4B.5 Groundwater/Surface Water Conjunctive Use

4B.5.1 Description of Strategy

Conjunctive use of surface water and groundwater resources for the Brazos G water plan features the use of surface water supplies during normal and wet periods and groundwater sources during droughts. Two conjunctive water management strategies are considered for the 2011 Brazos G water management plan. One is the use of Lake Granger and the Simsboro Aquifer to meet water shortages in Williamson County; and, the other is the use of Oak Creek Reservoir and the Dockum Aquifer to meet the City of Sweetwater's water demands. In these two cases, the firm yield of these surface water supplies is non existent or very limited during drought conditions. During these periods, the water stored in local aquifers is tapped to augment the surface water supplies, which together provides a meaningful firm yield.

4B.5.2 Lake Granger and Simsboro for Williamson County (Lake Granger Augmentation)

4B.5.2.1 Description of Option

Rapid population growth and development in Williamson County require additional water supplies throughout the planning period. The total need for new supplies in Williamson County is over 27,000 acft/yr by the year 2030, increasing to over 115,000 acft/yr by year 2060. Much of the increased demand is in the southwestern portion of the county in and adjoining the Cities of Cedar Park and Round Rock and extending along major highway corridors served by other potable water entities. This alternative will add 54,390 acft/yr by augmenting the long-term firm yield of Lake Granger with groundwater pumped from the Trinity Aquifer and the Carrizo-Wilcox Aquifer. In the initial phase of the project, water from the Trinity Aquifer in eastern Williamson County would be blended with treated water from the East Williamson County Regional Water Treatment Plant (EWCRWTP). In the second phase of the project, additional groundwater would be developed from the Carrizo-Wilcox Aquifer in areas east of Williamson County, in Milam, Lee and Burleson Counties. At this time specific locations for these supplies have not been identified. For the purposes of this plan, it is assumed that these supplies will come from Milam County.

Two alternatives have been previously studied for the second phase of the project. In the first alternative, referred to as the *Comingling Option*, Carrizo-Wilcox Aquifer water is first pumped into Lake Granger and comingled with natural runoff in the reservoir. The comingled water is subsequently diverted and all of the water is treated at the EWCRWTP. In the second alternative, referred to here as the *Bypass Option*, groundwater is blended with treated Lake Granger water rather than comingling the water in the reservoir. Because of concerns about blending groundwater in Lake Granger and the additional cost and treatment capacity associated with treating the blended water, current Brazos River Authority planning assumes that the Bypass Option will be used rather than the Comingling Option. Facilities for Phases 1 and 2 are depicted in Figure 4B.5-1. Concepts for this supply project are based on studies performed for the Brazos River Authority in 2005[1] and 2009[2].

4B.5.2.2 Available Yield

Using the Brazos G WAM, the firm yield of Lake Granger is projected to decline from the current yield of 18,007 acft/yr to 15,987 acft/yr in the year 2060. Reservoir sedimentation[3] is depleting conservation storage from its original permitted volume of 65,500 acft to a projected volume at year 2060 of 20,973 acft.

Water from the Trinity Aquifer in the Lake Granger area is relatively high in dissolved solids. This option envisions blending Trinity Aquifer water with treated water from the EWCRWTP to reduce dissolved solids concentration. A ratio of 2 parts Lake Granger water to 1 part Trinity Aquifer water should meet drinking water standards. As a result, the amount of water available from the Trinity Aquifer is limited by the yield of Lake Granger. Table 4B.5-1 shows the potential supply from the first phase of this project, which ranges from about 8,800 acft/yr of additional supply in 2010 to about 8,000 acft/yr in 2060.

As an alternative or complement to using blended Trinity Aquifer and Lake Granger water, the Trinity Aquifer could be used for aquifer storage and recovery (ASR). Treated surface water could be stored in the Trinity Aquifer during times of low demand or high flows and recovered for use at a later date. Pending further study ASR is not included as an option in Phase I at this time.

[1] Parsons Brinkerhoff Quade and Douglas, Inc. and Espey Consultants: Williamson County Water Supply Plan Groundwater Procurement, Implementation and Costs, prepared for the Brazos River Authority, July 2005.
[2] R.W. Harden and Associates and Freese and Nichols, Inc.: Assessment of the Use of Trinity Groundwater in Williamson County, Texas, prepared for the Brazos River Authority, July 2009.
[3] Sedimentation rate based on TWDB volumetric survey dated April 2002

