

4B.15 Carrizo-Wilcox Aquifer Development

The development of the Carrizo-Wilcox Aquifer option involves pumping the aquifer and transporting the water to municipal and industrial users in Williamson and Brazos Counties. The required facilities for each of the two areas are a well field, pipelines, pump stations, and storage facilities. Water treatment to remove possible iron and manganese constituents would be required for the Williamson County option, while only disinfection and cooling would be required for Brazos County.

The Carrizo-Wilcox Aquifer System in Central Texas is capable of producing large quantities of fresh water from the Simsboro and Carrizo Formations.^{1,2} The aquifer is primarily used for domestic, livestock, public supplies, and some industrial purposes (mining and power plants). The largest municipal pumpage to date is from the Simsboro for public supply in the Bryan-College Station area, which began over 50 years ago. Other significant pumping is in Milam and Robertson Counties for mining and steam electric purposes and is also from the Simsboro. Water level changes experienced to date are mainly limited to artesian pressure declines in the vicinity of pumping centers. Little or no change in water tables in outcrop (recharge) areas has been observed.

Groundwater availability in the Brazos, Burleson, and Lee Counties is based on a potential consensus by representatives in GMA-12 area. A discussion on the revisions from the 2006 Plan is presented in a Memo to the Brazos G Regional Planning Ground on April 8, 2009. A comparison of the groundwater availability of the Carrizo-Wilcox Aquifer in the 2006 and 2011 Plans for the three counties is presented in Table 1.

Table 1.
Groundwater Availability in Carrizo-Wilcox Aquifer

County	2006 Plan	2011 Plan	Change (2011-2006)
Brazos	53,000	57,156	4,156
Burleson	44,000	35,482	-8,518
Lee	45,000	27,533	-17,467

¹ Thorkildsen, D. and Price, R. D., 1991, "Groundwater Resources of the Carrizo-Wilcox Aquifer in the Central Texas Region," Texas Water Development Board (TWDB) Report 332.

² Kelley, V.A., and others, 2004, "Groundwater Availability Models for the Queen City and Sparta Aquifers", prepared for Texas Water Development Board by Intera, Inc, The University of Texas Bureau of Economic Geology and R.J. Brandes Co.

According to the information from GMA-12 representatives, the 2011 availability in Lee County is sufficient to accommodate an 18,000 acft/yr project. In Burleson County, there is a supply of about 31,000 acft/yr. The availability in Brazos County considers the growth in demands for Bryan, College Station, Texas A&M, and other in-county demands. For purposes of the Williamson County strategy, about 22,000 acft/yr will come from Burleson County and about 13,000 acft/yr from Lee County. Accordingly, these new demands are consistent with the 2011 Plan groundwater availability estimates. Finally, any development must address the permitting requirements of wells and export of groundwater by the respective groundwater conservation districts (GCD).

Regulations on the development of groundwater and the export of groundwater have been established for Lee County by the Lost Pines GCD; Milam and Burleson Counties by the Post Oak Savannah GCD; and Brazos and Robertson Counties by the Brazos Valley GCD. Well spacing and export requirements are to be addressed in the permitting process.

4B.15.1 Williamson County

4B.15.1.1 Description of Option

This option is an alternative to the Lake Granger Conjunctive Use Project that is planned to meet Williamson County's shortfall from 2050 to 2060. This maximum shortfall is estimated to be 35,000 acft/yr. Groundwater from the Carrizo-Wilcox Aquifer from a well field crossing the Lee-Burleson County line would be supplied to Williamson County, including the cities of Georgetown, Hutto, Round Rock, and Weir, the utility districts of Chisholm Trail, Jerrell-Schwertner, and Jonah, and county-other and manufacturing. The option is presented at uniform delivery of 31.2 MGD and at a peak-day delivery of 62.4 MGD. For purposes of this assessment, peak day demand is assumed to be 2.0 times the average day demand. The location of the Williamson County Project is shown in Figure 4B.15-1.

4B.15.1.2 Available Yield

The proposed well field is southeast of the Mexia-Talco Fault Zone and about midway between the outcrops of the Carrizo Aquifer and the downdip extent of freshwater. At this location, large capacity wells can be developed in both the Simsboro and Carrizo Aquifers.

