Water User Group	Strategy Source Basin	Strategy	Strategy ID	Total Capital Cost	Annual Cost/Year						Cost per Acre-Foot/Year					
						2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
Bandera	City of Bandera	San Antonio	Water loss audit and main-line repair	J-1	$5,327,000	$375,000	$375,000	$375,000	$375,000	$375,000	$375,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000
			Reuse treated wastewater effluent for irrigation of public spaces	J-2	$2,117,000		$179,000	$179,000	$30,000	$30,000	$30,000		$577	$577	$97	$97	$97
			Promote, design & install rainwater harvesting systems on public buildings	J-3	$83,000		$7,000	$7,000	$1,000	$1,000	$1,000		$7,000	$7,000	$1,000	$1,000	$1,000
			Additional Lower Trinity well and lay necessary pipeline **ALTERNATE**	J-4	$7,067,000		$611,000	$611,000	$114,000	$114,000	$114,000		$1,516	$1,516	$283	$283	$283
			Additional Middle Trinity wells within City water infrastructure area	J-5	$1,115,000	$93,000	$93,000	$14,000	$14,000	$14,000	$14,000	$578	$578	$87	$87	$87	$87
			Surface water acquisition, treatment and ASR	J-6	$50,501,000		$3,570,000	$3,570,000	$17,000	$17,000	$17,000		$2,380	$2,380	$11	$11	$11
	Bandera County FWSD #1	San Antonio	Public conservation education	J-7	$5,342	$876	$893	$893	$894	$893	$893	$256	$257	$252	$246	$241	$237
			Additional groundwater well	J-8	$1,562,000	$153,000	$153,000	$43,000	$43,000	$43,000	$43,000	$1,530	$1,530	$430	$430	$430	$430
	Bandera County-Other (Bridlegate Subdivision)	San Antonio	Water loss audit and main-line repair	J-9	$2,130,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000
	Bandera County-Other (Flying L Ranch PUD)	San Antonio	Water loss audit and main-line repair	J-10	$1,065,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$37,500	$37,500	$37,500	$37,500	$37,500	$37,500
	Bandera County-Other (Medina WSC)	San Antonio	Additional groundwater well	J-11	$2,129,000	$203,000	$203,000	$53,000	$53,000	$53,000	$53,000	$3,691	$3,691	$964	$964	$964	$964
	Bandera County-Other (BCRAGD)	San Antonio	Drought management	J-12	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	***Bandera County-Other	San Antonio	Vegetative Management	J-13	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Bandera County-Other (Volunteer Fire Dept.)	San Antonio	Additional groundwater wells to provide emergency supply **ALTERNATE**	J-14	$7,527,000	$616,000	$616,000	$86,000	$86,000	$86,000	$86,000	$3,259	$3,259	$455	$455	$455	$455
	Bandera County-Other (BCRAGD)	Nueces	Drought management	J-15	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	**Bandera County Irrigation	San Antonio	Irrigation scheduling	J-16	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			Additional groundwater wells	J-17	$399,000	$34,000	$34,000	$6,000	$6,000	$6,000	$6,000	$453	$453	$80	$80	$80	$80
	*Bandera County Livestock	Nueces	Livestock conservation	J-18	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			Additional groundwater wells	J-19	$671,000	$52,000	$52,000	$5,000	$5,000	$5,000	$5,000	$6,500	$6,500	$625	$625	$625	$625
Edwards	City of Rocksprings	Nueces	Public conservation education	J-20	$5,555	$1,148	$862	$863	$949	$903	$830	$656	$862	$863	$949	$903	$830
			Water loss audit and main-line repair	J-21	$2,130,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$30,000	$30,000	$30,000	$30,000	$30,000	$30,000
			Additional groundwater wells	J-22	$1,020,000	$102,000	$102,000	$30,000	$30,000	$30,000	$30,000	$843	$843	$248	$248	$248	$248
	Edwards County-Other (Barksdale WSC)	Nueces	Additional well in the Nueces River Alluvium Aquifer and RO wellhead treatment	J-23	$317,000	$63,000	$63,000	$41,000	$41,000	$41,000	$41,000	$1,167	$1,167	$759	$759	$759	$759
	***Edwards County-Other	Nueces	Vegetative Management	J-24	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	*Edwards County Irrigation	Rio Grande	Irrigation Scheduling	J-25	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Table 5-3. (continued) Summary of Recommended and Alternate Water Management Strategy Cost