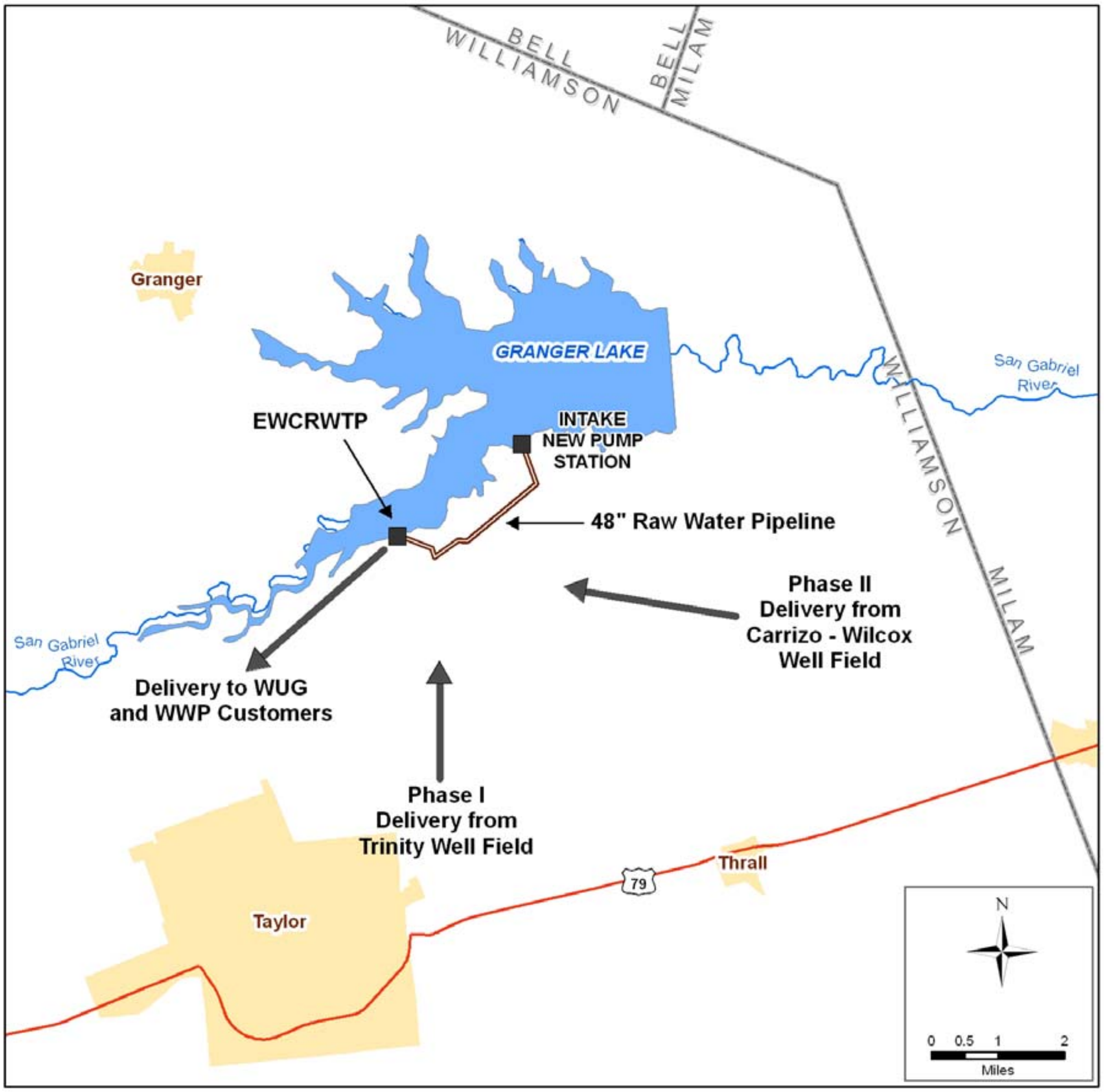

Figure 4B.5-1. Lake Granger Augmentation – Conjunctive Use with Trinity and Carrizo-Wilcox Aquifers

Table 4B.5-1
Potential Supply from First Phase of Lake Granger Augmentation Project
(Values in acft/yr)

Source	***2010***	***2020***	***2030***	***2040***	***2050***	***2060***
Granger Lake Firm Yield	17,670	17,334	16,997	16,660	16,324	15,987
Amount of Trinity Aquifer Groundwater	8,835	8,667	8,499	8,330	8,162	7,994
Total	26,505	26,001	25,496	24,990	24,486	23,981

The second phase of the project calls for overdrafting Lake Granger during times of high flow, utilizing interruptible surface water from the BRA System Operations Permit. Surface water supplies will be supplemented by water from the Carrizo-Wilcox Aquifer when interruptible water from Lake Granger is not available.

The conjunctive use project would develop a supply of 72,405 acft/yr, including supplies from the Trinity Aquifer. Of this amount, 18,015 acft/yr has been assigned to current and future needs for the City of Taylor, City of Hutto and the Jonah Water Special Utility District, leaving a supply of 54,390 acft/yr (46,390 acft/yr from Phase II conjunctive use plus 8,000 acft/yr from Phase I) for other future needs in Williamson County.

The Brazos G WAM was utilized to simulate operations of Lake Granger supplemented with the groundwater pumping. In the WAM it was assumed that all of the demand (less 8,000 acft/yr from the Trinity Aquifer) was taken from Lake Granger when the reservoir was full and spilling. When the reservoir is less than full demands are reduced as the storage in the reservoir declines. Figure 4B.5-2 shows the storage trace for Lake Granger modeled with these assumptions. The remaining demand is met by pumping from the Carrizo-Wilcox Aquifer. Using these assumptions, in 2060 the average pumping from the Carrizo-Wilcox Aquifer is 30,832 acft/yr with a maximum pumping of 58,459 acft/yr (Figure 4B.5-3).

4B.5.2.3 Environmental

Environmental impacts could include:

- Possible reduction in flood releases to the San Gabriel River downstream of Lake Granger,
- Possible moderate impacts on riparian corridors depending on specific locations of pipelines, and
- Possible low impacts on instream flows due to slight decrease in groundwater discharges from the Carrizo-Wilcox Aquifer.

A summary of environmental issues is presented in Table 4B.5-2.

4B.5.2.4 Engineering and Costing

Facilities for this option are shown in Tables 4B.5-3 and 4B.5-4. For costing purposes in this study it is assumed that in Phase I potable water supply will be delivered to a point just north of the City of Taylor. In Phase II, delivery would be extended to a point between the Cities of Taylor and Georgetown.

