Study 3
Regionalization Strategies to Assist Small Water Systems in Meeting New SDWA Requirements

Prepared for:

BRAZOS G
WATER PLANNING GROUP

Prepared by:

HDR | ONE COMPANY *Many Solutions*[SM]

With administration by:

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Regionalization Strategies to Assist Small Water Systems in Meeting New SDWA Requirements

STATE OF TEXAS
DAVID D. DUNN
82630
REGISTERED
PROFESSIONAL ENGINEER

4-28-09

David D. Dunn, P.E.

Cynthia Green

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Executive Summary

The Brazos G Regional Water Planning Group is in the process of developing the 2011 Brazos G Regional Water Plan. The 2011 Plan will be an update of the current 2006 Plan. As part of the process for developing the 2011 Plan, the Texas Water Development Board (TWDB) has provided funding to Brazos G to perform a preliminary investigation of the feasibility for small public water systems (PWSs) to cooperate on a regional basis to help meet ever increasing Safe Drinking Water Act (SDWA) regulations.

This study identifies and recommends two candidate groups of small PWSs in the Brazos G Area that may be amenable to using the regionalization of resources to optimize system operation, reduce costs, and maintain compliance with the SDWA. The study supports the work of the TWDB, which recognizes regionalization policy as promoting public and environmental health and as a critical component of effective and sustainable long-term water planning.

Small systems with potential SDWA compliance issues were initially identified using compliance records and analytical lab results obtained from the Texas Commission on Environmental Quality (TCEQ). Initial criteria were developed to screen for the most serious SDWA-compliance related conditions in the TCEQ data, and the resulting refined datasets were analyzed by overlying layers graphically using ArcGIS. Data analysis in ArcGIS indicated five potential regional groups based on the high density of PWSs with multiple compliance risks for human or environmental health. These five groups were scattered throughout the Brazos G Area, where group areas ranged in size from 330 to 3400 square miles and system density ranged between 26 and 190 square miles per PWS. Small systems located within the five regional groups were surveyed (64% response rate) to record the most important compliance-related issues faced by the system and to gauge interest in being evaluated as part of a regionalization strategy. Following completion of the survey, the five potential systems were evaluated and narrowed down to two candidate groups for regionalization. These two recommended groups were selected based on criteria that evaluated the severity of the issues as it relates to SDWA compliance, the extent to which the issues were shared among neighboring systems, and the engineering, political, and economic feasibility of regionalizing resources in the area.

The two recommended candidate regional systems are both attempting to mitigate contamination of groundwater resources that are currently exceeding chemical maximum containment level (MCLs) set by the Environmental Protection Agency (EPA) and enforced by TCEQ. One group of PWSs, located in an area encompassing parts of Falls, Hill, Limestone, and McLennan (FHLM) Counties, is looking for strategies to lower arsenic concentrations that are typically only 1-2 micrograms per liter (μg/L) above the arsenic MCL of 10 μg/L. The other group, located north of Abilene in Knox and Haskell Counties (Subgroup 3A), is looking for strategies to lower nitrate concentrations that are sometimes 3-5 milligrams per liter (mg/L) above the nitrate MCL of 10 mg/L.

There are a great number of ways for PWSs in these two candidate groups to regionalize resources based on engineering, financial, and other considerations. These basic considerations were summarized based on the available information and survey responses from interested systems. For the first group of systems (FHLM), blending to lower arsenic concentrations was deemed to be most appropriate strategy, assuming a reliable purchase water source can be identified. For the second group of systems (Subgroup 3A), treatment to lower nitrate concentration is probably the most feasible solution. Engineering details and cost analyses related to regionalization of resources to carry out these mitigation strategies will depend, ultimately, on the selection of technologies and/or source providers as well as the degree of participation by interested systems. Future steps in the regionalization process will required an entity to assume a leadership role (a "convener") to oversee and assist these identified systems in the regionalization process. Results of detailed cost and engineering analyses can be used to recommend a regionalization strategy in a future regional water plan, and allow participating PWSs to qualify for low-interest loans and grants to implement these strategies.

1.0 Background

Regionalization has emerged as a strategy for public water systems to optimize system operation by the sharing of financial, managerial, administrative, and technical resources. This section discusses how states enforce and public water systems comply with the Safe Drink Water Act, and how regionalization can assist smaller systems in maintaining compliance with the Act's provisions.

1.1 Safe Drinking Water Act

The Safe Drinking Water Act (SDWA), originally enacted by Congress in 1974 and amended in 1986 and 1996, is the primary piece of regulatory legislation targeting public drinking water supply for the protection of human health. The SDWA affects every public water system (PWS)[1] in the United States. The key provision of the SDWA is National Primary Drinking Water Regulations, national health-based standards for drinking water to protect against both naturally-occurring and man-made contaminants that may be found in drinking water. Early on, the SDWA primarily focused on treatment as a means of protecting drinking water, but in 1996 the Act was amended to include source water protection, operator training, funding for water system improvements, and public information as important components of protection.

1.2 Federal and State Compliance with the SDWA

The United States Environmental Protection Agency (EPA) sets drinking water standards and provides guidance, assistance, and public information about drinking water, collects drinking water data, and oversees state drinking water programs. Oversight of water systems themselves, however, is typically conducted by state agencies. In the State of Texas, water quality issues are typically addressed by the Texas Commission on Environmental Quality (TCEQ). TCEQ not only has primacy in enforcing SDWA regulations for PWSs located in the state, but is also responsible for reviewing and approving design and operating plans for proposed water systems. Water quantity issues are typically addressed by both TCEQ and the Texas Water Development

[1] PWS is defined as a drinking water system that has at least 15 connections or serves at least 25 people per day for at least 60 days out of the year. A PWS is comprised of the source of water, the water treatment plant, and the distribution lines.

Board (TWDB). The TWDB primarily assists in water resource planning, financial assistance, information, and education for the conservation and responsible development of water.

Compliance of the SDWA at the federal and state levels requires public water systems, regardless of size, to have (1) adequate and reliable sources of water that either is or can be made safe for human consumption; and (2) the financial resources and technical ability to provide services effectively and reliably, and safely for workers, customers, and the environment. Small public water systems must meet the same requirements as larger utilities, but with fewer financial resources available to them because of their smaller customer base. Federal and state programs do provide these small public water systems with extra assistance, such as training and funding,[2] but some small systems still struggle to remain in compliance.

1.3 Regionalization

Regionalization has emerged as an option for optimizing financial, managerial, operational, and technical resources in order to provide water or wastewater safely, reliably, and cost-effectively. Regionalization can be defined in many ways, but at the most basic it is the consolidation of the physical systems, capital, operations and management, support services, *or* ownership of two or more existing or proposed water and wastewater systems. Regionalization can result in an expanded service area comprised of a larger geographic area and/or multiple systems. Regional systems can be formalized into multi-jurisdictional utility commissions, special districts, authorities, or corporations, but regionalization can also result in non-formalized systems where water systems retain separate ownership or maintain autonomy, but have interlocal agreements that describe shared resources. Regionalization options can vary along a spectrum of transfer of responsibility from relatively minor changes in operation to the full transfer of ownership (Table 1).

Drivers for regionalization might include increased technical requirements (e.g., MCLs) for systems and operations, shared common interests between systems regarding planning and regulatory oversight, or shared regional problems with water supply (e.g., drought) or water

[2] For example, the SDWA authorized the EPA to provide TCEQ with a federal grant to reimburse the costs of training and licensing of persons operating community or non-transient non-community public water systems serving 3,300 persons or fewer.

quality (e.g., pollution). Some of the benefits of regionalization are economies of scale, improved service quality, and better access to lower costs of capital. Some of the challenges for regionalization include lack of funding or high economic costs of consolidation, geographic isolation of systems, systems wanting to maintain complete operational independence, and reluctance to share services based on political boundaries, sociopolitical boundaries, or legal impediments.

Texas Senate Bill 1 (SB1) in 1997 sought to encourage regionalization[3] as one of the major goals. To "encourage and promote the development and use of regional and area wide drinking water systems,"[4] TCEQ followed new legislation by issuing a policy statement[5] based on SB1 and statutory provisions as outlined in the Texas Health and Safety Code (§341.0315(a)-(d) and §341.035), the Texas Water Code (§13.241, (§13.246, and (§13.253), and Title 30 Texas Administrative Code (§290.039, §291.102(b), and §291.102(c)). The policy and statutes are primarily aimed at owners and operators of new PWSs or those who are seeking approval for a new water Certificate of Convenience and Necessity (CCN)[6] and "requires any new system within a municipality or ½ mile radius of a district or political subdivision providing the same service to prove an application for service was made to the provider."[7] The policy was also intended for existing PWSs that are struggling to meet compliance, or, more specifically, were constructed without approval, have a history of non-compliance, or are subject to a TCEQ enforcement action. TCEQ can force regionalization[8] for any system that "violates a final order or allows any property owned or controlled by it to be used in violation of a final order of the Commission; fails to provide adequate service or notice of public health hazards; fails to

[3] Regionalization under TCEQ policy can take any of the following forms: (1) one owner and one large system serving several different communities or subdivision; (2) one owner and several isolated systems, each providing service to one or more communities or subdivisions; (3) several owners, each with individual systems operated through a centrally coordinated operating system; (4) several owners, each with an isolated system, all served by a central wholesale provider; (5) the existence of permanent emergency interconnections.
[4] Texas Health and Safety Code (THSC) §341.0315(b).
[5] Texas Commission on Environmental Quality (TCEQ). Water Supply Division. *The Feasibility of Regionalizing Water and Wastewater Utilities: A TCEQ Policy Statement*. RG-357. January 2003.
[6] A Certificate of Convenience and Necessity (CCN) is issued by the TCEQ, and authorizes a utility to be the service provider of water and/or sewer service to a specific area. The CCN obligates the utility to provide continuous and adequate service to every customer who requests service in that area.
[7] EPA, 2007. Op.cit.
[8] i.e., the State Attorney General can sue in state court for the appointment of a receiver to collect the assets and operate and maintain the water system.