County	Water User Group	Strategy Source Basin	Strategy	Strategy ID	Total Capital Cost	Annual Cost/Year						Cost per Acre-Foot/Year					
						2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
Edwards	**Edwards County Livestock	Nueces	Livestock conservation	J-26	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	*Edwards County Mining	Nueces	Mining Conservation	J-27	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			Additional groundwater well	J-28	$154,000	$13,000	$2,000	$2,000	$2,000	$2,000	$2,000	$813	$813	$125	$125	$125	$125
Kerr	*City of Kerrville	Guadalupe	Increase wastewater reuse	J-29	$23,355,000	$1,340,000	$1,340,000	$246,000	$246,000	$246,000	$246,000	$536	$536	$98	$98	$98	$98
			Water loss audit and main-line repair	J-30	$28,757,000	$2,023,000	$2,023,000	$2,023,000	$2,023,000	$2,023,000	$2,023,000	$48,167	$48,167	$48,167	$48,167	$48,167	$48,167
			Additional groundwater well	J-31	$38,542,000	$3,142,000	$3,142,000	$430,000	$430,000	$430,000	$430,000	$2,718	$2,718	$372	$372	$372	$372
			Increased water treatment and ASR capacity	J-32	$21,621,000		$2,574,000	$2,574,000	$1,053,000	$1,053,000	$1,053,000		$766	$766	$313	$313	$313
	*Kerrville South Water	Guadalupe	Additional groundwater wells	J-33	$2,209,000	$202,000	$202,000	$47,000	$47,000	$47,000	$47,000	$1,010	$1,010	$235	$235	$235	$235
	Kerr County-Other (Eastern Kerr County Regional Water Supply Project)	Guadalupe	Project 1. Construction of an Ellenburger Aquifer water supply well	J-34	$906,000		$97,000	$97,000	$33,000	$33,000	$33,000		$898	$898	$306	$306	$306
			Project 2. Construction of off-channel surface water storage		$39,053,000		$2,005,000	$2,005,000	$176,000	$176,000	$176,000		$1,789	$1,789	$157	$157	$157
			Project 2. Construction of surface water treatment facilities and transmission lines		$48,636,000		$3,875,000	$3,875,000	$455,000	$455,000	$455,000		$3,457	$3,457	$406	$406	$406
			Project 3. Construction of ASR facility		$1,881,000		$145,000	$145,000	$13,000	$13,000	$13,000		$129	$129	$12	$12	$12
			Project 4. Construction of Trinity Aquifer wellfield for dense, rural areas		$13,067,000		$1,179,000	$1,179,000	$260,000	$260,000	$260,000		$1,371	$1,371	$302	$302	$302
			Project 4. Construction of desalination plant		$52,888,000		$9,118,000	$9,118,000	$5,398,000	$5,398,000	$5,398,000		$10,602	$10,602	$6,277	$6,277	$6,277
	Kerr County-Other (Center Point)	Guadalupe	Purchase water from EKCRWSP	J-35	$0		$12,000	$12,000	$12,000	$12,000	$12,000		$1,091	$1,091	$1,091	$1,091	$1,091
	Kerr County-Other (Center Point Taylor System)	Guadalupe	Purchase water from EKCRWSP	J-36	$0		$49,000	$49,000	$49,000	$49,000	$49,000		$1,140	$1,140	$1,140	$1,140	$1,140
	Kerr County-Other (Community Water Group WSC)	Nueces	Water loss audit and main-line repair	J-37	$1,065,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000
	*Kerr County-Other	Colorado	Purchase water from EKCRWSP	J-38	$0	$116,000	$116,000	$116,000	$116,000	$116,000	$116,000	$1,137	$1,137	$1,137	$1,137	$1,137	$1,137
	***Kerr County-Other	Guadalupe	Vegetative Management	J-39	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	*Kerr County Irrigation	Colorado	Irrigation scheduling	J-40	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	*Kerr County Irrigation	San Antonio	Irrigation scheduling	J-41	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	*Kerr County Livestock	Colorado	Livestock conservation	J-42	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			Additional groundwater wells **ALTERNATE**	J-43	$318,000	$24,000	$24,000	$2,000	$2,000	$2,000	$2,000	$1,000	$1,000	$83	$83	$83	$83
	*Kerr County Livestock	San Antonio	Livestock conservation	J-44	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			Additional groundwater wells **ALTERNATE**	J-45	$255,000	$24,000	$24,000	$6,000	$6,000	$6,000	$6,000	$444	$444	$111	$111	$111	$111
	*Kerr County Mining	Guadalupe	Mining Conservation	J-46	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			Additional groundwater wells **ALTERNATE**	J-47	$360,000	$32,000	$32,000	$7,000	$7,000	$7,000	$7,000	$667	$667	$146	$146	$146	$146
Kinney	City of Brackettville	Rio Grande	Increase supply to Spofford with new water line	J-48	$13,196,000		$1,023,000	$1,023,000	$95,000	$95,000	$95,000		$341,000	$341,000	$31,667	$31,667	$31,667
			Increase storage facility	J-49	$1,438,000		$111,000	$111,000	$10,000	$10,000	$10,000		$37,000	$37,000	$3,333	$3,333	$3,333
	Fort Clark Springs MUD	Rio Grande	Increase storage facility	J-50	$2,499,000		$194,000	$194,000	$18,000	$18,000	$18,000		$313	$313	$29	$29	$29

Table 5-3. (continued) Summary of Recommended and Alternate Water Management Strategy Cost

County	Water User Group	Strategy Source Basin	Strategy	Strategy ID	Total Capital Cost	Annual Cost/Year						Cost per Acre-Foot/Year					
						2030	2040	2050	2060	2070	2080	2030	2040	2050	2060	2070	2080
Kinney	Kinney County Other	Nueces	Vegetative Management	J-51	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Kinney County Other	Rio Grande	Vegetative Management	J-52	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Real	*City of Camp Wood	Nueces	Public conservation education	J-53	$4,697	$920	$757	$763	$782	$752	$722	$920	$757	$763	$782	$752	$722
			Additional groundwater wells	J-54	$2,531,000	$210,000	$210,000	$32,000	$32,000	$32,000	$32,000	$814	$814	$124	$124	$124	$124
	City of Leakey	Nueces	Public conservation education	J-55	$5,979	$1,172	$969	$973	$996	$965	$904	$1,172	$969	$973	$996	$965	$904
			Additional groundwater well	J-56	$646,000	$74,000	$74,000	$29,000	$29,000	$29,000	$29,000	$813	$813	$319	$319	$319	$319
			Develop interconnections between wells within the City	J-57	$791,000		$61,000	$61,000	$5,000	$5,000	$5,000		$753	$753	$62	$62	$62
	Real County Other - Real WSC	Nueces	Water loss audit and main-line repair	J-58	$1,065,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000
	Real County Other - Oakmont Saddle Mountain WSC	Nueces	Additional groundwater well	J-59	$615,000	$47,000	$47,000	$4,000	$4,000	$4,000	$4,000	$870	$870	$74	$74	$74	$74
	Real County Other	Nueces	Vegetative Management	J-60	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	**Real County Manufacturing	Nueces	Manufacturing Conservation	J-61	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Val Verde	*City of Del Rio	Rio Grande	Water loss audit and main-line repair	J-62	$89,466,000	$6,295,000	$6,295,000	$6,295,000	$6,295,000	$6,295,000	$6,295,000	$9,976	$9,976	$9,976	$9,976	$9,976	$9,976
			Additional groundwater well	J-63	$19,764,000	$2,105,000	$2,105,000	$720,000	$720,000	$720,000	$720,000	$293	$293	$100	$100	$100	$100
			Water treatment plant expansion	J-64	$10,489,000		$1,490,000	$1,490,000	$752,000	$752,000	$752,000		$1,580	$1,580	$797	$797	$797
			Develop a wastewater reuse program	J-65	$11,451,000		$888,000	$888,000	$82,000	$82,000	$82,000		$287	$287	$27	$27	$27
	Val Verde County Other - San Pedro Canyon Upper Subdivision	Rio Grande	Water loss audit and main-line repair	J-66	$1,065,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000
	Val Verde County Other - Tierra Del Lago	Rio Grande	Water loss audit and main-line repair	J-67	$1,065,000	$75,000	$75,000	$75,000	$75,000	$75,000	$75,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000
	Val Verde County Other	Rio Grande	Vegetative Management	J-68	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	*Val Verde County Mining	Rio Grande	Mining Conservation	J-69	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
			Additional groundwater wells	J-70	$1,348,000	$114,000	$114,000	$19,000	$19,000	$19,000	$19,000	$471	$471	$79	$79	$79	$79

* WUGs with a projected future supply deficit. *(See Table 4-1 for list of shortages)*

** WUGs with a projected future unmet need

Table 5-4. Summary of Recommended and Alternate Water Management Strategy Environmental Assessments