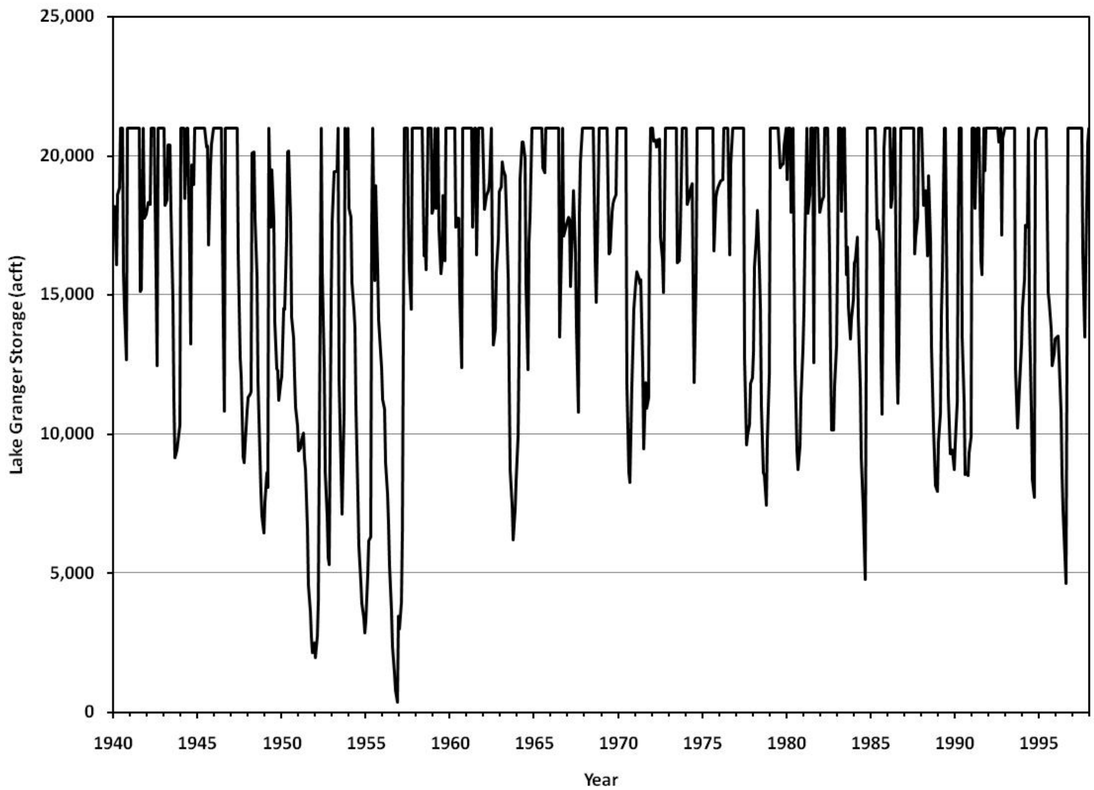

Figure 4B.5-2. Lake Granger Storage – 2060 Conditions

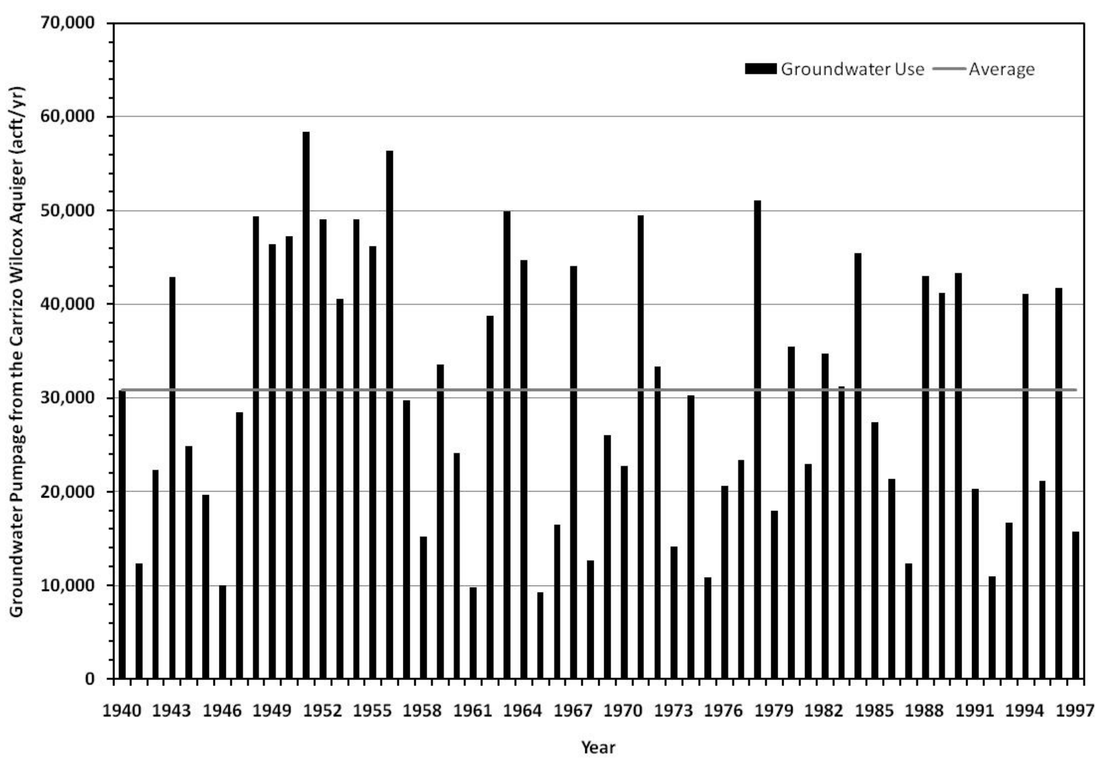

Figure 4B.5-3. Annual Carrizo-Wilcox Pumping – 2060 Conditions

Table 4B.5-2
Environmental Issues: Groundwater/Surface Water Conjunctive Use
(Lake Granger Augmentation)

Water Management Option	***Groundwater/Surface Water Conjunctive Use***
Implementation Measures	Construction of well fields, collection systems, pump stations, pipelines, and expansion of existing water treatment plant
Environmental Water Needs/Instream Flows	Possible impacts on instream flows
Bays and Estuaries	Negligible impact
Fish and Wildlife Habitat	Possible moderate impacts on riparian corridors and upland habitats depending on specific locations of pipelines
Cultural Resources	Possible low impact
Threatened and Endangered Species	Possible low impact
Comments	Assume institutional transfer agreements among water rights owners, suppliers, and users

For Phase I, the Trinity Aquifer well field is assumed to require six wells located near the EWCRWTP. Because there is little current use from Trinity Aquifer in this area, two test wells would be needed to verify productivity and water quality. Other facilities include a well field collection system, cooling towers (the water will most likely be hot), and expansions to the EWCRWTP. This option also requires construction of a new larger intake in Lake Granger, a new pump station and a 3.8-mile 48-inch raw water pipeline. The intake structure and raw water pipeline improvements are already underway by BRA, initially to replace an existing shallow-water intake structure that is subject to failure during both low lake conditions and high river flow events.

