4B.6 Desalination

4B.6.1 Description of Options

Water demands in Johnson County are increasing at a very significant rate, while the existing supply from the Surface Water and Treatment System (SWATS) water treatment plant at Lake Granbury is near operational capacity, and withdrawals from the Trinity Aquifer are substantially exceeding its estimated long-term capacity. Two desalination options are being considered for Johnson County to meet part or all of these demands. These options are treating and delivering: (1) additional brackish surface water from Lake Granbury and (2) fresh to brackish groundwater from the Woodbine and Paluxy Aquifers in the northeastern part of the county. The surface water desalination project expands the potable water supply from Lake Granbury to most all major water utilities in the county. The groundwater desalination project is an option to treat and blend groundwater from the Paluxy and Woodbine Aquifers and is considered for the northeastern part of the county.

4B.6.2 Desalination of Lake Granbury Water for Johnson County Regional Plan

4B.6.2.1 Description of Option

In the mid-1980s, the population growth of Johnson County was projected to result in water demands that would exceed available supplies. One largely unused supply was Lake Granbury, which impounds slightly saline (brackish) water. A study of alternatives determined if it would be feasible to install a desalination plant on the lake, using either electrodialysis reversal (EDR) or reverse osmosis (RO) technology. The initial design and construction of the SWATS plant followed for a 3.5 MGD first phase of an ultimate 26 MGD system of a coupled conventional and desalination water treatment plant located on the shore of Lake Granbury. This capacity was increased to 15 MGD. Within the last few years, water demands have increased to the point that an expansion of this plant is being considered in the near future.

Currently, the BRA operates the SWATS plant near Lake Granbury to serve four wholesale customers. Johnson County Special Utility District, and City of Keene are in Johnson County, while Acton Municipal Utility District and the City of Granbury are in Hood County.

Most municipal water user groups in Johnson County are projected to be water short by 2060. The three greatest shortages are: Johnson County Special Utility District (16,664 acft/yr), Bethesda WSC (3,660 acft/yr), and City of Cleburne (1,954 acft/yr). The City of Burleson is not

included because its water supply is expected to come from the Tarrant Regional Water District (TRWD). The combined municipal shortage for Johnson County in 2060, excluding Burleson, is about 23,600 acft/yr. Using a peaking factor of 2.0, the additional system capacity needed is 42 MGD.

Recognizing the substantial future water shortage in Johnson and Parker Counties, the Brazos River Authority (BRA) and the TRWD conducted a cooperative study[1] to explore the feasibility of developing regional facilities to help meet the growing water supply needs. For purposes of this plan, their option to expand SWATS (Scenario #1) is adjusted for this Brazos G option. Scenario #1 considered an expansion (new facilities that largely parallel the existing facilities) of an average of 15 MGD in 2020 and an additional expansion of 30 MGD in 2060, for a total of 45 MGD. In other units, Scenario # 1 provides an average water supply at build-out of 50,400 acft/yr and a peaking capacity of 90 MGD. For purposes of this analysis, the surface water desalination project is intended to meet Johnson County's long-term shortage of about 23,600 acft/yr.

Figure 4B.6-1 shows the locations of the existing SWAT facilities and pipelines planned for this option.

4B.6.2.2 Available Yield

In addition to current BRA supply at Lake Granbury, the expanded SWATS regional system could utilize additional raw water supplies from one or more of several possible sources: purchase of water from an entity that has unused supply (such as Luminant); enhancement of yield from an existing source, such as reallocation of storage at Lake Whitney; BRA System Operations; or negotiating a water trade among BRA customers to make additional water available in Lake Granbury.

[1] Freese and Nichols, Inc., "Regional Water Supply and Wastewater Service Study for Johnson and Parker Counties, Phase I," prepared for Brazos River Authority and Tarrant Regional Water District, April 2004.