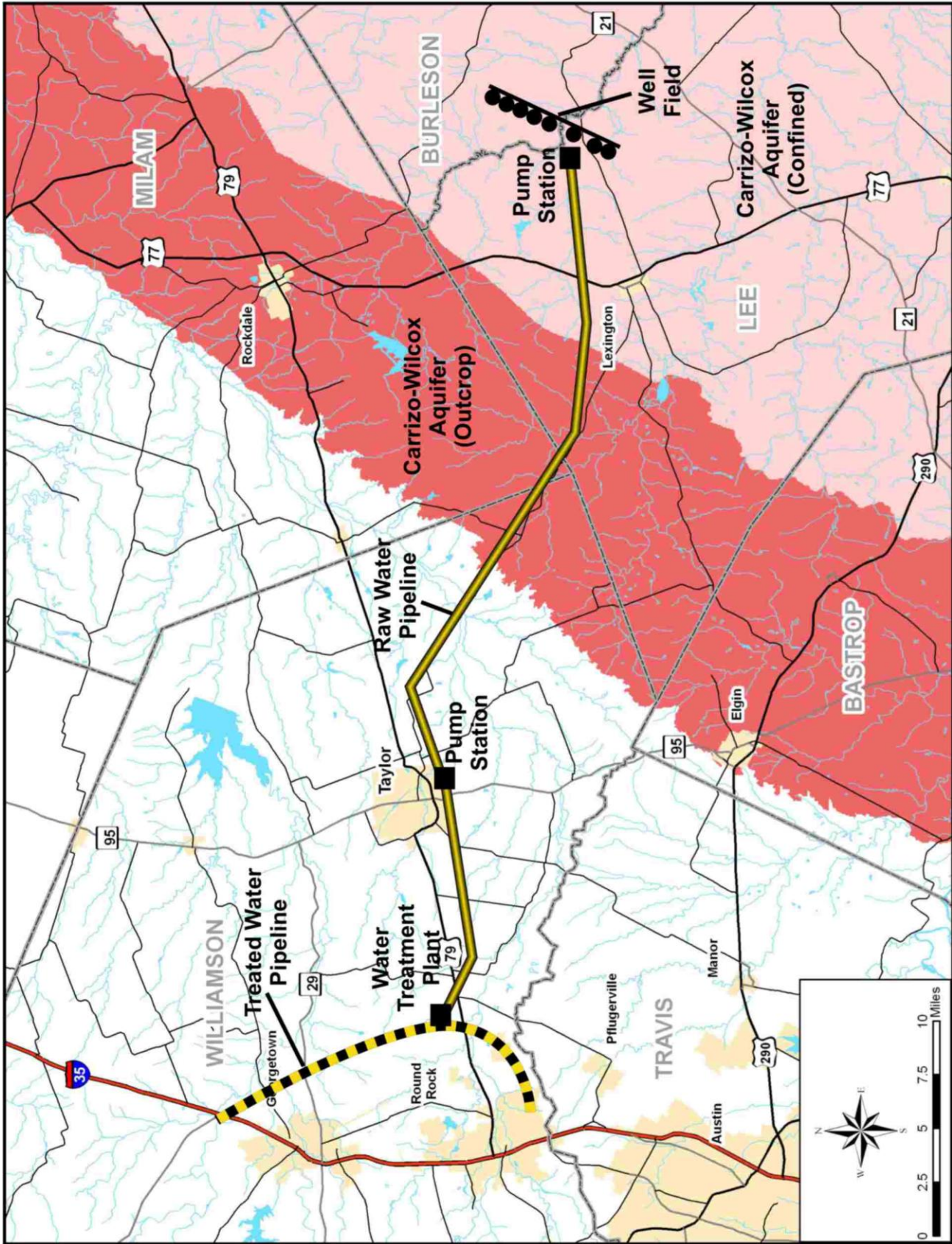


Figure 4B.15-1. Location of Carrizo-Wilcox Water Supply for Williamson County

Simsboro wells would be about 2,500 feet deep and are expected to yield 2,100 gpm. Carrizo wells would be about 900 feet deep and are expected to yield about 1,000 gpm. For a uniform delivery rate at 35,000 acft/yr (31.2 MGD), eight well yards consisting of a Simsboro well and a Carrizo well, producing at 4.4 MGD, are required for the design capacity and a 10 percent contingency. For a well field to meet the peak day demand of 62.4 MGD, 16 well yards would be required. The well yards would be spaced at about 3,000-foot intervals. About a third of the well field would be in Lee County and the remaining two-thirds would be in Burleson County, as shown in Figure 4B.15-1.

4B.15.1.3 Environmental Issues

New and/or expanded well fields in the Carrizo-Wilcox Aquifer in Lee and Burleson Counties, including storage facilities, pump stations and a 60-mile pipeline to Williamson County, and about 25 miles of treated water pipelines could possibly involve the following impacts:

- Impact on environmental water needs and instream flows over the Carrizo-Wilcox would possibly be low, if quantity withdrawn is relatively small. Potential increase in return flows to Brazos River. Base flows would decrease by less than 50 cfs across the outcrop in the Brazos River Basin from pumping of the full availability estimate.
- Possible low beneficial impact on bays and estuaries from increased return flows to Brazos River.
- Probable low impact on fish and wildlife habitat in general, including one amphibian and two plant species, all federally listed.
- Possible low impact on cultural resources.
- Unknown impacts of proposed well field on Houston toad habitat.
- Water level declines would be less than those estimated for pumping of full availability, as shown in Appendix B (Volume I).

4B.15.1.4 Engineering and Costing

The planned site of the well field is along a northeast-southwest line between US 77 and TX 36 and straddling the Lee-Burleson County line. A raw water pipeline would deliver the Carrizo and Simsboro water to a water treatment plant in Williamson County. From there, treated water pipelines would deliver water to individual water utilities.