The total capital cost for Phase I is $77.6 million as shown in Table 4B.5-3. Additional costs for professional services, land acquisition, well mitigation, and interest during construction add $35.5 million for a total project cost of $113 million. Annual debt service on this principal amount, calculated on the basis of 6 percent interest for 20-year debt, is $9.9 million. Operation and maintenance costs for pumping, transmission, and treatment to deliver a total annual supply of 26,505 acft, added to the annual debt service, gives a total annual cost for the full project of $22.2 million. For Phase I, the unit cost of water is $838 per acft/yr or $2.57 per 1,000 gallons.

Table 4B.5-3.
Cost Estimate Summary for Phase I of Lake Granger Augmentation)
(2008 Prices)

Item	*Estimated Costs for Facilities*
Capital Costs	
Raw Water Intake & Pump Station	$10,710,000
Raw Water Pipeline (48 in. dia., 3.8 miles)	$6,365,000
Trinity Aquifer Well Field (6 wells)	$33,004,000
EWCRWTP Expansions (12.5 MGD)	$25,770,000
Transmission Pump Station(s)	$1,730,000
Total Capital Cost	**$77,579,000**
Engineering, Legal Costs and Contingencies	$27,949,000
Environmental & Archaeology Studies and Mitigation	$979,000
Land Acquisition and Surveying (37 acres)	$153,000
Interest During Construction (1.5 years)	$6,400,000
Total Project Cost	**$113,060,000**
Annual Costs	
Debt Service (6 percent, 20 years)	$9,857,000
Operation and Maintenance	$5,639,000
Pumping Energy Costs ($ 0.09/kW-hr)	$6,723,000
Annual Groundwater Permitting and Acquisition Cost[1]	$0
Total Annual Cost	**$22,219,000**
Available Project Yield (acft/yr)	26,505
Annual Cost of Water ($ per acft)	$838
Annual Cost of Water ($ per 1,000 gallons)	$2.57

[1] No groundwater conservation district exists in Williamson County and no permitting costs are anticipated.

Phase II will provide an additional 46,390 acft/yr of supply. The location of the well field for Phase II has not been identified. For the purposes of this study, it is assumed that the well field will be located in Milam County, although all or part of the required well field may be located in Burleson, Lee or other counties to the east of Williamson County. Carrizo-Wilcox groundwater will be gathered by a well-field collection system and transported by parallel 36-inch and 48-inch pipelines (built in phases) to a blending facility near the EWCRWTP. Customers such as Chisholm Trail Special Utility District, Georgetown or Round Rock would need to build treated water pipelines from the delivery point to their respective retail systems.

The Phase II total capital cost is $275.4 million as shown in Table 4B.5-4. Additional costs for professional services, land acquisition, well mitigation, and interest during construction add $255.5 million for a total project cost of $530.9 million. Annual debt service for the groundwater rights acquisition ($100 million) calculated at 6 percent for 30 years is estimated at $7.26 million. This cost reflects acquisition of real property, not leasing or purchase of groundwater rights. Debt service on the remaining project costs calculated at 6 percent for 20 years is $37.6 million. Annual costs for the new annual supply of 46,265 acft, including regulatory groundwater withdrawal fees and annual debt service gives a total annual cost for the full project of $68.7 million. For Phase II, the unit cost of water is $1,484 per acft/yr or $4.55 per 1,000 gallons.

Costs shown are for the BRA to develop the supply. Costs for customers to utilize this supply would include a system rate cost for purchase of raw water that is not shown here. Individual water management strategies for WUGs and WWPs that would utilize these supplies will include the unit costs shown here, which will be assumed to reflect the total purchase cost of the treated water supply.

4B.5.2.5 Implementation Issues

Early significant activity toward implementation of this alternative has been accomplished by the Brazos River Authority via its ownership of Lake Granger water supply, application for a systems operation permit, ownership of the existing water treatment plant on Lake Granger, and pursuit of nearby groundwater supplies. Developing a suitable approach to the evaluated level of groundwater pumping requires additional cooperative agreements with local groundwater districts and landowners.

Table 4B.5-4
Cost Estimate Summary for Phase II of Lake Granger Augmentation)
(2008 Prices)

Item	***Estimated Costs for Facilities***
Capital Costs	
Carrizo-Wilcox Well Field (30 wells)	$30,839,000
Pipeline from Well Field to EWCRWTP (36 & 48 in. dia. each 44 miles)	$116,907,000
Blending Facility	$18,521,000
EWCRWTP Expansions (83 MGD)	$76,065,000
Transmission Pump Station(s)	$30,882,000
Treated Water Storage	$2,202,000
Total Capital Cost	**$275,416,000**
Engineering, Legal Costs and Contingencies	$106,917,000
Environmental & Archaeology Studies and Mitigation	$3,421,000
Land and/or Groundwater Rights Acquisition[1]	$100,000,000
Land Acquisition and Surveying	$4,123,000
Interest During Construction (3 years)	$40,991,000
Total Project Cost	**$530,868,000**
Annual Costs	
Debt Service for Infrastructure (6 percent, 20 years)	$37,565,000
Debt Service for Groundwater Rights Acquisition (6 percent, 30 years)	$7,265,000
Operation and Maintenance	$16,769,000
Pumping Energy Costs (@ 0.09 $/kW-hr)	$5,531,000
Annual Groundwater Permitting Cost (Assumed $55 per acft)	$1,546,000
Total Annual Cost	**$68,676,000**
Available Project Yield (acft/yr)	46,265
Annual Cost of Water ($ per acft)	$1,484
Annual Cost of Water ($ per 1,000 gallons)	$4.55

[1] Cost estimate provided by the BRA as estimated to acquire real property necessary to secure underlying groundwater rights.