maintain facilities such that potential health hazard may result; or displays a pattern of hostility toward or repeatedly fails to respond to TCEQ or its customers."[9]

Table 1.
The Spectrum of Regionalization (EPA, 2007)[10]

→ *Increasing Transfer of Responsibility* →				
Internal Changes	***Informal Cooperation***	***Contractual Assistance***	***Joint Powers Agency***	***Ownership Transfer***
Completely self-contained. Requires no cooperation or interaction with other systems	Work with other systems but without contractual obligations	Requires a contract, but contract is under system's control	Creation of a new entity by several systems that continue to exist as independent entities (e.g., regional water system)	Takeover by existing or newly created entity
Examples:	**Examples:**	**Examples:**	**Examples:**	**Examples:**
• Installing meters	• Sharing equipment	• Contracting operation and management	• Sharing system management	• Acquisition and physical interconnection
• Changing billing system	• Sharing bulk supply purchases	• Outsourcing engineering services	• Sharing operators	• Acquisition and satellite management
• Implementing an environmental management system	• Mutual aid arrangement	• Purchasing water	• Sharing source water	• One system transferring ownership to another to become a larger existing system or entity
• Reviewing rate structure and making changes as appropriate				

1.4 Role of the TWDB and Regional Water Planning Groups

Legislative passage of SB1 shifted area wide water planning from the state level to the regional level, creating 16 regional water planning areas, including the Brazos G Regional Water Planning Area. Every five years, the Brazos G Regional Water Planning Group develops a comprehensive water plan for the region, including all or part of 37 counties, extending from Kent, Stonewall and Knox Counties in the northwest to Washington and Lee Counties in the southeast. The Group is completing several studies pursuant to the development of the 2011

[9] EPA, 2007. Op.cit.
[10] Environmental Protection Agency (EPA). Office of Water. *Restructuring and Consolidation of Small Drinking Water Systems: A Compendium of State Authorities, Statutes, and Regulations.* EPA-816-B-07-00. October 2007.

Brazos G Regional Water Plan (2011 Plan). One of those studies, described in this report, is an investigation of regionalization strategies to assist small water systems in meeting SDWA requirements.

2.0 Purpose

This study supports water planning and the work of the TWDB by identifying those smaller public water systems in the Brazos G Area that may be amenable to using the regionalization of resources to optimize system operation, reduce costs, and maintain compliance with the Safe Drinking Water Act. This study recommends several regionalization strategies that promote public and environmental health and can be integrated as a component of effective and sustainable long-term water planning in the Brazos G Area.

3.0 Methodology

The study was comprised of two separate tasks: evaluation and reporting. Task 1 was the engineering and financial evaluation of two opportunities for regionalization of PWSs by considering both the individual PWSs' interest in being part of a regional system, and PWSs with current or potential treatment issues. Task 2 was the reporting of findings including maps delineating system boundaries and infrastructure requirements.

3.1 Data Sources

Compliance and water quality data were provided by TCEQ for the time period January 2005-March 2008 for PWSs in the 37 Brazos G counties listed in Table 2.

The following sets of raw data were retrieved from different TCEQ agency databases with help from the Public Drinking Water and Drinking Water Protection sections of the Water Supply Division.

- Chemical Analytical Results,
- Chemical Maximum Contaminant Level (MCL) Violations,
- Total Coliform Rule (TCR) Violations ,
- Turbidity and Surface Water Treatment Rule (SWTR) Violations,
- PWS Deficiency Scores (DScore), and
- Current MCL Violators.

Table 2.
Brazos G Counties

Bell	Haskell	Nolan
Bosque	Hill	Palo Pinto
Brazos	Hood	Robertson
Burleson	Johnson	Shackelford
Callahan	Jones	Somerville
Comanche	Kent	Stephens
Coryell	Knox	Stonewall
Eastland	Lampasas	Taylor
Erath	Lee	Throckmorton
Falls	Limestone	Washington
Fisher	McLennan	Williamson
Grimes	Milam	Young
Hamilton		

3.2 Data Selection Criteria

Brazos G comprises a large area with approximately 681 actively-operating PWSs servicing a combined population of approximately 2.2 million people and over 765,000 water connections. The small and medium public water systems[11] were screened to be those active community and non-community/non-transient systems servicing a population of greater than 80 and less than 10,000. The criteria used in data selection are shown in Table 3. A total of 469 systems met these criteria and subsequently were targeted in the analysis. A map of the extent and location of these PWSs is shown in Figure 1.

Both private/investor-owned utilities and federally-owned utilities were omitted from data selection. Despite the fact that some privately-owned PWSs have a long history of SDWA-related compliance problems, these systems were excluded from the analyses because there were too many to investigate and because private systems may not be eligible for state funding. Because of the limited external funding resources or desire to remain for-profit, private systems may be less inclined to show interest or invest in regionalization. In future studies, private

[11] EPA defines small systems as those systems with a service population less than 3,300 persons and medium systems as those systems with a service population between 3,300 and 10,000.

Table 3.
Criteria Used in Data Selection and Percent of Total

PWS Type	***Included?***	*%*
Community	Y	81.7
Non-community/non-transient	Y	6.3
Non-community/transient	N	12.0
PWS Activity Status	***Included?***	%
Inactive	N	4.5
Proposed	N	0.3
Merged/Annexed	N	0.5
Deleted/Dissolved	N	7.1
Active	Y	87.6
Owner Type	***Included?***	%
District/Authority	Y	6.6
State Government	Y	2.1
Water Supply Corporation	Y	24.8
Federal Government	N	2.1
Private (Investor)	N	37.7
Investor	N	7.6
Municipality	Y	19.2

Customer Type	***Included?***	*%*
Hotel/Motel	N	0.8
Residential	Y	71.9
Other Residential Area	Y	0.3
Summer Camp	N	0.9
Recreational Area	N	6.3
Restaurant/ Convenience Store	N	0.1
School	N	2.4
Water Hauler	N	0.1
Service Station	N	0.3
Other Non-transient Area	Y	0.5
Mobile Home Park	N	7.5
Industrial/Agricultural	Y	2.6
Institution	Y	1.5
Other Transient Area	N	1.4
Day Care Center	N	0.1
Water Bottler	N	0.1
Restaurant	N	2.1
Wholesaler (Treated Water)	Y	0.9
Wholesaler (Raw Water)	Y	0.1

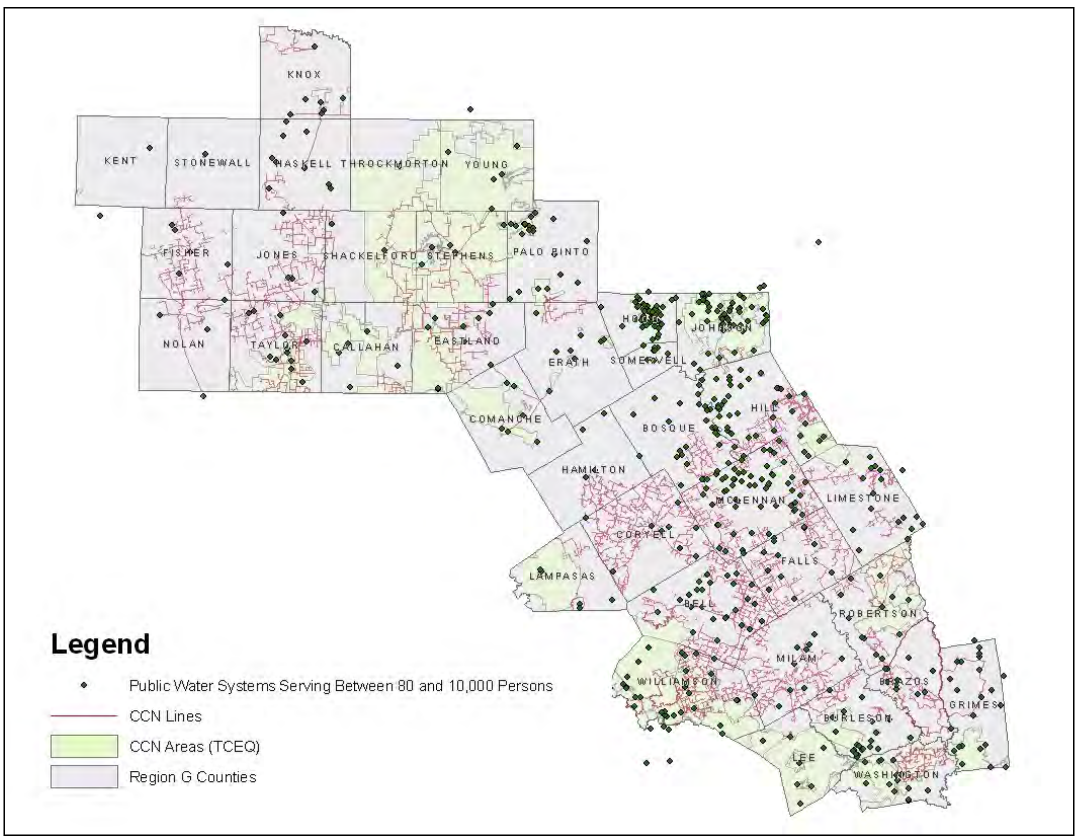

Figure 1. Small and Medium Public Water Systems Serving between 80 and 10,000 Persons in the Brazos G Area

systems should be considered. The small number of federally-owned PWSs in the region was excluded because of possible jurisdictional complications.