The major facilities required are:

- Water Collection and Conveyance System:
 - Wells,
 - Pipelines,

- Pump Station, and
- Storage.
- Transmission System:
 - Storage,
 - Pipeline, and
 - Pump Station.
- Water Treatment:
 - Removal of iron and manganese concentrations may be required.

Two facility options are evaluated, one for a uniform delivery rate of 31.2 MGD and the other for a peak delivery rate of 62.4 MGD.

Cost estimates were computed for capital costs, annual debt service, operation and maintenance, power, land, and environmental mitigation for uniform and peak day delivery. These costs are summarized in Table 4B.15-1. Treatment costs are for removal of iron, manganese, and possibly hydrogen sulfide by aeration and/or oxidation and filtration. The project costs, including capital, are estimated to be \$145,721,000 and \$257,884,000 for the uniform and peak delivery options, respectively. As shown, the annual costs, including debt service, operation and maintenance, and power, are estimated to be \$29,475,000 and \$46,383,000 for the uniform and peak day options, respectively. This option produces potable water at an estimated cost of \$842 per acft (\$2.58 per 1,000 gallons) and \$1,325 per acft (\$4.07 per 1,000 gallons), respectively.

4B.15.1.5 Implementation Issues

This water supply option has been compared to the plan development criteria, as shown in Table 4B.15-2, and the option meets each criterion.

The development of additional groundwater in the Carrizo and Simsboro Aquifers in Lee and Burleson Counties must address several issues. Major issues include:

- Competition with others for groundwater in the area.
- Purchase of groundwater rights.
- Impact on water levels in the aquifer. Anticipated pumping is less than the water availability estimates, but significant water level declines may trigger reductions in production permits with the Lost Pines and Post Oak Savannah Groundwater Conservation Districts.