This water supply option has been compared to the plan development criteria, as shown in Table 4B.5-5.

Table 4B.5-5.
Comparison of Lake Granger Augmentation to Plan Development Criteria

Impact Category	*Comment(s)*
A. Water Supply	
1. Quantity	1. Sufficient to meet needs
2. Reliability	2. High
3. Cost	3. Reasonable
B. Environmental factors	
1. Environmental Water Needs	1. Low impact
2. Habitat	2. Low to moderate impact
3. Cultural Resources	3. Low impact
4. Bays and Estuaries	4. Low impact
5. Threatened and Endangered Species	5. Low impact
6. Wetlands	6. Low impact
C. Impact on Other State Water Resources	• No apparent negative impacts on state water resources; no effect on navigation
D. Threats to Agriculture and Natural Resources	• Low to none
E. Equitable Comparison of Strategies Deemed Feasible	• Option is considered to meet municipal and 'County-Other' shortages
F. Requirements for Interbasin Transfers	• Not applicable
G. Third Party Social and Economic Impacts from Voluntary Redistribution	• None

Requirements for permits to use surface water and groundwater, as well as for pipeline construction, will require permits as follow:

- Local groundwater district pumping permits as needed;
- TCEQ water rights permit (pending) for BRA System Operations (Phase II);
- U.S. Army Corps of Engineers Section 404 permits for pipeline stream crossings, discharges of fill into wetlands and waters of the U.S. for construction, and other activities;
- NPDES Stormwater Pollution Prevention Plans; and
- TP&WD Sand, Shell, Gravel, and Marl permit for construction in state-owned stream beds.

4B.5.3 Oak Creek Reservoir and Dockum Aquifer for City of Sweetwater

4B.5.3.1 Description of Option

The City of Sweetwater (Sweetwater) utilizes water supplies from the Oak Creek Reservoir in Coke County and the Champion Well Field. The wells are in the Dockum Aquifer in Nolan County. Prior to the drought beginning in 1998, the primary water supply was Oak Creek Reservoir and supplemental supplies from Lake Sweetwater, Lake Trammel and about eight wells in the Champion Well Field. Because of the 1998-2007 drought, the water supplies from the lakes diminished and finally disappeared. As a result, the City installed about 35 new wells to the Champion Well Field on an emergency basis. During the later part of the drought, groundwater from the Champion Well Field was the sole source of supply.

To assess the long-term groundwater supplies from the Champion Well Field and in the general vicinity, a study was conducted for the Brazos G Regional Water Planning Group by HDR Engineering, Inc. (HDR). This study was partly funded by the City of Sweetwater and consisted of: (1) developing a local groundwater model for western Nolan and eastern Mitchell Counties, (2) evaluating four potential groundwater pumping scenarios in the vicinity of the Champion Well Field with the groundwater model, and (3) evaluating the performance of wells in Champion Well Field.

Studies of Oak Creek Reservoir by Water Planning Groups in Region F and K have concluded that there is no firm yield for Sweetwater when considering existing senior downstream surface water rights. These studies have noted the feasibility of subordinating downsteam rights from Oak Creek Reservoir in the Colorado River Basin to increase local supplies.

The conjunctive management concept for Sweetwater is to use Oak Creek Reservoir as the primary water supply and Champion Well Field as the secondary water supply. Furthermore, the concept is to overdraft Oak Creek Reservoir when water is available, and to only use Champion Well Field for supplemental supplies, except when the reservoir's supplies become depleted from overdrafting or during severe droughts.

The locations of Champion Well Field, Oak Creek Reservoir and Sweetwater are shown in Figure 4B.5-4.