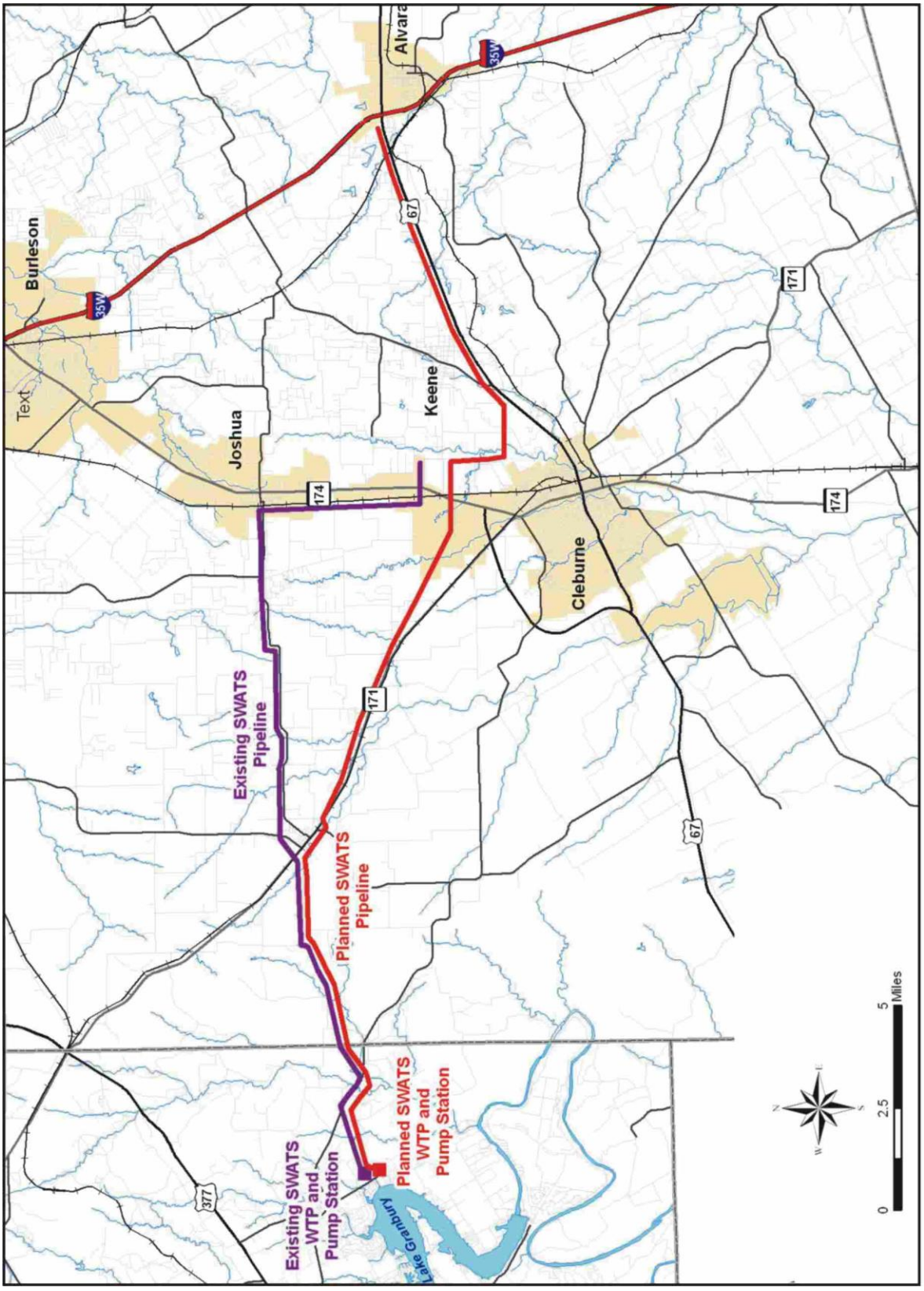

Figure 4B.6-1. Existing and Planned Facilities for SWATS Expansion in Johnson County

4B.6.2.3 Environmental Issues

The construction of a water supply project to supply water from Lake Granbury to Johnson County would involve relatively low environmental impacts:

- Reduced flows in the Brazos River below Lake Granbury could have a low impact on environmental water needs and instream flows.
- Pipeline construction effects on fish and wildlife habitat at creek and river crossings and on cultural resources would be low if inside existing highway right-of-way, possibly moderate if outside right-of-way.
- Brine disposal through blending of brine concentrate effluent would have possibly low impacts on Lake Granbury and other receiving streams.

4B.6.2.4 Engineering and Costing

The facilities needed to provide water for the long-term projected shortages in Johnson County by the Lake Granbury desalination project are:

- New raw water intake structure at Lake Granbury;
- Expanded SWATS water treatment plant (EDR or RO process preceded by a conventional water treatment plant);
- Treated water pump stations; and
- Water transmission pipelines to receiving entities.

The raw water intake, water treatment facilities, pump station, and transmission pipelines are all designed to be peaking facilities with a 50 MGD capacity and an average of delivery rate of 28,000 acft per year.