Microsoft Access was used to combine, refine, and query the datasets provided by TCEQ. Queries produced the following types of information for datasets for the time period January 2005-March 2008:

1. Public water systems that were issued non-monitoring/non-reporting (chemical) MCL notice of violations (NOVs).
2. MCL analytical results that exceeded the MCL: The number of exceedences was normalized to the number of connections to account for the size of the PWS, and to account for the ability for a PWS to correct a potential violation. An MCL exceedence does not necessarily result in a NOV. (NOVs are typically issued when violations are observed during inspection or following a review of records by TCEQ).
3. MCL analytical results that exceeded 70% of the MCL. The 70% criterion was used to target PWSs that may be susceptible to compliance problems. The number of exceedences was normalized to the number of connections to account for PWS size.
4. TCR violations: PWSs that violated TCR, including both coliform-MCL violations and TCR monitoring and reporting violations.
5. Turbidity and SWTR violations: PWSs that violated SWTR or IESTWR rules.
6. Deficiency Score: Deficiency Scores were used as a metric for evaluating the financial, managerial, or operational "fitness" of the PWS. A deficiency score is an aggregate combination of a points tied to Category A, B, and C violations. Deficiency scores alone DO NOT trigger enforcement actions. The category of violation may trigger enforcement action, however.[12] The points issued for each category of violation is given below.

   Category A violations: 20 points
   Category B violations: 5 points
   Category C violations: 2 points

   Details on the types of violations included under each of the categories can be found in the TCEQ document *Enforcement Initiation Criteria (EIC) Revision No. 11* (TCEQ, 2007). Typically, Category A violations are violations that are most threatening to human and environmental health and may include failures to provide minimum surface water treatment, failures to maintain the required minimum disinfectant residual, or violations of any primary chemical MCL. Category B and C violations, on the other hand, are often the result of failure or inadequate monitoring, testing, or data reporting.

[12] For example, Category A violations require automatic initiation of formal enforcement action when discovered. Category B violations lead to enforcement actions when a regulated entity had a "repeated" Category B violation documented during two consecutive investigations within a 5-year period. Category C violations *may* require initiation of formal enforcement action if the entity receives a notice of violation for the same violation 3 times within the most recent 5-year period, including the notification for the current violation (and where enforcement action is at the discretion of the section level manager reviewing the enforcement action).

The category of violations comprising the deficiency score can not readily be extracted. For example, a deficiency score of 20 could be the result of one Category A violation, four Category B violations, ten Category C violations, or some other combination. However, in the absence of any other readily available operational deficiency information, the deficiency score can give some indication of the relative "fitness" of the PWS, where higher deficiency scores are correlated with greater compliance problems. The Public Drinking Water Section at TCEQ has indicated that most deficiency score points are issued from TAC §290 Subchapter D violations (*Rules and Regulations for Public Water Systems*).

To evaluate the relative fitness of a PWS using the deficiency scores, all PWSs that were issued a deficiency score since 2005 were ranked according to score, and assigned a percent rank based on score, with a lower percent rank indicating higher deficiency score. The cumulative distribution of deficiency scores is shown in Figure 2. For example, almost 80%, or approximately 550 PWSs, had a deficiency score of 20 or lower.

7. Current MCL Violators: PWSs that were in chemical MCL violation on the query date of March 13, 2008. This metric was primarily used to identify PWSs with more recent and immediate problems.

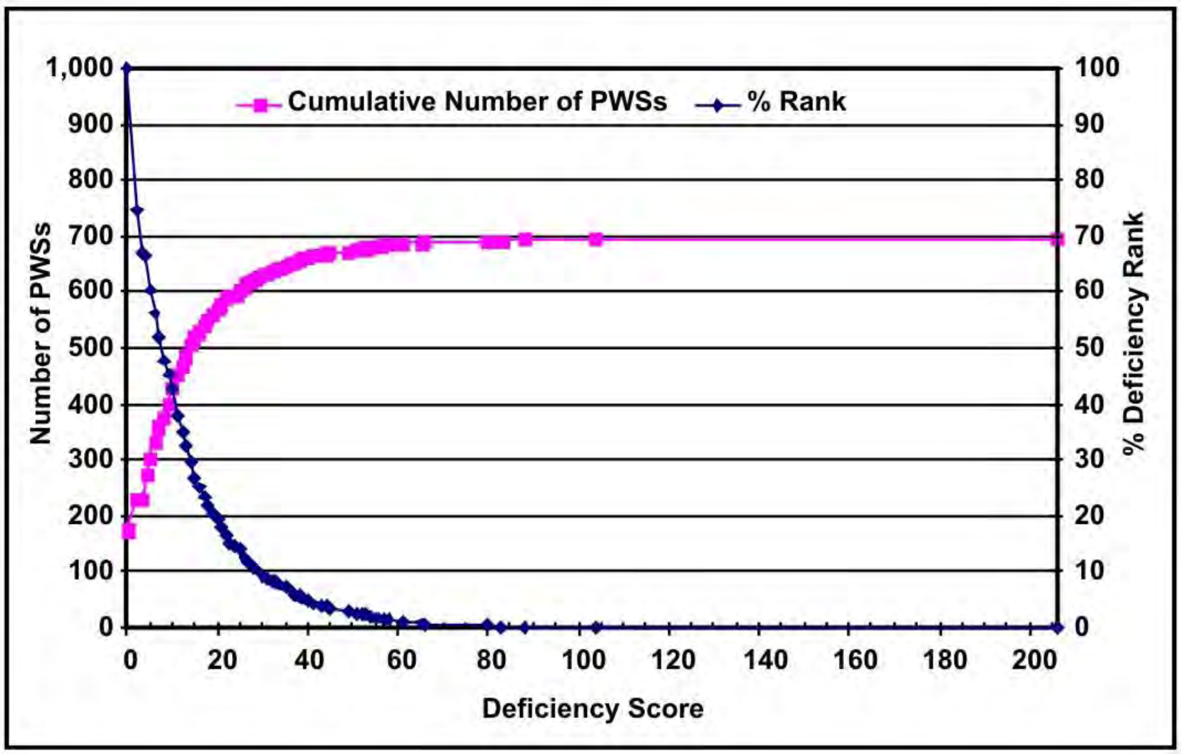

Figure 2. Deficiency Score Distribution (min=0, max=206)
(Lower % Rank Indicates Greater Deficiency)

3.3 Initial Screening of Data in GIS

The queried datasets were linked to PWS geographic coordinates in order to produce a graphical interface through which to analyze and group systems. Only datasets meeting the following initial screening criteria were included in the graphical analysis:

1. Top 50% (worst) deficiency scores (i.e., DScore > 7): Score was broken down into 0-25% (17 < DScore ≤ 205) and 25-50% (7 < DScore ≤ 17) categories
2. Top 50% (worst) MCL exceedences/connection, E/C: Score was further broken down into 0-25% (0.025226 ≤ E/C ≤ 7) and 25-50% (0.009174 ≤ E/C ≤ 0.025225) categories
3. Top 50% (worst) 70% MCL exceedences/connection, E/C: Score was further broken down into 0-25% (0.010204 ≤ E/C ≤ 0.033333) and 25-50% (0.033334 ≤ E/C ≤ 7) categories
4. All MCL violators
5. All TCR violators, including coliform MCL, monitoring, and reporting violations
6. All SWTR/IEWSTR/turbidity violators

A map of the overlay of these datasets showing the initial screening criteria is shown in Figure 3. The number of PWSs targeted by the initial screening criteria was 347.

3.4 TCEQ Regional Inspector Recommendations

TCEQ regional inspectors are familiar with PWSs in the Brazos G Area and were contacted to provide information not readily apparent from TCEQ datasets and to give additional insight into problematic PWSs, such as the rationale behind high deficiency scores. Regional inspectors identified PWSs in the Burleson-Washington County area and Hill-Limestone-McLennan-Falls area. Regional inspectors in the Abilene area were never successfully contacted and therefore, regional inspector recommendations for that area are not included. Regional inspectors recommended PWSs which, in their opinion, had the greatest needs for maintaining compliance, where the needs ranged from infrastructure to financial. These recommendations were typically based on the more recent inspections and correlated with high deficiency-score PWSs. Recommendations from the inspectors were integrated with database findings in subsequent mapping analyses and were included in Figure 3.