County	Water User Group	Strategy	Strategy ID	Environmental Impact Factor **					Comments
				Envir. Water Needs	Wildlife Habitat	Cultural Resources	Envir. Water Quality	Bays & Estuaries ***	
				(1-5)	(1-5)	(1-5)	(1-5)		
Bandera	City of Bandera	Water loss audit and main-line repair	J-1	2	2	2	2	na	Reduces water loss.
		Reuse treated wastewater effluent for irrigation of public spaces	J-2	2	2	2	2	na	Reduces dependence on new groundwater.
		Promote, design & install rainwater harvesting systems on public buildings	J-3	1	1	2	1	na	Provides sustainable supplemental fresh water.
		Additional Lower Trinity well and lay necessary pipeline **ALTERNATE**	J-4	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
		Additional Middle Trinity wells within City water infrastructure area	J-5	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
		Surface water acquisition, treatment and ASR	J-6	4	2	2	2	na	Construction of facilities will displace a small segment of natural habitat. Flow in Medina River would be reduced during periods of diversion.
	Bandera County FWSD #1	Public conservation education	J-7	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater well	J-8	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
	Bandera County-Other (Bridlegate Subdivision)	Water loss audit and main-line repair	J-9	2	2	2	2	na	Reduces water loss.
	Bandera County-Other (Flying L Ranch PUD)	Water loss audit and main-line repair	J-10	2	2	2	2	na	Reduces water loss.
	Bandera County-Other (Medina WSC)	Additional groundwater well	J-11	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
	Bandera County-Other (BCRAGD)	Drought management	J-12	na	na	na	na	na	Reduces dependence on existing supply sources.
	***Bandera County-Other	Vegetative Management	J-13	na	na	na	na	na	Reduces dependence on existing supply sources.
	Bandera County-Other (Volunteer Fire Dept.)	Additional groundwater wells to provide emergency supply **ALTERNATE**	J-14	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
	Bandera County-Other (BCRAGD)	Drought management	J-15	na	na	na	na	na	Reduces dependence on existing supply sources.
	**Bandera County Irrigation	Irrigation scheduling	J-16	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater wells	J-17	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
	*Bandera County Livestock	Livestock conservation	J-18	2	1	2	2	na	Reduces dependence on existing supply sources.
		Additional groundwater wells	J-19	2	2	2	2	na	Well construction and operation to follow BCRAGD regulations.
Edwards	City of Rocksprings	Public conservation education	J-20	na	na	na	na	na	Reduces dependence on existing supply sources.
		Water loss audit and main-line repair	J-21	2	2	2	2	na	Reduces water loss.
		Additional groundwater wells	J-22	2	2	2	2	na	Well construction and operation to follow RECRD regulations.
	Edwards County-Other (Barksdale WSC)	Additional well in the Nueces River Alluvium Aquifer and RO wellhead treatment	J-23	2	2	2	2	na	Caution is necessary to not overexploit the aquifer.
	***Edwards County-Other	Vegetative Management	J-24	na	na	na	na	na	Reduces dependence on existing supply sources.
	*Edwards County Irrigation	Irrigation Scheduling	J-25	na	na	na	na	na	Reduces dependence on existing supply sources.
	**Edwards County Livestock	Livestock conservation	J-26	na	na	na	na	na	Reduces dependence on existing supply sources.
	*Edwards County Mining	Mining Conservation	J-27	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater well	J-28	2	2	2	2	na	Well construction and operation to follow RECRD regulations.
Kerr	*City of Kerrville	Increase wastewater reuse	J-29	2	2	2	2	na	Reduces dependence on existing supply sources.
		Water loss audit and main-line repair	J-30	2	2	2	2	na	Reduces water loss.
		Additional groundwater well	J-31	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
		Increased water treatment and ASR capacity	J-32	2	2	2	2	na	Reduces dependence on new groundwater.
	*Kerrville South Water	Additional groundwater wells	J-33	2	2	2	2	na	Well construction and operation to follow HGCD regulations.

Table 5-4. (continued) Summary of Recommended and Alternate Water Management Strategy Environmental Assessments

County	Water User Group	Strategy	Strategy ID	Environmental Impact Factor **					Comments
				Envir. Water Needs	Wildlife Habitat	Cultural Resources	Envir. Water Quality	Bays & Estuaries ***	
				(1-5)	(1-5)	(1-5)	(1-5)		
Kerr	Kerr County-Other (Eastern Kerr County Regional Water Supply Project)	Project 1. Construction of an Ellenburger Aquifer water supply well	J-34	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
		Project 2. Construction of off-channel surface water storage		2	1	2	2	na	Provides temporary birding habitat.
		Project 2. Construction of surface water treatment facilities and transmission lines		2	3	2	2	na	Construction of facilities will displace a small segment of natural habitat.
		Project 3. Construction of ASR facility		2	2	2	2	na	Well construction and operation to follow HGCD regulations.
		Project 4. Construction of Trinity Aquifer wellfield for dense, rural areas		2	2	2	2	na	Well construction and operation to follow HGCD regulations.
		Project 4. Construction of desalination plant		2	3	2	2	na	Construction of facilities will displace a small segment of natural habitat.
	Kerr County-Other (Center Point)	Purchase water from EKCRWSP	J-35	na	na	na	na	na	Efficiency of supply through a regional project
	Kerr County-Other (Center Point Taylor System)	Purchase water from EKCRWSP	J-36	na	na	na	na	na	Efficiency of supply through a regional project
	Kerr County-Other (Community Water Group WSC)	Water loss audit and main-line repair	J-37	2	2	2	2	na	Reduces water loss.
	*Kerr County-Other	Purchase water from EKCRWSP	J-38	na	na	na	na	na	Efficiency of supply through a regional project
	***Kerr County-Other	Vegetative Management	J-39	na	na	na	na	na	Reduces dependence on existing supply sources.
	*Kerr County Irrigation	Irrigation scheduling	J-40	na	na	na	na	na	Reduces dependence on existing supply sources.
	*Kerr County Irrigation	Irrigation scheduling	J-41	na	na	na	na	na	Reduces dependence on existing supply sources.
	*Kerr County Livestock	Livestock conservation	J-42	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater wells **ALTERNATE**	J-43	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
	*Kerr County Livestock	Livestock conservation	J-44	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater wells **ALTERNATE**	J-45	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
	*Kerr County Mining	Mining Conservation	J-46	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater wells **ALTERNATE**	J-47	2	2	2	2	na	Well construction and operation to follow HGCD regulations.
Kinney	City of Brackettville	Increase supply to Spofford with new water line	J-48	2	2	2	2	na	Temporary land disturbance during excavation for new pipeline.
		Increase storage facility	J-49	2	3	2	2	na	Temporary land disturbance during facility construction.
	Fort Clark Springs MUD	Increase storage facility	J-50	2	3	2	2	na	Temporary land disturbance during facility construction.
	Kinney County Other	Vegetative Management	J-51	na	na	na	na	na	Reduces dependence on existing supply sources.
	Kinney County Other	Vegetative Management	J-52	na	na	na	na	na	Reduces dependence on existing supply sources.
Real	*City of Camp Wood	Public conservation education	J-53	na	na	na	na	na	Intended to reduce water use.
		Additional groundwater wells	J-54	2	2	2	2	na	Well construction and operation to follow RECRD regulations.
	City of Leakey	Public conservation education	J-55	na	na	na	na	na	Intended to reduce water use.
		Additional groundwater well	J-56	2	2	2	2	na	Well construction and operation to follow RECRD regulations.
		Develop interconnections between wells within the City	J-57	2	2	2	2	na	Temporary land disturbance during excavation for new pipeline.
	Real County Other - Real WSC	Water loss audit and main-line repair	J-58	2	2	2	2	na	Reduces water loss.
	Real County Other - Oakmont Saddle Mountain WSC	Additional groundwater well	J-59	2	2	2	2	na	Well construction and operation to follow RECRD regulations.
	Real County Other	Vegetative Management	J-60	na	na	na	na	na	Reduces dependence on existing supply sources.
	**Real County Manufacturing	Manufacturing Conservation	J-61	na	na	na	na	na	Reduces dependence on existing supply sources.