For purposes of this plan, the cooperative study's Scenario #1, which is an expansion of SWATS and delivery facilities, is adjusted for this Brazos G Lake Granbury desalination option. In developing the cost estimates for this option, the cost estimates for the Scenario #1 in the cooperative study were used as a basis and adjusted by reducing the capacity from 90 MGD to 50 MGD and updating costs to September 2008, as per regional water planning guidelines. Table 4B.6-1 summarizes the cost estimates for this water supply option. As shown in the table, the total project cost for the Lake Granbury Supply to Johnson County project is estimated to be $101,119,000, resulting in a unit cost of $932 per acft or $2.86 per 1,000 gallons. These costs include the purchase of raw water at the current BRA system price. Of importance, these costs are based on full utilization of the facility which does not occur until 2060. In the interim, with year 2030 as an example, the Johnson County shortage is estimated to be about 5,850 acft/yr. At

this level of utilization, after debt service has been paid, the unit cost of water from these customers would be about $2,991 acft/yr or $9.18 per 1,000 gallons.

Table 4B.6-1.
Cost Estimate Summary
Lake Granbury Supply to Johnson County
September 2008 Prices

Item	*Estimated Costs for Facilities*
Capital Costs	
Intake and Pump Station (50 MGD)	$671,000
Transmission Pipeline (60 in dia., 0 miles)	$23,593,000
Transmission Pump Station(s)	$5,166,000
Water Treatment Plant (50 MGD)	$40,296,000
Total Capital Cost	**$69,726,000**
Engineering, Legal Costs and Contingencies	$23,224,000
Environmental & Archaeology Studies and Mitigation	$1,083,000
Land Acquisition and Surveying	$1,509,000
Interest During Construction	$5,577,000
Total Project Cost	**$101,119,000**
Annual Costs	
Debt Service (6 percent, 30 years)	$8,590,000
Operation and Maintenance	
Intake, Pipeline, Pump Station	$382,000
Water Treatment Plant	$12,340,000
Pumping Energy Costs (36,133,333 kW-hr @ 0.09 $/kW-hr)	$3,252,000
Purchase of Water (28,000 acft/yr @ 54.5 $/acft)	$1,526,000
Total Annual Cost	**$26,090,000**
Available Project Yield (acft/yr)	28,000
Annual Cost of Water ($ per acft)	$932
Annual Cost of Water ($ per 1,000 gallons)	$2.86

4B.6.2.5 Implementation

The Lake Granbury water supply option has been compared to the plan development criteria, as shown in Table 4B.6-2, and the option meets each criterion.

Implementation will require these steps, in addition to development of the necessary supply from the BRA.

1. It will be necessary to obtain these permits:
   a. U.S. Army Corps of Engineers Sections 10 and 404 dredge and fill permits for stream crossings
   b. General Land Office Sand and Gravel Removal Permits
   c. Texas Parks and Wildlife Department Sand, Gravel and Marl permit for river crossings
2. Right-of-Way and easement acquisition.
3. Crossings
   a. Highways and Railroads
   b. Creeks and Rivers
   c. Other Utilities
4. Financing
   a. Sponsoring entity must be identified and be able to incur debt to finance project.
   b. Participating entities must negotiate water purchase contract with BRA and establish rate structure.

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

- U.S. Army Corps of Engineers Section 404 permit(s) for pipeline stream crossings; discharges of fill into wetlands and waters of the United States for pond construction; and other activities;
- National Pollutant Discharge Elimination System Storm Water Pollution Prevention Plan;
- Texas Parks and Wildlife Department Sand, Shell, Gravel and Marl permit for construction in state-owned streambed.

Table 4B.6-2.
Comparison of Lake Granbury Supply to Johnson 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. High in the short-term and moderate in the long-term
B. Environmental factors	
1. Environmental Water Needs	1. Low impact
2. Habitat	2. Low 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 industrial shortages
F. Requirements for Interbasin Transfers	• Not applicable
G. Third Party Social and Economic Impacts from Voluntary Redistribution	• None