Table 4B.15-1.
Cost Estimate Summary
Carrizo-Wilcox: Williamson County Option
September 2008 Prices

<i>Item</i>	<i>Uniform Option</i>	<i>Peaking Option</i>
Capital Costs		
Transmission Pipeline	\$91,176,000	\$158,438,000
Transmission Pump Stations	\$18,908,000	\$27,348,000
Well Field and Collection Pipeline	\$28,884,000	\$60,191,000
Water Treatment Plant (Level 1)	\$6,753,000	\$11,907,000
Total Capital Cost	\$145,721,000	\$257,884,000
Engineering, Legal Costs and Contingencies	\$46,444,000	\$82,338,000
Environmental & Archaeology Studies and Mitigation	\$1,407,000	\$1,506,000
Land Acquisition and Surveying (308 acres)	\$2,763,000	\$2,878,000
Interest During Construction (2 years)	\$15,707,000	\$27,569,000
Total Project Cost	\$212,042,000	\$372,175,000
Annual Costs		
Debt Service (6 percent, 20 years)	\$18,487,000	\$32,448,000
Operation and Maintenance		
Intake, Pipeline, Pump Station	\$1,641,000	\$2,814,000
Water Treatment Plant	\$2,203,000	\$4,236,000
Pumping Energy Costs (\$0.09/kWh)	\$4,519,000	\$4,260,000
Purchase of Water (35,000 acft/yr @ \$75/acft)	\$2,625,000	\$2,625,000
Total Annual Cost	\$29,475,000	\$46,383,000
Available Project Yield (acft/yr)	35,000	35,000
Annual Cost of Water (\$ per acft)	\$842	\$1,325
Annual Cost of Water (\$ per 1,000 gallons)	\$2.58	\$4.07

**Table 4B.15-2.
Comparison of Carrizo-Wilcox:
Williamson County Option 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. Low to moderate
B. Environmental factors	
1. Environmental Water Needs	1. Low impact
2. Habitat	2. Low impact; possible affect on several species
3. Cultural Resources	3. Low impact
4. Bays and Estuaries	4. Negligible 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	• None
E. Equitable Comparison of Strategies Deemed Feasible	• Option is considered to meet municipal and industrial shortages
F. Requirements for Interbasin Transfers	• Not applicable
G. Third Party Social and Economic Impacts from Voluntary Redistribution	• None

The regulatory permits that are expected to be requirements specific to wells and pipelines include:

- Regulations and permits by the groundwater conservation districts (Lost Pines and Post Oak Savannah).
- U.S. Army Corps of Engineers Sections 10 and 404 dredge and fill permits for the pipelines impacting wetlands or navigable waters of the United States.
- General Land Office easement for use of state-owned land.
- Texas Parks and Wildlife Department Sand, Gravel, and Marl permit for construction in state-owned streambeds.

- Mitigation requirements would vary depending on impacts, but could include vegetation restoration, wetland creation or enhancement, or additional land acquisition.

4B.15.2 Brazos County

4B.15.2.1 Description of Option

This Carrizo-Wilcox development option for Bryan and College Station is planned to meet their need for additional water by expanding their Simsboro Aquifer well fields. This shortfall totals about 11,200 acft/yr by 2060. Groundwater from the Simsboro Aquifer, which is the main water-bearing zone of the Wilcox Formation, would come from a well field in the extreme western part of the county (Figure 4B.15-2).