Table 5-4. (continued) Summary of Recommended and Alternate Water Management Strategy Environmental Assessments

County	Water User Group	Strategy	Strategy ID	Environmental Impact Factor **					Comments
				Envir. Water Needs	Wildlife Habitat	Cultural Resources	Envir. Water Quality	Bays & Estuaries ***	
				(1-5)	(1-5)	(1-5)	(1-5)		
Val Verde	*City of Del Rio	Water loss audit and main-line repair	J-62	2	2	2	2	na	Reduces water loss.
		Additional groundwater well	J-63	2	2	2	2	na	Temporary land disturbance during drilling, completion, and pipeline connection.
		Water treatment plant expansion	J-64	2	3	2	2	na	Temporary land disturbance during facility construction.
		Develop a wastewater reuse program	J-65	1	2	2	2	na	Temporary land disturbance during placement of new reuse distribution pipelines.
	Val Verde County Other - San Pedro Canyon Upper Subdivision	Water loss audit and main-line repair	J-66	2	2	2	2	na	Reduces water loss.
	Val Verde County Other - Tierra Del Lago	Water loss audit and main-line repair	J-67	2	2	2	2	na	Reduces water loss.
	Val Verde County Other	Vegetative Management	J-68	na	na	na	na	na	Reduces dependence on existing supply sources.
	*Val Verde County Mining	Mining Conservation	J-69	na	na	na	na	na	Reduces dependence on existing supply sources.
		Additional groundwater wells	J-70	2	2	2	2	na	Temporary land disturbance during drilling and completion of well.

* WUGs with a projected future water supply deficit. *(See Table 4-1 for list of shortages)*

See Appendix 5B for quantification description of impact ranges.

** Strategy impact range: 1 = Positive; 2 = No New; 3 = Minimal Negative; 4 = Moderate Negative; 5 = Significant Negative

*** All strategies occur beyond the distance of potential impact to flows into the coastal bay and estuary systems.

5.3 WATER CONSERVATION

Water conservation is one of the most important components of water supply management. Recognizing its impact, setting realistic goals, and aggressively enforcing implementation may significantly extend the time when new supplies and associated infrastructure are needed. This Chapter explores conservation opportunities and best management practices and provides a road map for integrating conservation planning into long-range water supply management goals.

5.3.1 State Water Conservation Overview

The Texas Water Development Board (TWDB) defines "conservation" as those practices, techniques, programs, and technologies that will protect water resources, reduce the consumption of water, reduce the loss or waste of water, improve the efficiency in the use of water, or increase the recycling or reuse of water so that a water supply is made available for future or alternative uses. Water conservation management strategies recommended in Chapter 5 include water loss audits to reduce distribution losses, public conservation awareness, and brush management.

Effective conservation programs implement best management practices to try to meet the targets and goals identified within the *Plan* and are important to water conservation planning for all entities such as: municipal, agricultural, industrial, and commercial. Water conservation management planning currently implemented by municipalities, agricultural and commercial interests, and other water users supersede recommendations in this *Plan* and are considered consistent with this *Plan.*

The TWDB and the Texas State Soil and Water Conservation Board (TSSWCB) jointly conducted a study of ways to improve or expand water conservation efforts in Texas. The results of that study are available in a joint 2018 report titled "An Assessment of Water Conservation in Texas, Prepared for the 85th Texas Legislature" and contains the following:

- An assessment of both agricultural and municipal water conservation issues;
- Information on existing conservation efforts by the TWDB and the TSSWCB;
- Information on existing conservation efforts by municipalities receiving funding from the TWDB, as specified in water conservation plans submitted by the municipalities as part of their applications for assistance;
- A discussion of future conservation needs;
- An analysis of programmatic approaches and funding for additional conservation efforts;
- An assessment of existing statutory authority and whether changes are needed to more effectively promote and fund conservation projects; and
- An assessment of the TWDB's agricultural water conservation program.

The implementation of water conservation programs that are cost effective, meet State mandates, and result in permanent real reductions in water use will be a challenge for the citizens of the Plateau Region. Smaller communities that lack financial and technical resources will be particularly challenged and will look to the State for assistance.

Since portions of the Region are particularly susceptible to water-supply shortages during periods of drought conditions, these areas are especially encouraged to develop conservation-oriented management plans. Likewise, water-user entities within these areas should become actively involved in the regional water planning activities associated with this *Plan.*

The PWPG considers all groundwater sources recognized in this P*lan* as being critical to the future health and economic welfare of the Plateau Region. Due to the Region's reliance on groundwater to meet current and future water needs, the PWPG recommends that local groundwater conservation districts be formed throughout the entire Region to administer sound, reasonable, and scientifically based management objectives; and that these districts play a major role in the regional water planning process.

It is generally recognized that brush infestations are the symptom of deeper ecological disturbances such as fire control, drought, grazing mismanagement, wildlife overpopulations and other causes. Selective Brush Management, as a tool to improve watershed yields and water quality, is a conservation management strategy of great interest in the Plateau Region, as well as in surrounding planning regions. A program is in place and administered through the Texas State Soil and Water Conservation Board to provide a cost-share funding program to landowners in the targeted watersheds for the Selective Brush Management. Funding for this program should be targeted on selected areas identified through modeling.

The PWPG joins with the Rio Grande Region (M) and the Far West Texas Region (E) in encouraging funding for projects aimed at the eradication and long-term suppression of salt cedar and other nuisance phreatophytes in the Rio Grande watershed.

5.3.2 Model Water Conservation Plans

Water Conservation Plan forms are available from TCEQ in WordPerfect and PDF formats. The forms for the following entity types listed below are available either on the TWDB's Water Conservation Plans webpage or on the TCEQ's Water Conservation website.

You can receive a print copy of a form by calling 512/239-4691 or by email to wras@tceq.texas.gov.

Municipal Use – Utility Profile and Water Conservation Plan Requirements for Municipal Water Use by Public water Suppliers (TCEQ-10218) Word

Wholesale Public Water Suppliers – Profile and Water Conservation Plan Requirements for Wholesale Public Water Suppliers (TCEQ-20162) Word

Industrial Use – Industrial Water Conservation Plan (TCEQ-20839) Word

Mining Use – Mining Water Conservation Plan (TCEQ-20840) Word

Agricultural Uses – Agriculture Water Conservation Plan-Non-Irrigation (TCEQ-10541) Word

System Inventory and Water Conservation Plan for Individually-Operated Irrigation System (TCEQ-10238) Word

System Inventory and Water Conservation Plan for Agricultural Water Suppliers Providing Water to More Than One User (TCEQ-10244) Word

5.3.3 State Water Conservation Programs and Guides

The TWDB provides a significant amount of information and services pertaining to water conservation that can be accessed at TWDB Water Conservation.