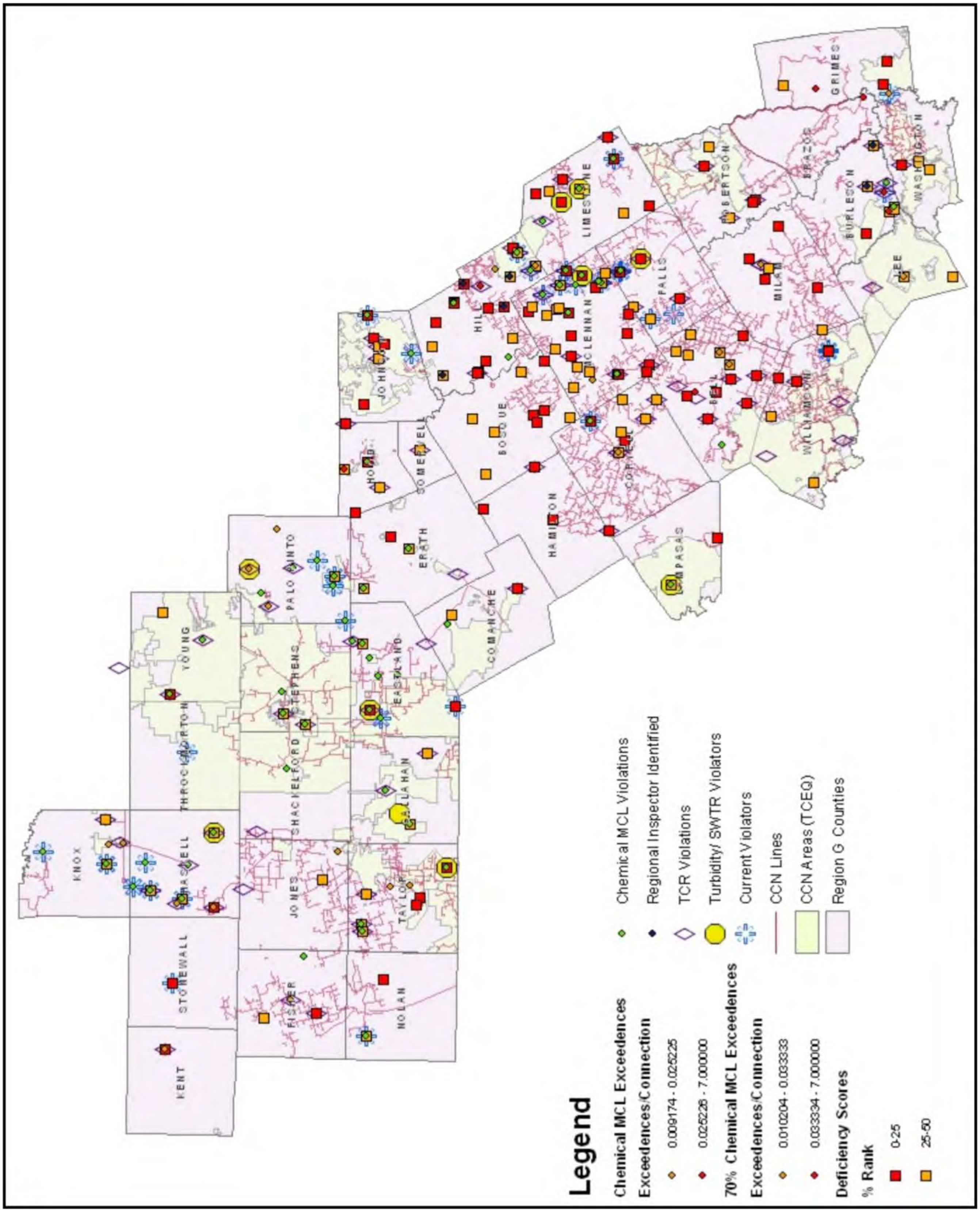

Figure 3. Map of Targeted PWS Using Initial Screening Criteria

3.5 Selection of Possible Regional Groups for Closer Analysis

Following the initial screening, three regional areas were selected based on density and geographic proximity of systems exhibiting at least one of the screening criteria conditions. Groupings based on density and proximity were somewhat subjectively determined. For example, an assumption was made that PWSs in the sprawling western counties of Brazos G have the history, knowledge, and/or existing infrastructure to regionalize resources over large areas. In eastern parts of Brazos G, on the other hand, PWSs are located much closer together. In addition to choosing systems that were naturally clustered, the severity or high risk of SDWA non-compliance was also taken into account when choosing areas for closer review. Therefore, areas where there were a number of PWSs with current or recent MCL violations and/or high deficiency scores were prioritized. The following three areas were chosen for closer analysis:

1. Burleson-Washington County area in the southeast portion of Brazos G (Figure 4): Area of 336 sq. miles and PWS density[13] of 1 PWS per 33.6 sq. miles.
2. Hill-Limestone-McLennan-Falls and eastern Bosque County area in the central-east portion of Brazos G (Figure 5): Area of 650.7 sq. miles and PWS density of 1 PWS per 26 sq. miles.
3. The Abilene area region in northwest portion of Brazos G, including Jones, Fisher, Shackelford, Stephens, Nolan, Taylor, Callahan, Eastland, Haskell, and Knox Counties. The Abilene area is further split into three sub-areas (Figure 6):
   - 3A. Haskell/North Jones/Northwest Shackelford/Knox Counties : Area of 2316 sq. miles and a PWS density of 1 PWS per 121.9 sq. miles
   - 3B. Fisher/South Jones/Nolan/Taylor/West Callahan Counties: Area of 3379 sq. miles and a PWS density of 1 PWS per 187.7 sq. miles
   - 3C. Stephens/Eastland/East Shackelford/East Callahan Counties: 1626 sq. miles and a PWS density of 1 PWS per 108.4 sq. miles

3.6 Final Screening of Data: PWS Survey

An informal survey was produced to record PWS self-assessment and the level of interest in regionalization. Prior to the survey administration, data from the TCEQ databases and Water System Data Sheet Reports[14] were compiled for PWSs that met the initial screening criteria for each of the three selected regional areas. This information included system size and type

[13] PWSs density calculation included only those PWSs that were targeted by the initial screening criteria.
[14] Available for each PWS from TCEQ's Water Utility Database (WUD) at http://www10.tceq.state.tx.us/iwud/.