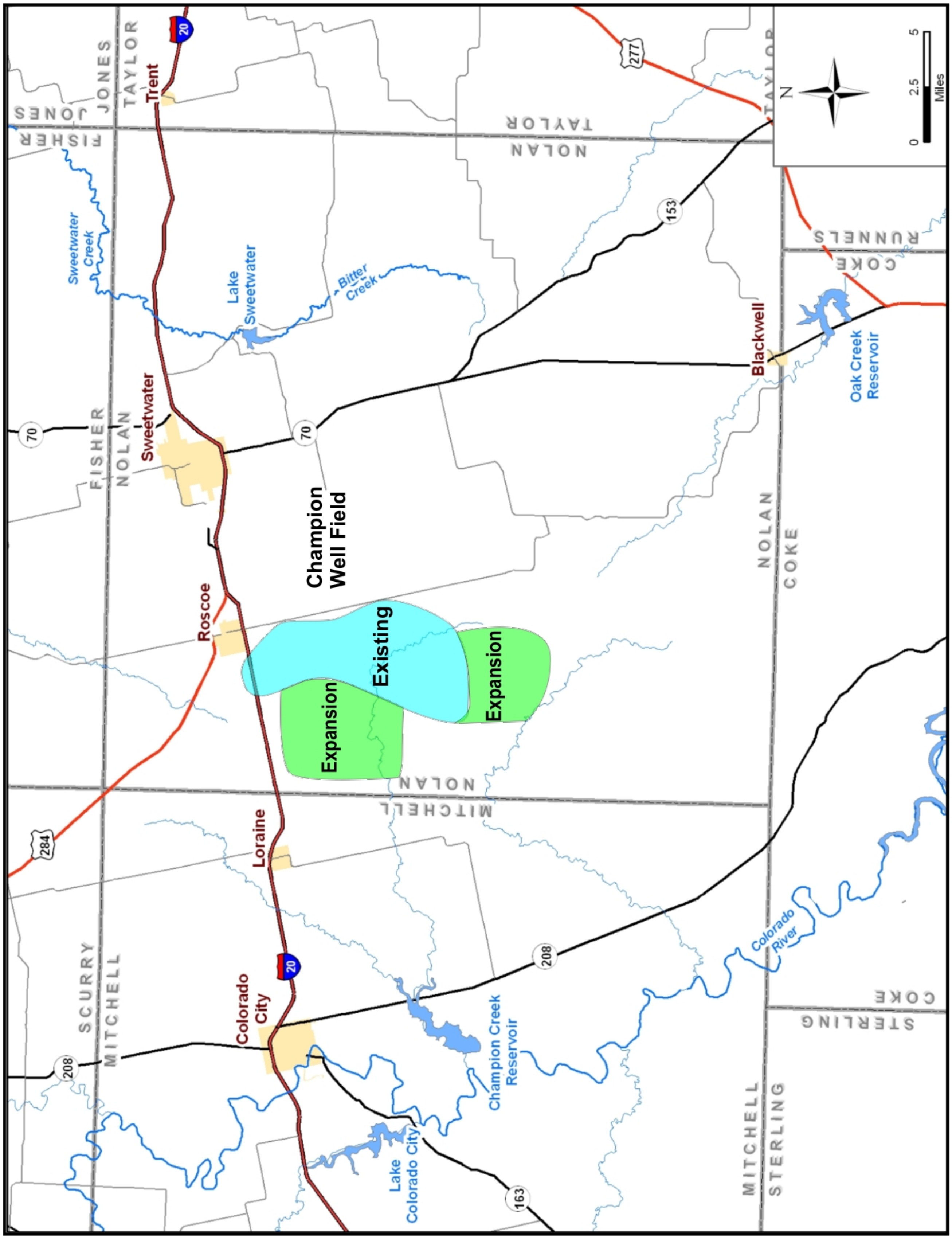

Figure 4B.5-4. Location of Champion Well Field

4B.5.3.2 Available Yield

A study utilizing the groundwater model developed for this study and well performance data from Sweetwater's production wells in the Champion Well Field suggests that: (1) the current well field could provide a long-term supply of about 2,000 acft/yr while allowing overdrafting by 2,500, 2,000 and 1,500 acft/yr for droughts lasting 1, 4, and 7 years respectively and (2) if the well field was expanded considerably to the south and west, the long-term supply would be about 3,000 acft/yr while allowing overdrafting by 3,500, 3,000 and 2,500 acft/yr for droughts lasting 1, 4 and 7 years respectively. An analysis of Sweetwater's demands and water supply contracts shows the peak demand during the planning period is 5,435 acft/yr in 2030 (Table C-52). A comparison of this demand with supplies from Champion Well Field shows that the existing well field is not capable of meeting this demand; however, the expanded well field could meet this demand for a 7-year drought. This 7-year drought is essentially equivalent to the duration of no yield from Oak Creek Reservoir recently experienced from 2001-2007.

At least three Water Availability Model (WAM) simulations have been made for the Oak Creek basin by consultants for Region F. They are called the Basin WAM, Run 3, and Mini-WAM. The first two simulations have a daily time step and end in 1998, thus they miss the apparent drought of record from 1998-2007. The Mini-WAM has monthly time intervals and ends in 2004. A comparison of the results of the Mini-WAM for Oak Creek Reservoir with historical results showed a reasonable match. For these reasons, the results from the Mini-WAM were used in this conjunctive use analysis.

A study was conducted to: (1) estimate the optimal maximum annual diversion rate from Oak Creek Reservoir and minimal annual pumping from Champion Well Field with a sensitivity analysis of a range of maximum annual diversion rates and (2) estimate the number of years when there is an insignificant amount of water in Oak Creek Reservoir for Sweetwater. The optimal diversion is a balance between maximizing the diversions from Oak Creek Reservoir, minimizing the amount of pumpage from Champion Well Field, and limiting the number of consecutive years when the Champion Well Field would need to be overdrafted. Figure 4B.5-6 shows the relationship between the maximum annual diversions from Oak Creek Reservoir and average annual diversions and pumpage. For this optimization, this figure shows maximum annual diversion from Oak Creek Reservoir would be about 3,300 acft/yr. Figure 4B.5-7 shows the relationship between the maximum annual diversions from Oak Creek Reservoir and the

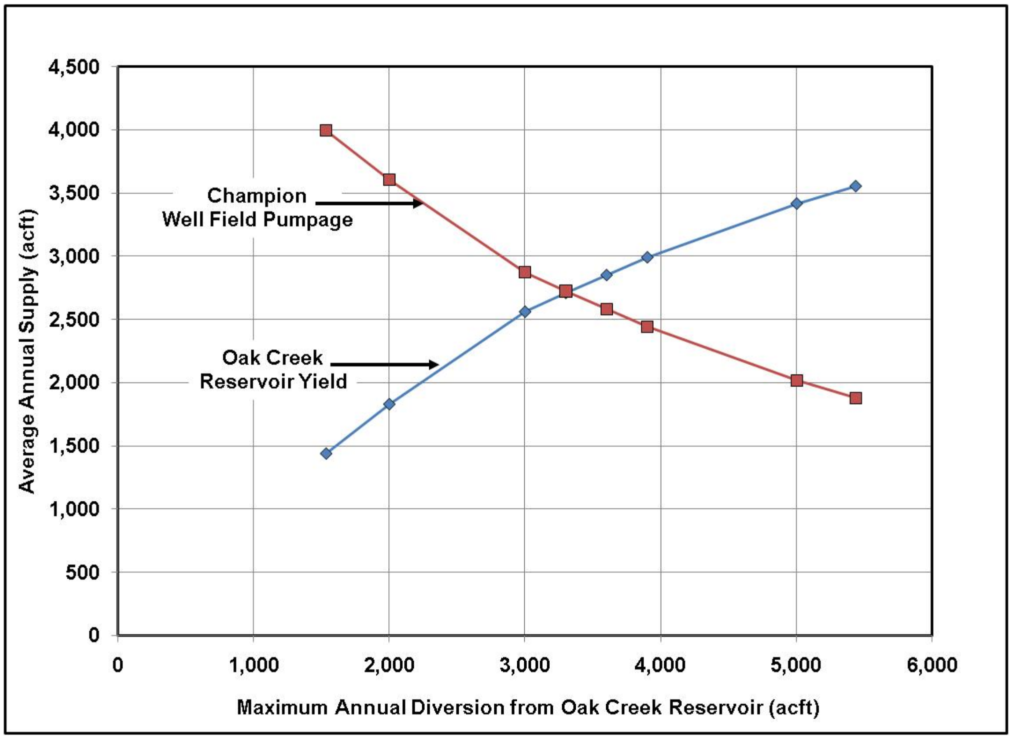

Figure 4B.5-6. Average Annual Oak Creek Reservoir Yield and Champion Well Field Pumpage with 1940-2007 Hydrologic Conditions