Likewise, water conservation tips developed by the TCEQ and made available through their Take Care of Texas educational campaign can be accessed at TCEQ's Water Conservation webpage.

Water-Saving Plumbing Fixture Program

The Texas Legislature created the Water-Savings Plumbing Fixture Program on Jan. 1, 1992, to promote water conservation. Manufacturers of plumbing fixtures sold in Texas must comply with the Environmental Performance Standards for Plumbing Fixtures, which requires all plumbing fixtures such as showerheads, toilets and faucets sold in Texas to conform to specific water use efficiency standards.

As of January 1, 2014, Texas (House Bill 2667) mandates all toilets and urinals sold in Texas must meet new efficiency standards.

- Bath faucets cannot exceed 2.2 gallons per minute (GPM)
- Showerheads cannot exceed 2.5 gallons per minute (GPM)
- Kitchen faucets cannot exceed 2.2 gallons per minute (GPM)
- Toilets cannot exceed 1.28 gallons per flush (GPF)
- Urinals cannot exceed 0.5 gallons per flush (GPF)

Since more water is used in the bathroom than any other place in the home, water-efficient plumbing fixtures play an integral role in reducing water consumption, wastewater production, and consumers' water bills. It is estimated that switching to water-efficient fixtures can save the average household between $50 and $100 per year on water and sewer bills. Many hotels and office buildings find that water-efficient fixtures can save 20 percent on water and wastewater costs.

The EPA's WaterSense program labels water-efficient products that meet most of the criteria above, and on average are certified to use at 20 percent less water than legacy fixtures. Their website also provides a product search tool and a rebate finder.

Water Conservation Best Management Practices

The 78th Texas Legislature under Senate Bill 1094 created the Texas Water Conservation Implementation Task Force and charged the group with reviewing, evaluating, and recommending optimum levels of water use efficiency and conservation for the State. The TWDB and TCEQ in coordination with the Water Conservation Advisory Council prepared TWDB Report 362, Water Conservation Best Management Practices Guides for agricultural, commercial, institutional, and industrial water users. In addition, guides were developed for both municipal and wholesale water providers. These suggested BMPs are structured for delivering a conservation measure or series of measures that are useful, proven, cost-effective, and generally accepted among conservation experts. Each BMP structure has several elements that describe the efficiency measures, implementation techniques, schedule of implementation, scope, water savings estimating procedures, cost effectiveness considerations, and references to assist end-users in implementation. These documents can be accessed here:

Texas Water Development Board Report 362 - Water Conservation Implementation Task Force: Water Conservation Best Management Practices Guide

An update to the introduction in TWDB Report 362 can be found here: Water Conservation Best Management Practices - Understanding Best Management Practices

Public Water Conservation Education

Public education may be one of the most productive actions that can result in the greatest amount of water savings. Most citizens are willing to actively do their part to conserve water once the need is

communicated and how to accomplish the most benefit is explained. Numerous state, county, and academic agencies provide educational material and demonstrations. Groundwater conservation districts also provide water conservation activities.

The TWDB provides a significant amount of information and services pertaining to water conservation that can be accessed at: TWDB Water Conservation.

Likewise, water conservation tips developed by the TCEQ and made available through their Take Care of Texas educational campaign can be accessed at the following website: Take Care of Texas: Conserve & Keep Water Clean.

TPWD also offers programs geared toward the appreciation and conservation of the State's outdoor natural resources which include:

- Freshwater Inflows and Estuaries
- Coastal Studies
- River Studies
- Texas Gulf Ecological Management Sites

Education of our youth may be one of the best ways to spread the word about conservation of water. The TWDB provides excellent educational programs for all grade levels K-12th. Information pertaining to this program can be accessed at: TWDB Kids.

The Groundwater Conservation Districts in the Far West Texas Region have water conservation management goals that include:

- Publishing conservation articles in local newspapers;
- Providing conservation presentations and demonstrations at county shows;
- Conducting school programs relating to conservation issues; and
- Working with river authorities to promote the clean rivers program.

Watershed Best Management Practices

Watershed best management practices are activities taken to manage, protect, and restore the quality of water resources. Best management practices are designed to consider a variety of water uses and maximize conservation. The Environmental Protection Agency has put together a list of fourteen recommended BMPs and have developed a siting tool which identifies potential suitable locations for implementing different types of BMPs that have proven to be helpful in water conservation efforts. Several of these practices are discussed further for being cost effective, practical, and efficient for the Plateau Region.

Brush Management

A potential means of increasing water supply is to reduce the amount of water consumed by shrubs and trees on rangelands. The density and coverage of shrubs has increased dramatically during the past century as former grasslands have now converted to shrub-lands or closed-canopy woodlands. A total loss of herbaceous vegetation cover will increase water yields in the form of surface runoff. However, this process will accelerate erosion, degrade water quality, and damage aquatic ecosystems. A more desirable way of increasing water yield is to manage vegetation to decrease evapotranspiration, which will generally increase the amount of water that percolates below the root zone into groundwater and eventually back into streams. Researchers[1] believe it is appropriate to broaden the issue from solely focusing on "brush control for increasing water yield" to "best management practices for watershed health and sustainability." See Section 5.2.8 of this Chapter for further discussion on vegetative management as water management strategy.

Rainwater Harvesting

The following discussion on Rainwater Harvesting is taken from the Texas Water Development Board's 'The Texas Manual on Rainwater Harvesting', 3rd Edition.

Rainwater is valued for its purity and softness. It has a nearly neutral pH, and is free from disinfection by-products, salts, minerals, and other natural man-made contaminants. Plants thrive under irrigation with stored rainwater. Appliances last longer when free from the corrosive or scale effects of hard water. Users with potable systems prefer the superior taste and cleansing properties of rainwater. Rainwater harvesting, in its essence, is the collection, conveyance, and storage of rainwater.

Rainwater harvesting systems can be as simple as a rain barrel for garden irrigation at the end of a downspout, or as complex as a domestic potable system or a multiple end-use system at a large corporate campus. Advantages and benefits of rainwater harvesting are numerous (Krishna, 2003):

- The water is free; the only cost is for collection and use.
- The end use of harvested water is located close to the source, eliminating the need for complex and costly distribution systems.

[1]Wilcox, B.P., Dugas, W.A., Owens, M.K., Ueckert, D.N., and Hart, C.R., 2005, Shrub Control and Water Yield on Texas Rangelands, Current State of Knowledge: Texas Agricultural Experiment Station Research Report 05-1.

- Rainwater provides a water source when groundwater is unacceptable or unavailable, or it can augment limited groundwater supplies.
- The zero hardness of rainwater helps prevent scale on appliances, extending their use; rainwater eliminates the need for a water softener and the salts added during the softening process.
- Rainwater is sodium free, important for persons on low sodium diets.
- Rainwater is superior for landscape irrigation.
- Rainwater harvesting reduces flow to storm water drains and reduces non-point source pollution.
- Rainwater harvesting helps utilities reduce the summer demand peak and delay expansion of existing water treatment plants.
- Rainwater harvesting reduces consumers' utility bills.