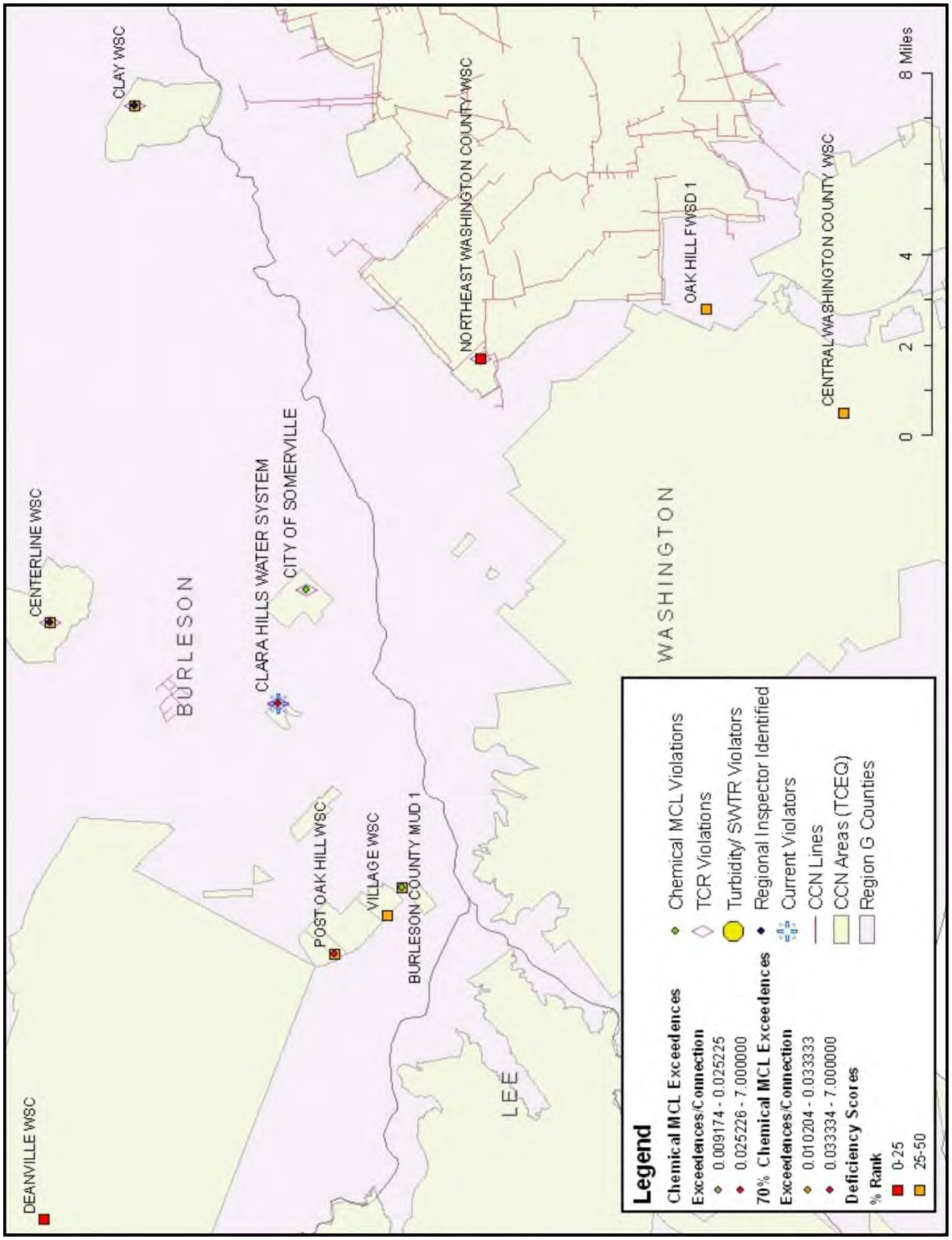

Figure 4. Group 1: PWSs in Burleson and Washington Counties

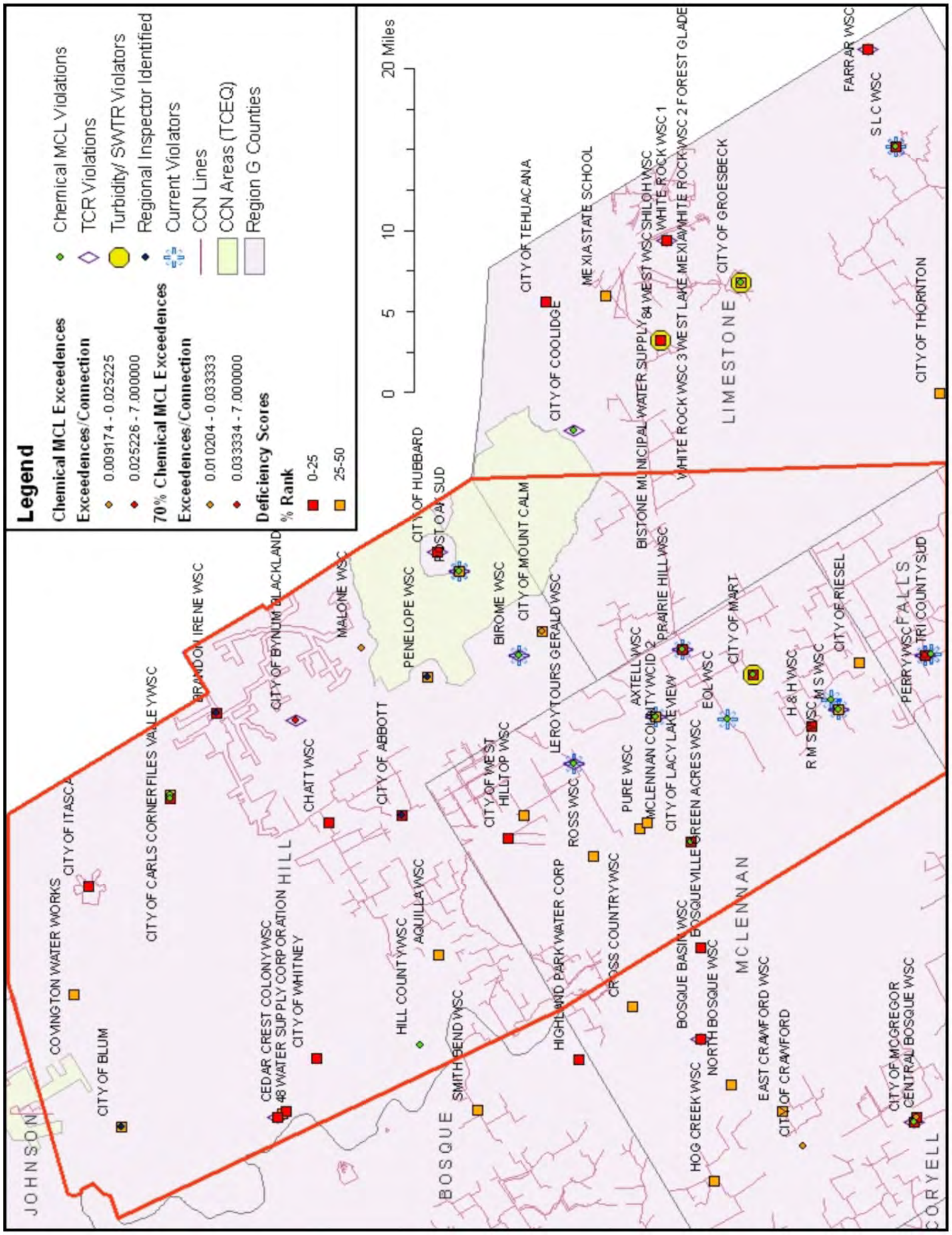

Figure 5. Group 2: PWSs in Falls, Hill, Limestone, and McLennan Counties (Area of Analysis is Outlined in Red)

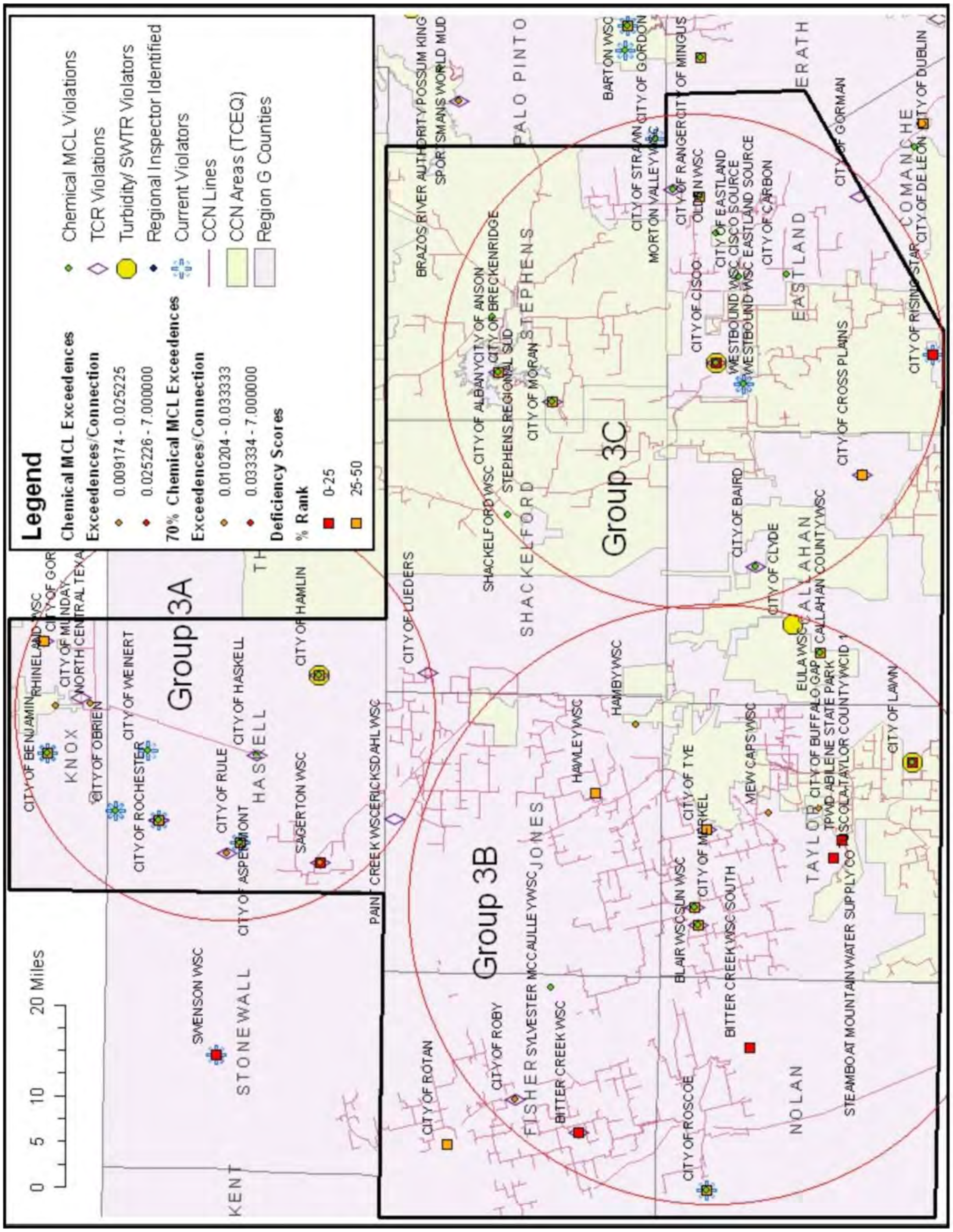

Figure 6. Group 3: PWSs in Knox, Haskell, Fisher, Jones, Shackelford, Stephens, Nolan, Taylor, Callahan, and Eastland Counties (Black Outline) (Subgroups are Circled in Red)

(e.g., municipality, water supply corporation, etc.), compliance and chemical analysis history for the previous 2 years (e.g., violations, deficiency scores, MCL exceedences), water sources (e.g., groundwater, surface water, purchased water) and treatment train process details, if any. This background information was subsequently used in preparation for discussion with PWS contacts and in comparison with survey responses.

Each surveyed PWS was contacted via telephone and asked a series of PWS self-assessment questions to identify the PWS's greatest needs (if any), to determine if regionalization might mitigate those needs, and to gauge the level of interest and record any concerns about participating in a regional system. The same "script" was referenced for each and every PWS contacted. A copy of the script is provided in the Appendix A.

Although attempts were made to contact every PWS in the area, not all systems were successfully surveyed for a number of reasons, which included disconnected or wrong phone numbers, unreturned phone calls, recent changes in PWS management or ownership, or contacts who felt unauthorized to speak on behalf of the system. Seventy-five PWSs were targeted in the survey in which over which 48 were interviewed, giving a 64 percent response rate for the survey.

In several cases, the surveyed respondent was not the same individual listed as the main PWS contact. Responses to the survey were provided by PWS employees of myriad roles and responsibilities that ranged from book-keeping to presidential or mayoral to operator (and in some cases, by employees who did all of the above). Responses were strongly dependent on the perspective (e.g., operational, engineering, financial, managerial) of the respondent and answers did not necessarily capture all the nuances affecting PWS operation, compliance, or the willingness of a PWS as a whole to participate in regionalization.

Many PWSs had a unique set of needs and priorities that differed from that of their neighbors. Other PWSs had similar enough problems with neighboring systems to propose regional groupings (Section 4.0). In some cases, PWSs could not identify any areas of improvement and saw no need for further evaluation. In other cases, systems wanted to be included in the study despite not having explicit need for additional resources. Table 4 shows a summary of the issues that were most commonly reported by PWSs in each region. Note that not all of the issues listed below *directly* affect SDWA compliance. However, issues may have indirect effects and compromise the ability of a PWS to maintain SDWA compliance in the future. Note that the issues listed below are not listed in any order of priority. Table 4 does show, however, that many of the systems in a region have overlapping needs. Sections 4.1-4.3 describe these PWS needs in more detail.

Table 4.
Identified Issues of Concern for PWSs and Number of Responses

Issue	Burleson-Washington Group 1	Falls-Hill-Limestone-McLennan Group 2	Abilene Group 3A	Abilene Group 3B	Abilene Group 3C	All Groups
Number of PWS Responding	7	14	10	11	11	53
Treatment (MCL, taste/odor)		8	6	3		17
Water lines	2	3	2	3	5	15
Other infrastructure (tanks, clarifiers, pumps, meters, valves)	1	2	1	2	2	8
Qualified operator	2	3			1	6
Operator training				2		2
Backup operator	2	2	1		1	6
Financial	3	1		2	4	10
Administrative and billing	1	2	1	2		6
Water resources		3		2		5
Equipment	1	2	3	2		8
Testing/Inspection/Repairs	2		1	1		4
Energy/Electric		2		2		4
Mechanical		1				1
Mapping				1		1

For those PWSs who identified concerns with their current configuration or could see room for improvement, responses to the question of regionalization were just as varied. Some PWSs expressed skepticism and suspicion as to how a regionalized system might work. For example, a few systems expressed concerns that they would not be able to maintain autonomy in a regionalized system and other systems expressed concerns regarding partnering with systems that were not as financially solvent. Many PWSs, however, were eager to be evaluated further to determine if any resources could be shared on a regional level. Other PWSs identified the role the PWS might play under a regionalized system. Table 5 shows a summary of interest in the regionalization evaluation by regional group.