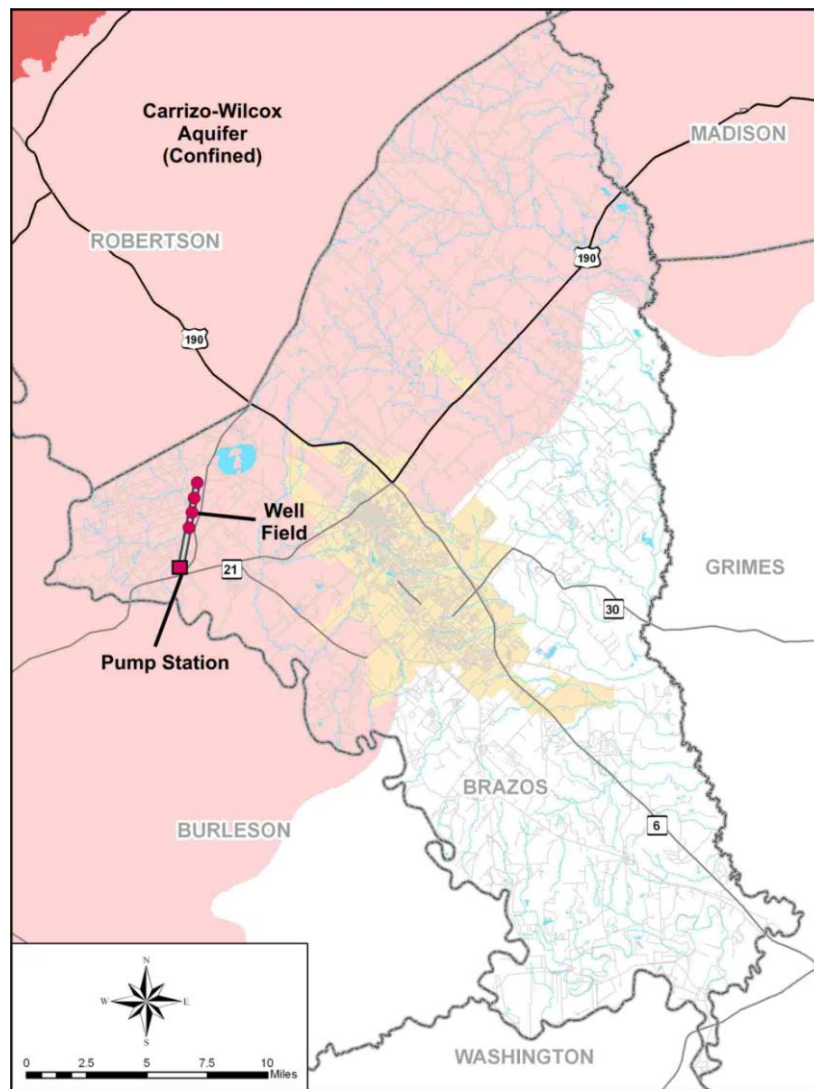


Figure 4B.15-2. Location of Carrizo-Wilcox Water Supply for Brazos County

The option is presented at two delivery capacities. One is for a uniform delivery of water and the other is sized to meet peak day demands. For purposes of this assessment, peak day demand is 2.0 times the average day demand.

4B.15.2.2 Available Yield

Previous studies^{3,4} and the ones conducted for Brazos G indicate that this quantity of water from the Simsboro part of the Carrizo-Wilcox Aquifer is available for development. In this area, Simsboro wells average 2,800 feet in depth and commonly yield 2,100 gpm. For planning purposes, the maximum annual production of water from the Brazos County well field is 11,200 acft/yr. For the uniform water delivery option, five wells would be required when considering a contingency of one well. A well field sized to provide a peak day delivery rate would require a peak production rate of 20.0 MGD. This demand would require eight wells. The estimated well spacing would be similar to existing wells in the area (i.e., 2,000 to 2,500 feet). The location of the proposed well field is in Brazos County and is shown in Figure 4B.15-2.

4B.15.2.3 Environmental Issues

New and/or expanded well fields in the Carrizo-Wilcox Aquifer in Brazos Counties, include wells, storage facilities, pump stations and a 3-mile pipeline to existing or planned pipelines. This development is expected to have the following environmental impacts:

- Impact on environmental water needs and instream flows over the Carrizo-Wilcox would possibly be low. Potential increase in return flows to Brazos River downstream of Bryan-College Station. Base flows would decrease by less than 50 cfs across the outcrop in the Brazos Basin from pumping at the full estimated availability.
- Possible low beneficial impact on bays and estuaries from increased return flows to Brazos River.
- Probable low impact on fish and wildlife habitat in general, including one amphibian and two plant species, all federally listed.
- Possible low impact on cultural resources.
- Water level declines would be less than those estimated for pumping of full availability, as shown in Appendix B (Volume I).

³ Thorkildsen, D. and R.D. Price, Op. Cit., 1991.

⁴ Muller, D.A. and R.D. Price, Op. Cit., 1979.

4B.15.2.4 Engineering and Costing

For the Brazos County option, groundwater would be developed from a well field along a north-south line about 5 miles west of Bryan. Water treatment would require cooling and disinfection. The location is subject to adjustment, due to future expansions of adjoining well fields.