The TWDB has a rainwater harvesting webpage that focuses on rainwater projects, training, the Texas Rain Catcher Award and FAQs.

Landscape Maintenance

A significant amount of water is used each year in the maintenance of residential and non-residential landscapes. Landscape irrigation conservation practices are an effective method of accounting for and reducing outdoor water usage while maintaining healthy landscapes and avoiding runoff. Water wise landscape programs should follow the seven principals of xeriscape:

- Planning and design
- Soil analysis and improvement
- Appropriate plant selection
- Practical turf area
- Efficient irrigation
- Use of mulch
- Appropriate maintenance

Additional detail on this subject is available in TWDB Report 362 'Water Conservation Best Management Practices Guide.

Water Loss Audit

Reported municipal use generally includes a variable amount of water that does not reach the intended consumer due to water leaks in the distribution lines, unauthorized consumption, storage tank overflows, and other wasteful factors. For some communities, attending to these issues can be a proactive conservation strategy that may result in significant water savings.

To address the lack of information on water loss, the 78th Texas Legislature passed House Bill 3338, which required retail public utilities that provide potable water to perform and file with the TWDB a water audit computing the utility's most recent annual system water loss every five years. In response to the mandate of House Bill 3338, TWDB developed a water audit methodology for utilities to quantify water losses, standardize water loss reporting and help measure water efficiency. This standardized

approach to auditing water loss provides utilities with a reliable means to analyze their water loss performance. Utilizing a methodology derived from the American Water Works Association (AWWA) and the International Water Association (IWA), the TWDB has published a manual that outlines the process of completing a water loss audit: "Water Loss Audit Manual for Texas Utilities" – TWDB Report 367 (2008).

Additionally, for the sixth cycle of regional water planning, the TWDB developed several helpful resource guides regarding water loss performance targets and water loss threshold values. These documents can be accessed on the TWDB's website page titled Conservation Resources for 2026 Regional Water Plan Development.

The TWDB provides a significant amount of information and services pertaining to water loss audit that can be accessed on their website.

- Additional resources and appropriate forms provided by TWDB include:
- Water Audit Worksheet Instructions
- Water Loss Guidance
- Guidelines for Setting a Target Infrastructure Leakage Index (ILL)
- Water Loss Manual for Texas Utilities (Updated March 2008)
- Main Line Water Loss Calculator
- Monthly Water Loss Report
- Leak Detection Loan Form
- Ultrasonic Flow Meter Equipment Loan Form

5.3.4 Regional Conservation Water Management Strategies

Many of the recommended water management strategies listed in are classified as "Conservation" and are first to be considered in meeting future water-supply needs. These strategies compiled are listed in Table 5-5 and include:

- Water loss audit and main-line repair
- Vegetative management
- Drought management
- On-site reuse
- Public conservation awareness
- Specified activities for irrigation and livestock use

Table 5-5. Conservation Water Management Strategies

County	Water User Group	Source Basin	Strategy	Strategy ID
Bandera	City of Bandera	San Antonio	Water loss audit and main-line repair	J-1
	Bandera County FWSD #1	San Antonio	Public conservation education	J-7
	Bandera County Other Bridlegate Subdivision	San Antonio	Water loss audit and main-line repair	J-9
	Bandera County Other Flying L Ranch PUD	San Antonio	Water loss audit and main-line repair	J-10

	Bandera County Other	San Antonio	Drought management	J-12
		San Antonio	Vegetative management	J-13
		Nueces	Drought management	J-15
	Bandera County Irrigation	San Antonio	Irrigation scheduling	J-16
	Bandera County Livestock	Nueces	Livestock conservation	J-18
Edwards	City of Rocksprings	Nueces	Public conservation education	J-20
			Water loss audit and main-line repair	J-21
	Edwards County Other	Nueces	Vegetative management	J-24
	Edwards County Irrigation	Rio Grande	Irrigation scheduling	J-25
	Edwards County Livestock	Nueces	Livestock conservation	J-26
	Edwards County Mining	Nueces	Mining Conservation - On-site reuse	J-27
Kerr	City of Kerrville	Guadalupe	Water loss audit and main-line repair	J-30
	Kerr County Other (Community Water Group WSC)	Nueces	Water loss audit and main-line repair	J-37
	Kerr County Other	Guadalupe	Vegetative management	J-39
	Kerr County Irrigation	Colorado	Irrigation scheduling	J-40
		San Antonio	Irrigation scheduling	J-41
	Kerr County Livestock	Colorado	Livestock conservation	J-42
		San Antonio	Livestock conservation	J-44
	Kerr County Mining	Guadalupe	Mining conservation - On-site reuse	J-46
Kinney	Kinney County Other	Nueces	Vegetative management	J-51
		Rio Grande	Vegetative management	J-52
Real	City of Camp Wood	Nueces	Public conservation education	J-53
	City of Leakey	Nueces	Public conservation education	J-55
	Real County Other (Real WSC)	Nueces	Water loss audit and main-line repair	J-58
	Real County Other	Nueces	Vegetative management	J-60
	Real County Manufacturing	Nueces	Manufacturing Conservation	J-61
Val Verde	City of Del Rio	Rio Grande	Water loss audit and main-line repair	J-62
	Val Verde County Other	Rio Grande	Water loss audit and main-line repair for San Pedro Canyon Subdivision (Upper)	J-66
			Water loss audit and main-line repair for Tierra Del Lago	J-67
	Val Verde County Other	Rio Grande	Vegetative management	J-68
	Val Verde County Mining	Rio Grande	Mining conservation - On-site reuse	J-69

5.3.5 Municipal Conservation Programs

Texas Water Code §11.1271 requires water conservation plans for all municipal and industrial water users with surface water rights of 1,000 acre-feet per year or more and irrigation water users with surface water rights of 10,000 acre-feet per year or more. Also, all entities with 3,300 or more connections and/or a financial obligation with TWDB greater than $500,000 are required to submit water conservation plans. Water conservation plans have been developed for the cities of Kerrville and Del Rio, which meet these criteria. The Upper Guadalupe River Authority, which also has water rights that meet the criteria, is not currently providing water and therefore has not developed a conservation plan under the above TWC requirement. However, UGRA does have a Water Conservation/Drought Management Plan, which was adopted in 1993. Water conservation plans are also required for all other water users applying for a State water right and may also be required for entities seeking State funding for water supply projects.

5.3.6 Irrigation Conservation

Irrigated agriculture is the biggest user of water in Texas. Approximately 7.5 million acre-feet was represented within the 2020 planning decade, of the 2022 State Water Plan. Irrigation water use represents 45 percent of total water use in the State. This is 10 percent greater than municipal water use, which ranks as the second largest use of water State-wide.