Table 5. Interest Level for Regionalization Evaluation

Regional Group	Number of PWS Responding	Interested?	
		Yes	No
Burleson-Washington Group 1	7	5	2
Falls-Hill-Limestone-McLennan Group 2	14	10	4
Abilene Group 3A	10	9	1
Abilene Group 3B	11	11	0
Abilene Group 3C	11	8	3
All Groups	53	43	10

4.0 Screening of Regional Groups

Survey responses provided valuable information as to the feasibility of regionalization for each of the three regional groups that were initially targeted using TCEQ data and GIS analysis. Subgroups with similar issues emerged from these larger areas based on these responses. A summary of these findings is described in this section.

4.1 Regional Group 1: Burleson and Washington Counties

Burleson and Washington Counties in the southeast of the Brazos G Area emerged as a possible target for regionalization based on the high density of proximate PWSs meeting the initial screening criteria. All the PWSs targeted in this regional group are groundwater systems that treat their own water. The major aquifers in the area include the Carrizo-Wilcox Aquifer, primarily found in Burleson County, and the Gulf Coast Aquifer, primarily found in Washington County. Minor aquifers in the area include the Queen City and Sparta Aquifers, which are often considered part of the Carrizo-Wilcox group.

TCEQ database records from 2005-2008 indicated the most common SDWA chemical issues encountered by PWSs in the Burleson-Washington area were elevated levels of total trihalomethanes (TTHM) and total haloacetic acids (HAA5), typical disinfection by-products (DBP). However, two of the systems with the highest number of MCL violations in the last two years had recently switched to chloramine treatment, with the expectation that disinfection by-product formation would decrease. Another system with TTHM MCL violations on record recently altered water tank storage time to address water age issues, and has subsequently seen TTHM concentrations fall. There are a handful of other systems in the area that are currently using gaseous or hypo-chlorination and have recorded occasionally high TTHM and HAA5 concentrations (with some records exceeding the MCL); however, these systems have not been issued MCL violations and currently remain in compliance. Despite the history and occurrence of high DBP concentrations for systems in the area, none of those surveyed mentioned DBP treatment issues as a concern, indicating it may be an issue that individual PWSs believe they can address independently.

Another water quality and treatment issue that arose in the historical record but was not indicated as a problem by surveyed PWSs was coliform. TCEQ records showed 11 TCR violations for 6 PWSs in this area since 2005, but all violations were related to monitoring or reporting and not the coliform MCL. Although 4 of these violations occurred since 2007, not one surveyed PWS mentioned concerns with coliform levels in their system. Since all violations were related to reporting and monitoring, deficiencies in operations and management, rather than in treatment, are more crucial to maintaining compliance.

The issues most cited in the survey of Burleson and Washington County PWSs were the need for more funding, the need for new and updated infrastructure, the need for repairs and inspection, and the need for qualified licensed and/or backup operators. Finance is a large issue for many of these small systems because of the perception that most grants in rural areas have first and foremost gone to funding in wastewater treatment and infrastructure and not drinking water. Finance issues will be somewhat removed from this discussion, because funding is a fundamental requirement for all PWS needs. A larger discussion of finance can be found in Section 5.2.2.

Infrastructure improvements were at the top of the list for three systems. Two systems, Clara Hills Water System and the City of Somerville, specifically mentioned old water lines that needed replacement. These two PWSs are located less than 5 miles apart[15], although the former system only serves approximately 100 people in a small community and the latter system serves over 2,600 people. Nearby Clay WSC, less than 15 miles from both Clara Hills and Somerville,

[15] Note that all distances in Section 4 are minimum, straight-line distances and not driving distances.

had smaller identified infrastructure repair and inspection needs (painting, fencing, and storage inspection).

The need for qualified or backup operators was another issue that came up for at least three of the PWSs in the area. Clara Hills Water System, Clay WSC, and Bluebonnet Rural Water Systems, located less than 15 miles apart, currently have licensed operators, but the systems all noted the difficulty of finding qualified operators in the past and were interested in introducing some operator redundancy, perhaps in the form of roving operators, to their systems. Other issues mentioned include the need for better library and record-keeping (Clay WSC) and the desire for an equipment and parts loan or share program (City of Somerville). Some PWSs in the region have benefited from technical and educational assistance given by the Texas Rural Water Association (TRWA), but the need for more personnel and training was expressed.

Regionalized systems in this area may be feasible, as there is precedence in PWSs working together. For example, the City of Somerville already has interlocal agreements (to loan personnel) with the Burleson County MUD (7 miles away) and the City of Caldwell (15 miles away). Other systems, including include Clara Hills Water System, Clay WSC, Bluebonnet Rural Water Systems, and Central Washington WSC, may be amenable to additional agreements depending on the terms and cost/benefit analysis. At least one system in the region, Bluebonnet Rural Water Systems (formerly Northeast Washington County WSC), is part of a regional electric cooperative (Bluebonnet Electric Coop), and would be interested in a leadership role. However, another system, Oak Hill FWSID 1, suggested regionalization of the PWS into the larger system would be politically infeasible, barring system annexation, as customers had recently voted to reject integration with the nearby City of Brenham.

Of the seven systems contacted in Group 2, the following five systems expressed an interest being evaluated for regionalization:

- City of Somerville,
- Clara Hills Water System,
- Clay WSC,
- Bluebonnet Rural Water Systems, and
- Central Washington WSC.

4.2 Regional Group 2: Falls, Hill, Limestone, and McLennan Counties

The Falls-Hill-Limestone-McLennan (FHLM) County area is one of the more densely populated areas in Brazos G and contains a high density of PWSs identified by the initial screening criteria. The group described here covers all of Hill County, McLennan County east of Waco, northern Falls County, and northwestern Limestone County, as outlined in red in Figure 5.

The issue most often cited in the survey of these entities related to the treatment of water for elevated levels of arsenic. Currently, most public water systems in the area rely on groundwater from the Trinity Aquifer as a water source. Previous research[16] has suggested that elevated arsenic concentrations in Texas are mostly confined to the Edwards-Trinity Aquifer of the High Plains and the Gulf Coast Aquifer. Arsenic in the Edwards-Trinity Aquifer is naturally-occurring and may have originated from volcanic ash beds in the overlain Ogalalla Aquifer, Cretaceous black shales, saline lakes, or desorption from metal oxide clays. Sources of arsenic in the Gulf Coast Aquifer may originate from the volcanic ashes associated with the Catahoula formation. The sources of arsenic in the southeast portion of the Trinity Aquifer may be related to these sources found in either the High Plains or the Gulf Coast, or the area may be an unrelated "hot spot" where arsenic is of unknown natural or anthropogenic origin.

Regardless of the source, the concentrations of arsenic in the groundwater supplying the PWSs in the area are slightly greater than the new arsenic MCL of 10µg/L. Prior to the new standard taking effect on January 23, 2006, the MCL was 50µg/L and practically all PWSs in the FHLM area complied with the old standard. For PWSs in this area meeting the initial screening criteria, the TCEQ database contained 144 records where water sample arsenic concentration exceeded the current MCL since 2005. Most of these 144 records showed arsenic concentrations just slightly greater than the 10µg/L limit, and only one record was above the old standard of 50µg/L. Several of the systems are now struggling to maintain compliance following the adoption of the new MCL standard. Of the 17 MCL violations issued for arsenic since 2005, 16 were issued after the new standard took effect in early 2006.

PWSs in the FHLM area that have recorded elevated arsenic concentrations are no more than 25 miles apart from one another. Based on the close proximity of systems, an informal

[16] Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin. 2005. Evaluation of Arsenic Contamination in Texas: Report Prepared for the Texas Commission on Environmental Quality.

partnership of ten PWSs in the area, the FHLM partnership, has recently formed and is in the preliminary stages of looking at obtaining alternative (surface) water sources for blending to reduce arsenic concentrations. According to several members of the partnership, blending with surface water seems to be the only alternative available because of the expense of individual system treatment options, especially related to the disposal of arsenic waste. The ten PWSs that currently are associated with the FHLM partnership are Birome WSC (with President Charles Besada leading the effort), City of Mt. Calm, Axtell WSC, Chalk Bluff WSC, City of Mart, City of Riesel, Cottonwood WSC, Ross WSC, Gholson WSC, and EOL WSC. In addition to the ten PWSs that comprise the partnership, five other PWSs in the area have elevated arsenic concentrations and may benefit from joining a regionalized effort.

Other PWSs in the region are experiencing elevated DBP levels, especially in western Hill County. At least five PWSs having surface or conjunctive (surface + ground) sources of water have records of elevated TTHM or HAA5, and three of these five systems have been issued MCL violations for the high DBP concentrations. All five systems treat water using gaseous or hypo-chlorination. Of these five systems, two were successfully contacted, and suggested capital/infrastructure improvements and sustained employment of qualified operators was the best approach to addressing water quality problems.

Although treatment was the single most oft-cited SDWA issue, PWSs in the area also reported several other issues of concern including the need for infrastructure improvements (distribution lines and well storage); better energy alternatives (backup generation); improved or shared equipment, operator, and administrative resources; future water planning assistance; and more secure and alternative water resources to meet future needs. Again, financial problems were often mentioned as the primary cause of several of these unfulfilled needs. For example, several PWSs expressed concern with paying for infrastructure improvements when declining populations and/or low-income rural customers are unable to support them. In addition, the difficulty of obtaining and retaining qualified operators was thought to be a result of insufficient community salaries. As with the Burleson-Washington County area, organizations such as TRWA have been providing assistance where possible to several of these systems, but there is greater demand for technical assistance in particular.

Many of the systems in the FHLM area already have prior relationships with other systems and are amendable to working with their neighbors. The recently formed FHLM partnership is one example of how systems have come together to find ways of addressing a common problem. Other systems (e.g., City of Mart, City of Riesel, and Tri-County SUD) have instituted interlocal agreements as a way to share resources. Despite the precedence, several PWSs were concerned in maintaining their continued autonomy if they were to join into a regionalized system. For example, several systems expressed distrust, fear, or unwillingness to cooperate with what they perceive to be predatory behavior of one of the largest PWSs in the region, which has been expanding in the region by acquiring several smaller systems.