4B.6.3 Brackish Groundwater Desalination for Northeast Johnson County

4B.6.3.1 Description of Option

This water supply option is targeted for the extreme northeastern part of Johnson County, as shown in Figure 4B.6-2. This option evaluates the use of groundwater from the Woodbine and Paluxy Aquifers[2,3,4,5] that ranges in salinity from fresh to brackish. Figure 4B.6-3 is a schematic of a hydrogeologic cross-section. In the target area, the Woodbine Aquifer is relatively shallow and confined. Wells are about 200 to 400 feet deep and produce about 75 gallons per minute (gpm). TWDB water quality data show very high concentrations of iron and manganese, which requires removal. Data on salinity indicate most wells have concentrations of total dissolved solids (TDS) concentration of 500 to 1,000 milligrams per Liter (mg/L). However, some wells have concentrations ranging up to 2,000 mg/L. Data from wells with multiple samples indicate that water quality can vary considerably over time. The underlying Paluxy Aquifer, which is the upper water-bearing zone of the Trinity Aquifer, is confined and well depths are expected to range from 800 to 900 feet. The capacity of high capacity wells is expected to be about 100 gpm. TWDB water quality data indicate that the water has moderate iron and manganese concentrations. The concentrations of TDS typically range from 500 to 1,000 mg/L; however, some samples indicate concentrations up to 1,200 mg/L.

4B.6.3.2 Available Yield

For Johnson County as a whole, the current withdrawals substantially exceed the estimated groundwater availability from the Trinity Aquifer. However, most of this pumpage is from the deep, most productive water-bearing units (Hensell and Hosston) and in the central and eastern parts of the county. Of considerable importance, the Paluxy Aquifer in this area is seldom used because higher yielding wells can be obtained in the deeper Hensell and Hosston and shallower supplies are available in the overlying Woodbine. For the Woodbine Aquifer, current

[2] Thompson, G.L., 1969, Ground-water resources in Johnson County, Texas: Texas Water Development Board Report 94.
[3] Klemt, W.B. and others, Ground-water resources of Part of Central Texas with Emphasis on the Antlers and Travis Peak Formations: Texas Water Development Board Report 195, v. I and II.
[4] Nordstrom, P.L., Occurrence, Availability, and Chemical Quality of Ground Water in the Cretaceous Aquifers of North-Central Texas: Texas Water Development Board Report 269, v. I and II.
[5] R.W. Harden & Associates, Inc., 2004, Northern Trinity/Woodbine Aquifer Groundwater Availability Model: Texas Water Development Board Contract Report