On a regional level, irrigation represents approximately 30 percent of all the water used in the Plateau Water Planning area. During significantly dry periods, insufficient water is available to meet the full permitted allotments, and farmers in these areas have generally approached this situation by reducing acreage irrigated, changing types of crops planted, or possibly not planting crops until water becomes available during the following season. In some cases, farmers may benefit from management practices described in Chapter 5, which are a mixture of site-specific management, educational, and physical procedures that have proven to be effective and are cost-effective for conserving water.

The implementation of water conservation programs that are cost effective, meet State mandates, and result in permanent real reductions in water use will be a challenge for the citizens of the Plateau Water Planning area. Smaller communities that lack financial and technical resources will be particularly challenged and will look to the State for assistance. Irrigation conservation may result in significant reductions in water use. However, without financial and technical assistance, it is unlikely that aggressive irrigation conservation programs will be implemented.

5.3.7 Manufacturing Conservation

Manufacturing water use is one of the three largest uses of water in Texas. In the 2022 State Water Plan, approximately 1.7 million acre-feet was reported within the 2020 planning decade. This represents 10% of total water use in the State. In the Plateau Water Planning Region, manufacturing water use accounts for less than one percent of the total non-municipal water use. The use of water for manufacturing purposes only occurs in Kerr, Real and Val Verde Counties (Table 2-7).

Refinery water consumption depends primarily on which of three configurations (cracking, light coking, and heavy coking) is utilized. These processes consume 14 to 20 gallons of water per barrel of crude processed.

Water consumption at most refineries includes cooling water evaporation loss, water embedded with product, steam trap losses, steam vent losses firewater main leaks to ground, evaporation from usage during maintenance, and evaporation from open water ponds in the wastewater treatment plant.

Recent improved practices across the industry include the following:

- Monitoring of steam used to purge and disperse flare tips
- Replacing turbines that vent steam to the atmosphere with non-vented options
- Capturing blowdown water from boilers in lower-pressure drum and cooling before sending to WWTP
- Identifying and minimizing steam leaks
- Rerouting steam traps that vent to ground to condensate recovery headers, and
- Capturing steam lost through top of de-aerators.

5.3.8 Gallons Per Capita Daily Goals

Effective municipal conservation can best be monitored in terms of reduction in gallons per day per capita (GPCD). The PWPG decided to utilize the maximum historical GPCD (2010-2020) for 10 of the 17 water user groups (WUGs) within the Region. The remaining seven WUGs calculated projected water demands by using the 2021 Plan values. In addition, the TWDB established several key changes to the water demand projection methodology for the sixth cycle of regional water planning. One of the key changes assumes that the expected water efficiency savings by replacement and new growth would reasonably be fully realized by the first projected decade of 2030, based on the effective year of the relevant plumbing code savings projections for the current planning cycle. Plumbing code savings from 2040 through 2080 are held constant.

Table 5-6 presents the PWPG approved 2020 base GPCDs, along with the projected GPCD reductions in 2030 which includes plumbing code savings. The planning group recommends conservation water management strategies (water loss audit and main-line repair) for eight entities listed below. More detail related to those water management strategies can be found in Appendix 5A. It is highly recommended that these entities take advantage of a water loos audit to guide needed repairs.

~~The PWPG recommends the GPCD reduction goals listed in Table 5-6, which provides a listing of projected GPCD reductions anticipated as water efficiency and recommended conservation savings occur on a decadal basis. Entities listed in the table with higher GPCDs than 200 are likely impacted by water loss issues in their distribution systems. It is highly recommended that these entities take advantage of a water loss audit to guide needed repairs.~~

Table 5-6. Gallons Per Capita Daily Goals

Water User Group	Base 2020 GPCD	Adjusted 2030 GPCD	Adjusted 2040 GPCD	Adjusted 2050 GPCD	Adjusted 2060 GPCD	Adjusted 2070 GPCD	Adjusted 2080 GPCD
*Bandera	174	169	168	168	168	168	168
Bandera County FWSD #1	289	284	284	284	284	284	284
Brackettville	442	437	437	437	437	437	437
Camp Wood	391	386	386	386	386	386	386

*County-Other, Bandera	102	97	97	97	97	97	97
County-Other, Edwards	108	103	103	103	103	103	103
*County-Other, Kerr	150	145	145	145	145	145	145
County-Other, Kinney	127	121	121	121	121	121	121
*County-Other, Real	103	98	97	97	97	97	97
*County-Other, Val Verde	126	121	121	121	121	121	121
*Del Rio Utilities	327	322	322	322	322	322	322
Fort Clark Springs MUD	478	473	473	473	473	473	473
*Kerrville	217	212	211	211	211	211	211
Kerrville South Water	118	113	113	113	113	113	113
Laughlin Air Force Base	533	528	527	527	527	527	527
Leakey	611	606	605	605	605	605	605
*Rocksprings	239	234	234	234	234	234	234

*Entities that have water loss audit & main-line repair strategies.

Significantly more restrictive measures should be initiated in response to varying degrees of drought conditions such as:

- Mild Drought (Stage 1) – 10% reduction
- Moderate Drought (Stage 2) – 20% reduction
- Severe Drought (Stage 3) – 30% reduction
- Extreme Drought (Stage 4) – 40% reduction

5.3.9 Groundwater Conservation District Management Plans

The Texas Legislature has established a process for local management of groundwater resources through Groundwater Conservation Districts. The districts are charged with managing groundwater by providing for the conservation, preservation, protection, recharging and prevention of waste of groundwater within their jurisdictions. An elected board governs these districts and establishes rules, programs and activities specifically designed to address local problems and opportunities. Texas Water Code §36.0015 states, in part, “Groundwater Conservation Districts created as provided by this chapter are the state’s preferred method of groundwater management.” Four districts are currently in operation within the planning Region.

- Bandera County River Authority and Groundwater District
- Headwaters Groundwater Conservation District (Kerr County)
- Kinney County Groundwater Conservation District
- Real-Edwards Conservation and Reclamation District

In recent sessions, the Texas Legislature has redefined the way groundwater is to be managed by Groundwater Management Areas. The TWDB provides more information regarding Groundwater Management Areas. This new process is summarized in Chapter 1, Section 1.1.6. The Real-Edwards and a portion of Kinney districts are in GMA 7; while the Bandera and Kerr (Headwaters) districts are in GMA 9. A portion of the Kinney district is in GMA 10.

As part of the joint planning process, groundwater conservation districts are responsible for determining the desired future conditions within a management area. Desired future conditions are defined in Title 31, Part 10, §35601. (6) of the Texas Administrative Code as “the desired, quantified condition of

groundwater resources (such as water levels, spring flows, or volumes) within a management area at one or more specified future times as defined by participating groundwater conservation districts." Desired future conditions are implemented to help meet the planning goal for the conservation of water that is to be used for future uses. More information regarding Desired Future Conditions can be found on the TWDB's website.

Based on adopted desired future conditions, the TWDB estimates the amount of withdrawals that can occur over a specified time (modeled available groundwater) that does not deplete the aquifer beyond the stated desired future condition. As of ~~2018~~ May 1, 2021, desired future conditions have been adopted and modeled available groundwater has been determined for the following aquifers in the Plateau Region: Trinity, Edwards Group of the Edwards Trinity (Plateau), Edwards BFZ, and Edwards-Trinity (Plateau).