Of the 14 systems contacted in the survey, ten systems expressed interest in being evaluated for regionalization:

- Axtell WSC,
- Birome WSC,
- City of Mount Calm,
- City of Riesel,
- City of Mart,
- Ross WSC,
- Penelope WSC,
- Parker WSC,
- Cedar Crest Colony WSC, and
- Beachview Acres Water Association.

4.3 Regional Group 3: Abilene Area

The third regional group consists of several western counties in Brazos G centered around Abilene, shown outlined in black in Figure 6. This area of study is very large (over 7000 sq. miles) and the density of PWSs (less than 1 PWS per 100 sq. miles) is much less than elsewhere in Brazos G. In the western part of Texas, water lines have historically run great distances and systems cover large service areas, so the radius of analysis is subsequently larger than denser areas of Brazos G. Despite the large area, low density of PWSs, and breadth of SDWA-compliance issues illustrated in Figure 6, this regional group has potential for supporting several regionalized systems. To investigate these diverse issues in greater detail, the large area was divided into three subgroups based on the natural clustering of systems and shared concerns.

4.3.1 Subgroup 3A: Haskell, North Jones, Northwest Shackelford, and South Knox Counties

The first subgroup, encircled in red and noted as Group 3A in Figure 6, is comprised of PWSs located in several counties north of the City of Abilene, including Haskell County and parts of Jones, Shackelford, and Knox Counties. Some systems in this subgroup receive surface water from Hubbard Creek Reservoir, Lake Stamford, Millers Creek Reservoir, Lake Abilene, and Lake Ft. Phantom Hill. Other systems rely on groundwater from the Seymour Aquifer.

The Seymour Aquifer contains the highest nitrate concentrations in groundwater in the State of Texas, found to have a median value of almost 60 mg/L.[17] In Haskell and Knox Counties, 75% of wells have consistently exceeded the 10 mg/L MCL since 1950.[18] The aquifer is particularly susceptible to land-surface contamination of nitrate because it is unconfined, comprised of porous sandy soils, extremely shallow and near the surface, and located in a highly cultivated region of Texas.[19] Agricultural practices are likely the primary cause of high nitrate in the region, although feed lots, septic systems, and lawn fertilization may account for localized sources of contamination.[20] However, anecdotal information indicates that some level of nitrate contamination might occur naturally, as the “blue baby” syndrome typically associated with high levels of nitrate has been recognized as a problem in the area long before the use of high-nitrogen synthetic fertilizers.

Regardless of the source of contamination, several PWSs have difficulty meeting the MCL for nitrate because of the widespread contamination of the aquifer. Some systems in the region are able to address the problem by blending groundwater with surface water to lower the concentration. Surface water from Millers Creek Reservoir (via North Central Texas Municipal Water Authority, NCTMWA) is most commonly blended with groundwater by systems in the area. Decades-old water contracts for water from Millers Creek Reservoir complicate the water rates that are paid by “member” and “non-member” systems in the area. According to the NCTMWA, “member” cities and systems in the subgroup pay a property-based tax to the

[17] Hudak, PF, 2000. Regional trends in nitrate content of Texas groundwater. Journal of Hydrology. 228(2000) 37–47

[18] Olyphant, J; Scanlon, BR. Unsaturated Zone Profiles Linking Land Surface Applications and Groundwater Nitrate Contamination: Case Studies Seymour Aquifers, Texas. 2008 Joint Meeting of The Geological Society of America, Soil Science Society of America, American Society of Agronomy, Crop Science Society of America, Gulf Coast Association of Geological Societies with the Gulf Coast Section of SEPM.

[19] Olyphant, J, 2008. Ibid.

[20] Hudak, PF, 2000. Op.cit.

NCTMWA in addition to the contracted water rate.[21] On the other hand, "non-member" systems in this subgroup, which do not pay taxes to NCTMWA, have higher water rates; however, these rates are essentially equivalent to the member city rate plus the tax for the consumer. For these "non-member" systems who neglected to "buy in" to the contracts years ago, blending with Millers Creek Reservoir water does not seem to be a long-term solution to the nitrate problem, because from the point-of-view of the utility system, the water rates are higher. For these surveyed non-member systems, the treatment of nitrate continues to be the largest issue of concern. Four systems in the area have been issued a total of 19 MCL violations for nitrate in the last two years, and nitrate concentrations in groundwater for these systems are consistently around 13-15 mg/L. Non-member systems are looking at other treatment methods, such as reverse osmosis (e.g., City of Benjamin) or ion-exchange (e.g., City of Weinert, City of Rochester) to address the issue.

Other issues emerged from the survey of PWSs in the region, especially for those systems not currently preoccupied with treating nitrate. Two systems (Sagerton WSC, City of Haskell) cited infrastructure improvements, such as repair or replacement of pump stations, electric lines, holding tanks, and aging distribution lines, as the most pressing need. Three systems (City of Goree, City of Weinert, and Paint Creek) were interested in an equipment/parts/contract repair sharing program. One system (City of Weinert) was interested in administrative and billing improvements, and noted that modern billing software is prohibitively expensive for just one small system alone.

The feasibility of PWSs in the Subgroup 3A area working together is somewhat limited by the prioritization of needs that differs between non-member systems (mostly concerned with reducing nitrate levels) and member systems (mostly concerned with capital improvements and equipment issues). However, both member and non-member systems may be able come together on other issues not directly related to issues of purchased water-supply, such as sharing qualified and licensed operators. Some cities already have interlocal agreements or a history of working together. For example, the City of Aspermont shares water lines with the City of Rule, and the City of Benjamin and Rhineland WSC have worked together in the past.

Of the ten systems contacted in the Abilene Subgroup3A area, nine were interested in being evaluated for regionalization:

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[21] Although the current property tax is set to expire in 2010 (once reservoir bonds are paid off), member cities may try to pass an operations and maintenance tax for continued O&M funding.

- City of Benjamin (non-member of Millers Creek system),
- City of Rochester (non-member),
- City of Weinert (non-member),
- City of Obrien (non-member),
- City of Goree (member),
- City of Munday (member),
- Paint Creek WSC (member),
- City of Haskell, and
- Sagerton WSC.

4.3.2 Subgroup 3B: Fisher, South Jones, Nolan, Taylor, and West Callahan Counties

The second subgroup near Abilene is comprised of PWSs in Fisher, Nolan, and Taylor Counties, and South Jones and West Callahan Counties, encircled in red and labeled Group 3B in Figure 6. Most systems in this subgroup have surface water as their primary source of water, although several of these systems purchase water from other systems, with many systems receiving some of their water from as far away as Abilene and Lake Ivie. The surface water sources include Lake Ivie, Lake Daniel, Lake Ft. Phantom Hill, Mulberry Creek, Hubbard Creek Reservoir, Lake Clyde, Lake Coleman, and Oak Creek Reservoir. Groundwater sources in the area come from the Dockum, Blain, Edwards-Trinity, and Trinity Aquifers.

Of the 17 systems surveyed for this subgroup, 16 systems purchase water from another water system. Of these, 11 systems use purchased water as a primary supply and 5 systems use purchased water to augment local surface or groundwater sources. Thirteen systems purchase water from Abilene or from another system that purchases water from Abilene. Eight of the systems that purchase water do not rechlorinate purchased water regularly as part of a treatment train but do boost disinfection occasionally, whereas four systems regularly boost disinfection using gaseous chlorination prior to distribution.

Occasional elevated DBP concentrations were found for 11 systems, and 5 systems have been issued MCL violations since 2005 (31 violations total, but with only 9 violations occurring since 2007). Seven PWSs with elevated DBPs purchase water from another source and often distribute water without further treatment; six of these systems receive that purchased water from the City of Abilene, and one system receives water from the City of Sweetwater (Oak Creek Reservoir). These purchased water systems are capable of boosting disinfectant using chlorine or chloramines, but typically only boost during the summer or when disinfectant levels in purchased water are low. The primary provider of most purchased water systems in the area, Abilene, disinfects water using chlorine dioxide in pre-treatment and chloramines in post-treatment. Chloramines are less reactive than chlorine and typically form fewer DBPs with organic matter in the system. Abilene has been operating within compliance and has not been issued any MCL violations (TTHM, HAA5, or otherwise) in the time period investigated (since 2005). A time-series analysis of TTHM concentrations at Abilene and PWSs that purchase water from Abilene shows little correlation between concentrations (Figure 7). However, DBP formation must be occurring at some point between the Abilene PWS and distribution from the six purchased water systems. DBP formation may be attributed to the occasional, but improper levels of disinfectant boosting provided by purchased water systems prior to distribution. DBP formation may also be affected by the piping or storage system configuration, residence times/water age, or the presence of reactive organic materials at various points between source and distribution.