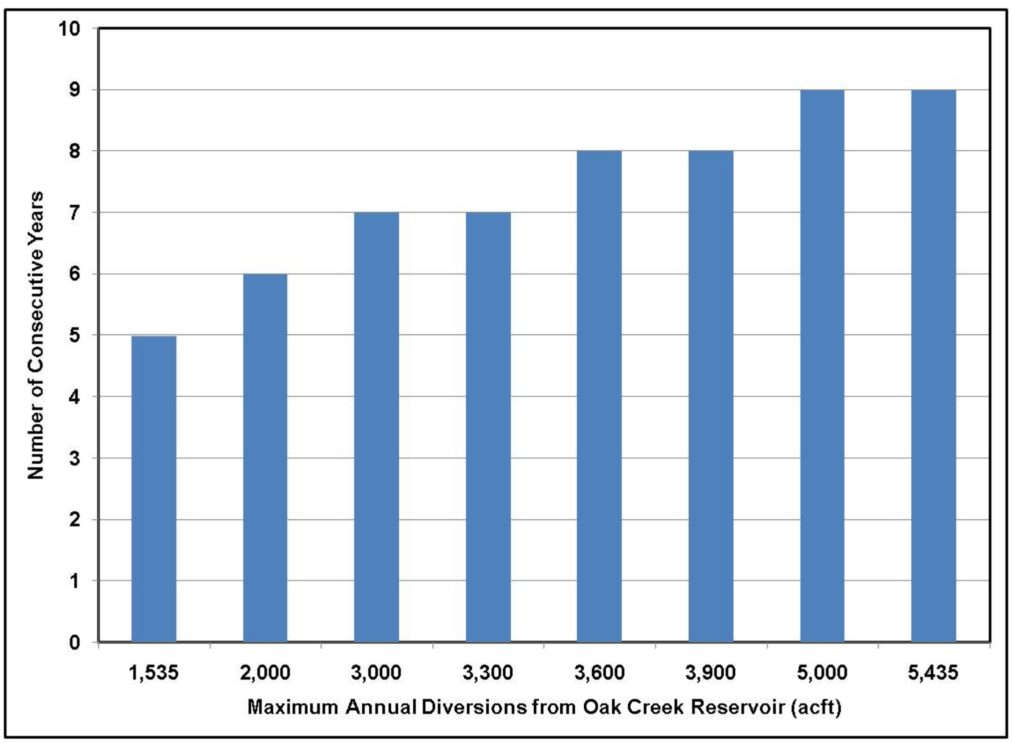

Figure 4B.5-7. Maximum Number of Consecutive Years with Little or No Supply from Oak Creek Reservoir with 1940-2007 Hydrologic Conditions

maximum number of consecutive years with little or no water supply from Oak Creek Reservoir. This figure shows a 7-year period of little or no water supply from Oak Creek when the maximum annual diversion rate is 3,000 and 3,300 acft/yr. This shortage can be accommodated by an expanded Champion Well Field. Figure 4B.5-8 shows the temporal distribution of annual diversions and annual pumpage for projected 2030 water demands. This figure shows that, by far, the worst drought condition for this conjunctive water management strategy since 1940 would have been for 2001-2007 conditions.

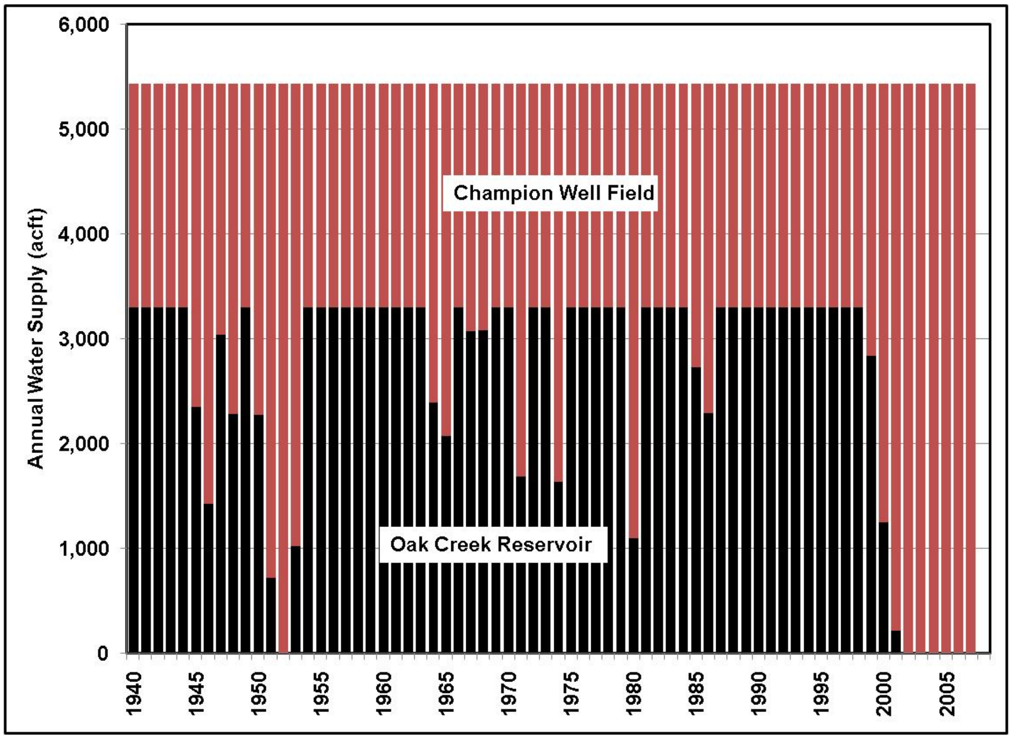

Figure 4B.5-8. Distribution of Water Sources for Sweetwater for 2030 Demands with 1940-2007 Hydrologic Conditions