The major facilities required for these options are:

- Wells,
- Pipelines,
- Storage,
- Booster Station, and
- Water Treatment Plant.

These facilities are designed for a uniform delivery rate of 10.0 MGD and a peak delivery rate of 20.0 MGD. The approximate location of these facilities is shown in Figure 4B.15-2.

Estimates were prepared for capital costs, annual debt service, operation and maintenance, water purchases, power, land, and environmental mitigation. These costs are summarized in Table 4B.15-3. The project costs, including capital, are estimated to be \$28,101,000 and \$51,856,000 for the uniform and peak delivery options, respectively. The annual costs, including debt service, operation and maintenance, and power, are estimated to be \$4,410,000 and \$7,270,000 for base and peak options, respectively. This water management option produces water at estimated costs of \$394 and \$649 per acft for base and peak options, respectively.

4B.15.2.5 Implementation Issues

The development of additional groundwater in the Carrizo and Simsboro Aquifers in Brazos County must address several issues, including:

- Impact on water levels in the aquifer. Anticipated pumping in combination with current supplies is less than the water availability estimates presented in Section 3.4 and Appendix B, and water level declines would be less than those projected under a full availability analysis.
- Possibly purchase of groundwater rights.
- Competition with others for groundwater in the area.
- Regulations and permits by the Brazos Valley Groundwater Conservation District.

- Mitigation requirements would vary depending on impacts, but could include vegetation restoration, wetland creation or enhancement, or additional land acquisition.

This water supply option has been compared to the plan development criteria, as shown in Table 4B.15.2-4, and the option meets each criterion.

**Table 4B.15-3.
Cost Estimate Summary
Carrizo-Wilcox Well Field: Brazos County Option
September 2008 Prices**

<i>Item</i>	<i>Uniform Option</i>	<i>Peaking Option</i>
Capital Costs		
Transmission Pipeline	\$2,306,000	\$3,623,000
Transmission Pump Stations	\$3,996,000	\$6,025,000
Well Field and Collection Pipeline	\$10,196,000	\$21,967,000
Water Treatment Plant (Level 1)	\$3,357,000	\$4,955,000
Total Capital Cost	\$19,855,000	\$36,570,000
Engineering, Legal Costs and Contingencies	\$6,834,000	\$12,618,000
Environmental & Archaeology Studies and Mitigation	\$111,000	\$158,000
Land Acquisition and Surveying (308 acres)	\$220,000	\$515,000
Interest During Construction (2 years)	\$1,081,000	\$1,995,000
Total Project Cost	\$28,101,000	\$51,856,000
Annual Costs		
Debt Service (6 percent, 20 years)	\$2,450,000	\$4,521,000
Operation and Maintenance		
Intake, Pipeline, Pump Station	\$218,000	\$395,000
Water Treatment Plant	\$895,000	\$1,510,000
Pumping Energy Costs (\$0.09/kWh)	\$847,000	\$844,000
Total Annual Cost	\$4,410,000	\$7,270,000
Available Project Yield (acft/yr)	11,200	11,200
Annual Cost of Water (\$ per acft)	\$394	\$649
Annual Cost of Water (\$ per 1,000 gallons)	\$1.21	\$1.99

**Table 4B.15-4.
Comparison of Carrizo-Wilcox:
Brazos County Option to Plan Development Criteria**

Impact Category	Comment(s)
A. Water Supply 1. Quantity 2. Reliability 3. Cost	1. Sufficient to meet needs 2. High reliability 3. Low to moderate
B. Environmental factors 1. Environmental Water Needs 2. Habitat 3. Cultural Resources 4. Bays and Estuaries 5. Threatened and Endangered Species 6. Wetlands	1. Low impact 2. Low impact; possible affect on one endangered species 3. Low impact 4. Negligible impact 5. Low impact 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	• None
E. Equitable Comparison of Strategies Deemed Feasible	• Option is considered to meet municipal and industrial shortages
F. Requirements for Interbasin Transfers	• Not applicable
G. Third Party Social and Economic Impacts from Voluntary Redistribution	• None