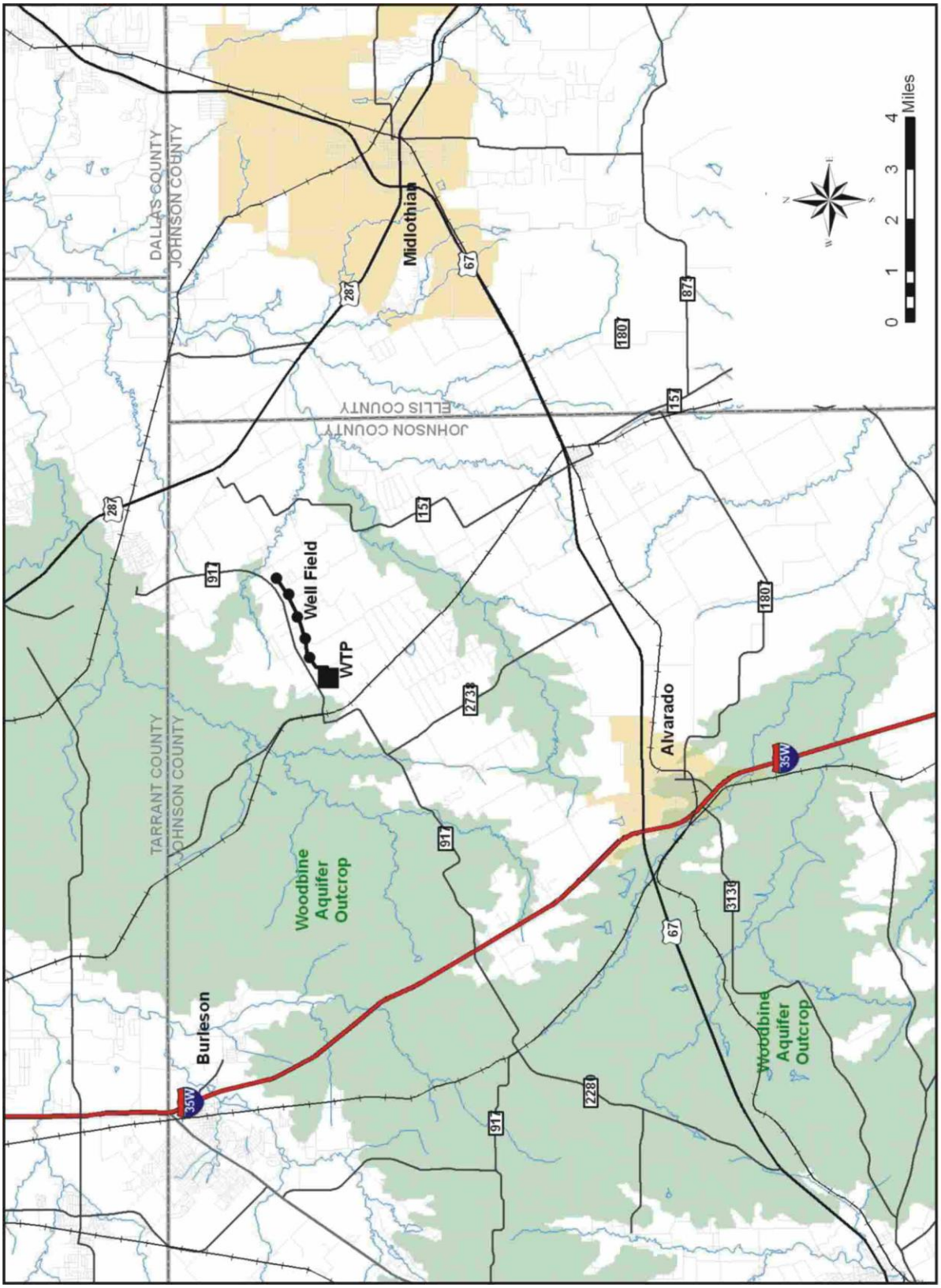

Figure 4B.6-2. Brackish Groundwater Desalination Option for Northeast Johnson County

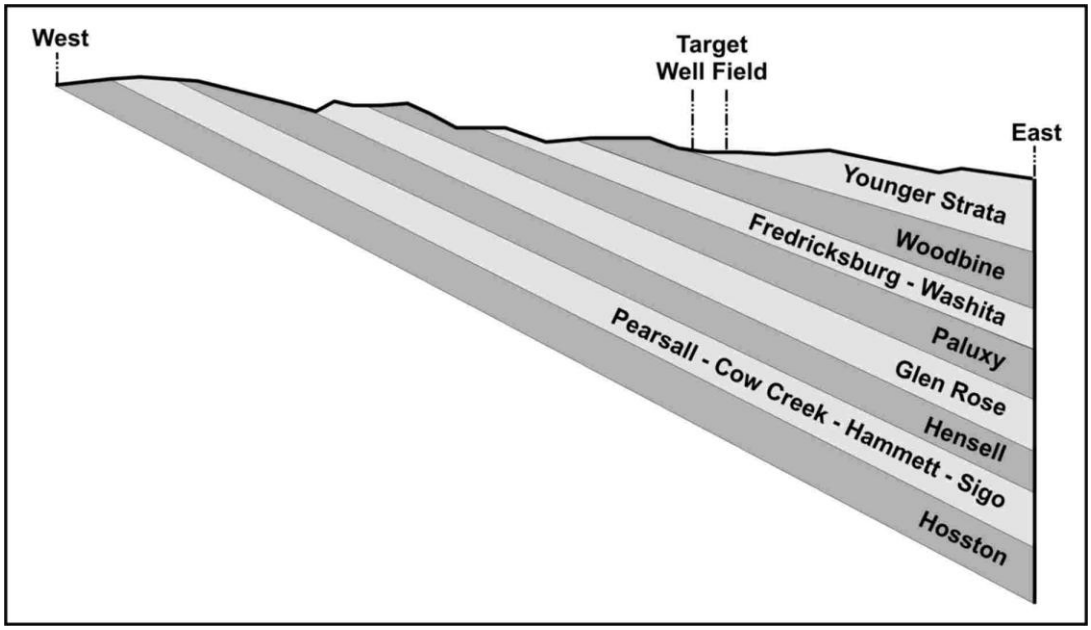

Figure 4B.6-3. Hydrogeologic Cross-Section

groundwater withdrawals are made by both local users and by distant water utilities. The planned well field is relatively close to the outcrop of the Woodbine area. Pumpage of an average 0.4 MGD from the Woodbine wells and 0.6 MGD from the Paluxy wells are not expected to significantly impact the other wells.