Bandera County River Authority and Groundwater District

The Bandera County River Authority and Groundwater District was originally the Bandera County River Authority, created by the Texas legislature in 1971, and the Springhill's Water Management District, created by the legislature in 1989. The authority of the Bandera County River Authority was incorporated into the Springhill's Water Management District, and in 2003 the TCEQ authorized changing the District's name to Bandera County River Authority and Groundwater District. The District includes all of Bandera County within its jurisdiction. The mission of the District is to manage, protect and conserve the County's water and natural resources, while protecting private property rights. The approved 2023 Management Plan is available on their website, or by following the link above.

Adopted Future Conditions for Bandera County

Aquifer	Edwards Group of the Edwards-Trinity (Plateau)	Trinity
DFC	No net increase in average drawdown through 2080	Increase in average drawdown of approximately 30 feet through 2080

Headwaters Groundwater Conservation District

The Headwaters Groundwater Conservation District is part of the Hill Country Priority Groundwater Management Area (9) and was created by the Texas legislature in 1991 (HB 1463). The District includes all of Kerr County within its jurisdiction. The District's approved 2022 Amended Plan is available on their website, or by following the link above.

The purpose of the District is to provide for the conservation, preservation, protection, recharging and prevention of waste of groundwater reservoirs or their subdivisions within the defined boundaries of the District. The District is responsible for registering and permitting wells drilled in the County, along with conducting aquifer analysis to help determine appropriate plans for future development.

Adopted DFCs for the aquifers in Kerr County are shown below. With regards to the Edwards Group of the Edwards-Trinity (Plateau) Aquifer, GMA 9 declares it 'non-relevant.' Districts in a groundwater management area may, as part of the process for adopting and submitting desired future conditions, propose classification of a portion or portions of a relevant aquifer as non-relevant (31 Texas Administrative Code 356.31 (b)). This classification of an aquifer is made if the districts determine that aquifer characteristics, groundwater demands, and current groundwater uses do not warrant adoption of a desired future condition. Further details explaining 'non-relevant' aquifers can be at TWDB website.

Adopted Desired Future Conditions for Kerr County

Aquifer	Edwards Group of the Edwards-Trinity (Plateau)	Trinity
DFC	Non-relevant	Increase in average drawdown of approximately 30 feet through 2080.

Kinney County Groundwater Conservation District

The Kinney County Groundwater Conservation District was created by the legislature in 2001 (HB 3243) and was confirmed by the voters of Kinney County in 2002. The District includes all of Kinney County within its jurisdiction. The District was created to develop, promote, and implement water conservation and management strategies to conserve, preserve, protect groundwater supplies within the District, protect and enhance recharge, prevent waste and pollution, and to promote the efficient use of groundwater within the District. The approved 2023 Management Plan includes goals such as: provide the most efficient and sustainable use of groundwater; address conjunctive surface water management issues; address drought conditions and participate in the development of desired future conditions of aquifers.

Adopted Desired Future Conditions for Kinney County (GMA 7)

Aquifer	Edwards-Trinity (Plateau)	Trinity
DFC	Drawdown which is consistent with maintaining an annual average flow of 23.9 cfs and an annual median flow of 23.9 cfs at Las Moras Springs.	

Adopted Desired Future Conditions for Kinney County (GMA 10)

Aquifer	Edwards BFZ (GMA10)	Edwards-Trinity (Plateau)
DFC	Water level in well 70-38-902 (J-17) shall not fall below 1,184 feet MSL as mandated by Edwards Aquifer Authority legislation.	

Real-Edwards Conservation and Reclamation District

The Real-Edwards Conservation and Reclamation District was formed by the Texas legislature in 1959 (HB 447) and includes all of Real and Edwards Counties within its jurisdiction. The District was created to provide for the conservation preservation, protection, recharge and prevention of waste of the underground water reservoirs located under the District. The District strives to bring about conservation, preservation and the efficient, beneficial and wise use of water for the benefit of the citizens and the economy of the District through monitoring and protecting the quantity and quality of the groundwater. The District also aims to maintain groundwater ownership and rights of the landowners.

District activities include regulating groundwater withdrawals by means of spacing and production limits, using the Texas Water Development Board's observation network to monitor changing storage conditions of groundwater supplies within the District, undertaking, as necessary, and cooperating with investigations of the groundwater resources within the District and making the results of investigations available to the public upon adoption by the Board, and potentially requiring reduction of groundwater withdrawals to amounts which will not cause harm to the aquifer.

Adopted Desired Future Conditions for Real County (GMA 7)

Aquifer	Edwards-Trinity (Plateau)	Trinity (Real County)
DFC	Total net drawdown not to exceed 4 feet in 2070 as compared to 2010 aquifer levels	

Adopted Desired Future Conditions for Edwards County (GMA 7)

Aquifer	Edwards-Trinity (Plateau)	Trinity (Real County)
DFC	Total net drawdown not to exceed 2 feet in 2070 as compared to 2010 aquifer levels	

5.3.10 Upper Guadalupe River Authority Conservation Program

The Upper Guadalupe River Authority (UGRA) provides a significant conservation outreach program serving citizens of Kerr County. Two full-time employees focus on public education programs and activities with emphasis on water conservation. Recent water conservation programs and activities include:

- Working with TPWD on the Healthy Creeks Initiative, assisting landowners with control and management of giant cane (*Arundo doanx*);
- Partnering with the Hill Country Master Gardeners on planning, design, and maintenance of the UGRA EduScape, which is a major landscape project providing educational venues demonstrating water conservation, low maintenance plants, pervious walkway options, and rainwater collection;
- Partnership with the Riverside Nature Center to provide "UGRA 2nd grade Science Day" field trip to all Kerr County 2nd graders;
- Annual River Clean Up event and assistance with cleanups coordinated by other groups;
- Water Enhancement Cost Share Program provides additional reimbursement to landowners enrolled in USDA Natural Resources Conservation Service (NRCS) or Texas State Soil and Water Conservation Board (TSSWCB) brush management programs. Landowners in the Guadalupe River watershed in Kerr County can receive 25% of the amount reimbursed by NRCS or TSSWCB once they have completed brush management activities;
- Water and sediment control basin structures have been constructed at seven locations in the upper Guadalupe River watershed. The structures function to slow runoff during rain events to reduce flooding and sediment loading into the river;
- Rebates up to $200 are issued to Kerr County residents on their purchases of rainwater catchment system equipment;
- The Rainwater Catchment System Cost Assistance Program annually awards one $2,500 payment to incentivize the construction of larger rainwater catchment systems. The program is open to anyone in Kerr County, but the applications submitted by entities that promote water conservation education to the public will be given a higher priority;

- Additional opportunities to provide information to the public on water conservation are made available through presentations to students and adults, radio public service announcements, routine newspaper articles, and advertisements in local publications.

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