4B.5.3.3 Environmental

Environmental impacts could include:

- Possible low impacts on instream flows due to slight decrease in groundwater discharges from the Dockum Aquifer; and
- A summary of environmental issues id presented in Table 4B.5-6.

Table 4B.5-6.
Summary of Environmental Impacts

Water Management Option	***Groundwater/Surface Water Conjunctive Use***
Implementation Measures	Construction of well field (26 wells) and collection pipeline (28-mile corridor)
Environmental Water Needs/Instream Flows	Possible very minor impacts on instream flows
Bays and Estuaries	Negligible impact
Fish and Wildlife Habitat	Possible very minor impacts on riparian corridors and upland habitats depending on specific locations of pipelines
Cultural Resources	Possible low impact
Threatened and Endangered Species	Possible low impact
Comments	Assumes subordination of water rights and purchase of groundwater leases

4B.5.3.4 Engineering and Costing

Based on the above analysis suggesting a withdrawal of 3,300 acft/yr from Oak Creek Reservoir when water is available, Champion Well Field would need to provide up to 5,345 acft/yr of water for 2030 demands and severe drought conditions. Assuming worst case conditions where these demands occur at the end of a 7-year drought, the existing wells in Champion Well Field would be capable of producing about 3,500 acft/yr (2,000 acft/yr while allowing an overdraft of 1,500 acft/yr during a 7-year drought) and a well field expansion would need to produce about 2,000 acft/yr for up to 7-years. With the existing and expanded well fields combined, the Champion Well Field capacity would be about 3,000 acft/yr while allowing for overdrafting of 3,500, 3,000 and 2,500 acft/yr for 1, 4, and 7 years, respectively. Thus, the capacity of the expansion to the Champion Well Field would be 1,000 acft/yr while allowing an overdraft of 1,000 acft/yr for up to 7 years. This analysis suggests that the well field expansion would result in a drought supply for this conjunctive management scenario of 2,000 acft/yr or 1.8 MGD. Allowing for peak seasonal demands, the expansion would need to have a capacity of about 3.6 MGD.

The average capacity of the new wells is estimated to be equivalent to the average capacity of the existing Champion Well Field wells, which is about 105 gallons per minute (gpm). Based on the expanded capacity requirements, the average well yield, and a contingency of about 10 percent, 26 new wells are needed. Water from the wells would be gathered by a 28-mile long well-field collection system and delivered to an existing ground storage tank and booster pump station within the existing Champion Well Field for transmission to Sweetwater for treatment and delivery to the distribution system.

For regional planning purposes, the new facilities include new wells and the collection pipelines. It's assumed that existing pump stations and pipelines for the delivery of this quantity of water and water treatment capacity are adequate for both Oak Creek Reservoir and Champion Well Field.

The total capital cost including wells, well-field collection system, and water system improvements is $9,993,000 as shown in Table 4B.5-7. The project costs, including capital and expenses for professional services, land acquisition, well mitigation, and interest during construction will be $15,015,000. Annual debt service on this principal amount, calculated on the basis of 6 percent interest for a 20-year loan is $1,309,000. Annual operation and maintenance costs for operating the well field, including groundwater leases at $50/acft, are $327,000. With a drought yield of 1,935 acft/yr, the unit cost of water is $849 per acft/yr or $2.61 per 1,000 gallons. If one considered the long-term average use of the well field expansion instead of drought conditions, the unit cost would be somewhat greater.

4B.5.3.5 Implementation Issues

Development of this water management strategy requires the subordination of the senior water rights that are downsteam of Oak Creek Reservoir and securing groundwater leases or property for wells. It would also require an engineering evaluation of the water transmission and water treatment facilities to accommodate the projected Brazos G demands for Sweetwater.

Requirements for permits to use groundwater, as well as for pipeline construction, will require permits as follow:

- Well construction and production permits from the Wes-Tex Groundwater Conservation District; and
- TCEQ approval for wells, water quality, and facilities.

Table 4B.5-7.
Cost Summary for Expansion of Champion Well Field
(September 2008 Prices)

Item	*Estimated Costs for Facilities*
Capital Costs	
Well Fields (26 wells) and Collection Pipelines (28 miles of 4-12 in-diameter)	$9,302,000
Water Treatment Plant	$0
Distribution	$691,000
Total Capital Cost	**$9,993,000**
Engineering, Legal Costs and Contingencies	$3,498,000
Environmental & Archaeology Studies and Mitigation	$726,000
Land Acquisition and Surveying (33 acres)	$220,000
Interest During Construction (1 years)	$578,000
Total Project Cost	**$15,015,000**
Annual Costs	
Debt Service (6 percent, 30 years)	$1,309,000
Operation and Maintenance	
Wells and Collector Pipeline	$100,000
Water Treatment Plant	$0
Pumping Energy Costs (1,520,360 kW-hr @ 0.09 $/kW-hr)	$137,000
Purchase of Water (1,935 acft/yr @ 50 $/acft)	$97,000
Total Annual Cost	**$1,643,000**
Available Project Yield (acft/yr)	1,935
Annual Cost of Water ($ per acft)	$849
Annual Cost of Water ($ per 1,000 gallons)	$2.61