4B.6.3.3 Environmental Issues

The development of wells in the Paluxy and Woodbine Aquifers and the construction of wells, collector pipelines, and water treatment facilities would involve relatively low environmental impacts:

- Drawdown from wells is expected to have little or no effect on discharge to Walnut Creek or Mountain Creek.
- Construction of pipelines, wells and water treatment facilities would have little or no effect on wildlife habitat and would be in existing rights-of-way or in disturbed areas. No streams or wetlands are expected to be encountered.
- No brine concentration is expected to be produced.

4B.6.3.4 Engineering and Costing

For preliminary design, a Woodbine well and a Paluxy well would be constructed in a well yard and have a combined yield of 175 gpm. To provide a peak capacity of 1.0 MGD, five Woodbine and five Paluxy wells are needed. The planned site of the well field and water

treatment plant is along Farm Road 917 and between the town of Lillian and the Johnson-Ellis County line. Five well yards are required and would be spaced about a half mile apart. Well depths are estimated to be about 300 and 800 feet for the Woodbine and Paluxy, respectively. The water treatment facility will be designed to remove the high iron and manganese concentrations and to blend water from the 10 wells producing brackish water and with other water in the distribution system. Thus, no desalination treatment or disposal of brine concentrate is expected to be required. The water treatment plant is planned to be located next to existing water mains and only limited water transmission and interconnect facilities are required.

The major facilities required are:

- Water Collection and Conveyance System:
  - Wells,
  - Pipelines from well fields to treatment plant,
  - Pump Station, and
  - Storage.
- Water Treatment:
  - Removal of iron and manganese concentrations, and
  - Blending of water from wells and from existing water distribution system.

Cost estimates are based on a peak capacity of 1.0 MGD with an average delivery of 560 acft/yr. These estimates include capital costs, annual debt service, operation and maintenance, power, land, and environmental mitigation for peak day delivery and are summarized in Table 4B.6-3. Water treatment costs are for removal of iron and manganese, filtration, blending, and disinfection. As shown, the project cost is estimated to be $5,683,000; and the annual costs, including debt service, operation and maintenance, and power, are estimated to be $731,000. This option produces potable water at an estimated cost of $1,305 per acft ($4.01 per 1,000 gallons).

4B.6.3.5 Implementation

The brackish groundwater supply option for northeast Johnson County has been compared to the plan development criteria, as shown in Table 4B.6-4, and the option meets each criterion.

Implementation will require these steps:

1. Acquisition of groundwater rights;
2. Right-of-way and easement for wells, pipelines, and water treatment plant; and
3. Financing and operations by a sponsoring entity, who must be identified.

Table 4B.6-3.
Cost Estimate Summary
Water Supply Project Option (Sept 2008 Prices)
Northeast Johnson County: Paluxy and Woodbine Wells, Blend with Other Water

Item	*Estimated Costs for Facilities*
Capital Costs	
Treated Water Transmission and Interconnect (12 in, 500 ft)	$597,000
Water Wells (5 Paluxy and 5 Woodbine)	$2,188,000
Well Field Collector Pipeline (8-12 in, 2 mi)	$303,000
Water Treatment Plants (Pretreatment Only)	$807,000
Total Capital Cost	**$3,895,000**
Engineering, Legal Costs and Contingencies	$1,362,000
Environmental & Archaeology Studies and Mitigation	$94,000
Land Acquisition and Surveying (32 acres)	$113,000
Interest During Construction (1 years)	$219,000
Total Project Cost	**$5,683,000**
Annual Costs	
Debt Service (6 percent, 20 years)	$495,000
Operation and Maintenance	
Wells, Pipeline, Pump Station	$36,000
Water Treatment Plant	$161,000
Pumping Energy Costs (438810 kW-hr @ 0.09 $/kW-hr)	$39,000
Purchase of Water and Groundwater District Fees	$0
Total Annual Cost	**$731,000**
Available Project Yield (acft/yr)	560
Annual Cost of Water ($ per acft)	$1,305
Annual Cost of Water ($ per 1,000 gallons)	$4.01

Table 4B.6-4.
Comparison of Brackish Groundwater Option in Northeast Johnson County to Plan Development Criteria

Impact Category	*Comment(s)*
A. Water Supply	
1. Quantity	1. Sufficient only for local needs
2. Reliability	2. High
3. Cost	3. Moderately expensive
B. Environmental factors	
1. Environmental Water Needs	1. Low impact
2. Habitat	2. Low impact
3. Cultural Resources	3. Low impact
4. Bays and Estuaries	4. None
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

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