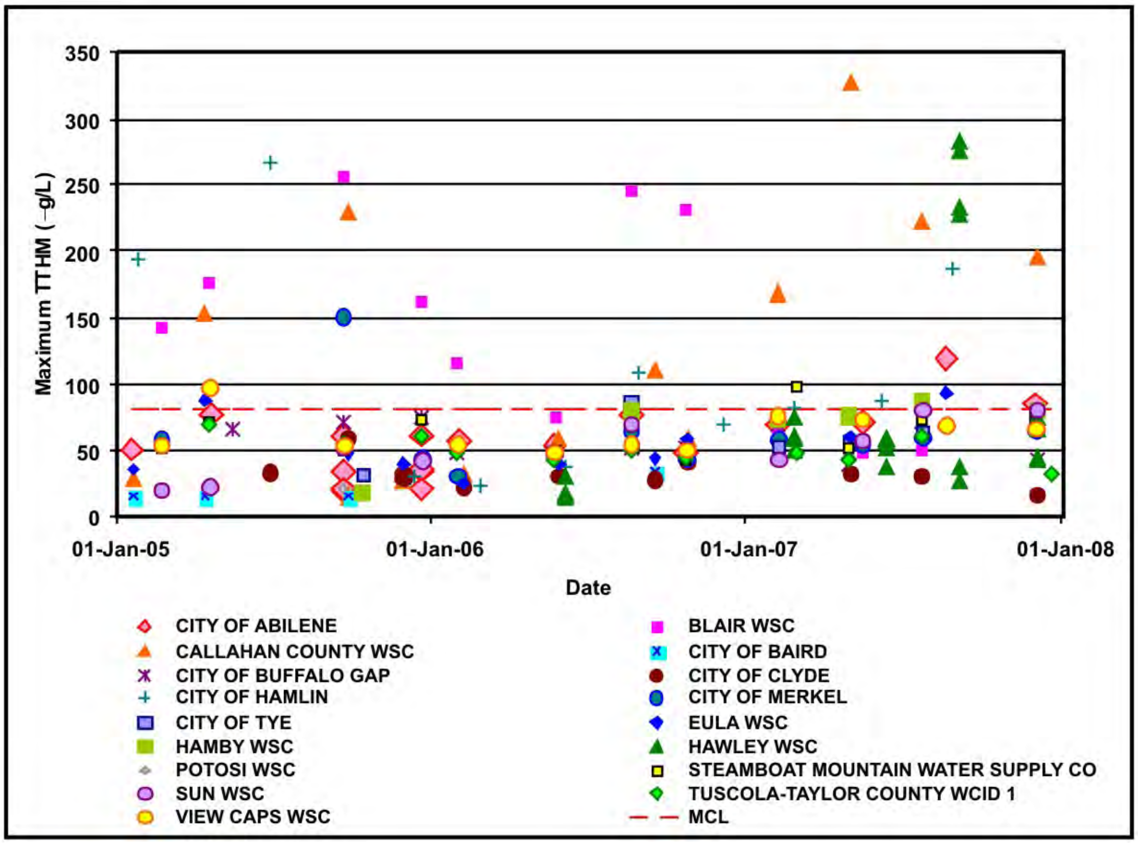

Figure 7. Maximum Sampled TTHM Concentrations at Abilene (pink diamond) and PWSs that Purchase Water from Abilene. (Data source: TCEQ Chemical Analysis Database)

One other interesting DBP observation concerns the four water systems with elevated DBPs that **do** treat water (and not just boost disinfectant on occasion). These four systems use different disinfection methods, including gaseous chlorination (1 PWS), chloramines (1 PWSs), or a combination of gaseous chlorination and chloramines (2 PWSs). The type of disinfectant, at least for this small sample of systems, has little effect on the potential for DBP formation. Despite the potential for DBP formation, however, only one surveyed system in the area (City of Lawn) expressed a concern for current DBP levels, and has recently secured a rural development grant to rebuild filters and the chlorine system to address the problem. Other purchased water PWSs with potential DBP issues were less concerned, perhaps because the number of exceedences and violations has decreased over time, indicating the problem is being addressed.

Violations of the TCR coliform MCL were also a problem for three PWSs in the area. Two of the systems with coliform MCL violations are purchased water systems located less than 9 miles apart that use the same supplier, but only boost disinfection occasionally. The other system, located 16 and 25 miles from the other two systems, is a groundwater system that uses gaseous chlorination to treat water. These three systems could remedy coliform problems by properly boosting disinfectant, but should take care to minimize DBP formation. There may be opportunity for sharing resources to address the coliform issue, as two of the systems (City of Merkel, City of Tye) currently have an interlocal agreement, although these two systems recently have been unable to work out a purchase agreement.

Most PWSs in the area were concerned with various other non-treatment issues such as infrastructure, equipment and electrical needs, and operator training. The most common infrastructure need, cited by three PWSs (City of Lawn, Bitter Creek WSC South, City of Tye), was the replacement or repair of older distribution lines. The future need for new or refurbished large treatment infrastructure was also a concern for two systems with different treatment requirements (City of Lawn – refurbished filtration and chlorination system; Sylvester McCaulley WSC – possible reverse osmosis treatment). Two PWSs (Potosi WSC, Bitter Creek WSC South) were interested in equipment resource sharing, and another two PWSs (Potosi WSC, Hamby WSC) cited a need for shared electric substation redundancy or emergency power generation. Two other PWSs (City of Merkel, City of Roscoe) indicated a need for better and more comprehensive operator education and training.

In general, the group of issues prioritized by PWSs in the Subgroup 3B were extremely varied and not shared by large numbers of neighboring systems. Some PWSs in this subgroup had very specific concerns not shared by other surveyed systems. For example, the City of Buffalo Gap was most concerned with mapping old distribution lines. The City of Roscoe was most concerned with securing blending options for high-nitrate groundwater. [22] Although data since 2005 indicate that elevated DBP concentrations have the potential to affect several PWSs in the group, only one surveyed PWS brought up the issue as being of particular concern.

The willingness for PWSs in this area to work together under some sort of regionalized system has some precedence supporting the possibility. Many PWSs in the area already have informal or interlocal agreements with neighboring systems. For example, the City of Merkel has an interlocal agreement with the City of Tye, and the City of Clyde has an interlocal agreement with the City of Baird. In addition, all 16 PWSs using purchased surface water have arrangements and working relationships with their water suppliers. Two systems (Potosi WSC, Eula WSC) have even entertained the concept of managerial regionalization in the past. The limiting factor for regionalization in this area seems not to be whether PWSs can work together, but rather whether there is consensus on what issues are most pressing and whether resources can be shared to address those issues.

Of the seven systems surveyed in the Abilene Group 3B area, all expressed some interest in being evaluated for regionalization:

- City of Lawn,
- City of Buffalo Gap,
- Callahan County WSC,
- Eula WSC,
- City of Clyde,
- City of Tye,
- Blair WSC,
- City of Merkel,
- Hamby WSC,
- City of Roscoe, and
- Sylvester McCaulley WSC.

[22] The City of Roscoe has consistent problems with nitrate, which cannot be solved by constructing new wells in the area. The City is addressing issue by purchasing water for blending with the City of Sweetwater. Roscoe is located over 70 miles away from the Group 3A region where other PWSs are also experiencing high-nitrate concentrations.

4.3.3 Subgroup 3C: Stephens, Eastland, East Shackelford, and East Callahan Counties

The final groups of PWSs under consideration in the Abilene area are those systems located east of Abilene in Stephens, Eastland, East Shackelford, and East Callahan Counties, encircled in red and labeled Group 3C in Figure 6. Most systems in this subgroup use surface water or purchased surface water as a source. These surface water sources include Lake Leon, Hubbard Creek Reservoir, Lake Daniel, Lake McCarty, Lake Proctor, Lake Baird, Lake Clyde, Lake Cisco, Lake Abilene, Lake Ft. Phantom Hill, and Lake Ivie. Groundwater sources in the area come from Antlers Sand zone of the Trinity Aquifer.

Of the 16 systems surveyed for this subgroup, 12 systems purchase water from another water system, and use purchased water as a primary source of water (10 PWSs) or to augment local groundwater sources (2 PWSs). Of the purchased water systems, three PWSs boost disinfectant using hypochlorination and one system uses both hypochlorination and chloramines as part of a prescribed treatment train, and the other seven systems only boost disinfectant occasionally when levels in purchased water are low.

Elevated DBP (TTHM and HAA5) concentrations are common for PWSs in this area. Fourteen PWSs in this subgroup were issued a total of 116 (TTHM or HAA5) MCL violations since 2005, but after 2007 only 14 DBP violations were issued for 5 PWSs. Eight of these PWSs with a DBP violation history do not have a prescribed treatment train, but occasionally boost disinfectant before distribution. Most elevated DBP purchased water originates from one or more of the following sources: Lake Leon/Eastland County Water Supply District (7 PWSs), Abilene (3 PWSs), Lake Cisco/City of Cisco (2 PWSs), Hubbard Creek Reservoir/City of Anson (2 PWSs), Lake Clyde/City of Clyde (1 PWS), Lake McCarty/City of Albany (1 PWS), and Lake Daniel/City of Breckenridge (1 PWS). However, these sources of purchased water do not typically have the same DBP issues as their customers.

Most PWSs in subgroup 3C expressed less concern with elevated DBP issues than other non-treatment related issues. The lack of concern of most surveyed systems to DBP issues may be the result of recent improvements in controlling the MCL; for example, there was a large drop in the number of systems violating DBP MCLs from 2005 to present day, with only 12% of the violations occurring after 2007.

Further complicating the problem for treating elevated DBPs is that four systems with elevated DBPs also received coliform MCL (TCR) violations since 2005. Only one of these four systems is a non-treatment, purchased water system. The other three systems must delicately balance treatment to control coliform while maintaining DBP levels below the MCL to meet simultaneous compliance with both TCR and chemical MCLs.

Most PWSs in Group 3C were more concerned with financial and infrastructure issues than treatment issues. Five systems (Morton Valley, City of Moran, Stephens Regional SUD, Shackelford, and City of Ranger) were concerned with the repair, upgrade, or expansion of water distribution lines. Many of the systems in the area have original small diameter (1”-2”) pipes from the 1940s that have developed leaks, do not provide sufficient fire flow needs (City of Moran), or are not sufficiently looped to ensure reliable and available water during pipe failure (Morton Valley WSC). Other large infrastructure issues noted were the need for new pump stations (Shackelford WSC), water storage (City of Moran), and clarifiers (City of Baird). The desire to share qualified operators was the concern of only one system in the area (City of Ranger).

Examples of working agreements in the area are numerous: Morton Valley shares operators with the Carbon system, and has other arrangements with City of Eastland and the City of Ranger; Staff WSC has loaned Morton Valley personnel; Stephens Regional SUD has worked with Shackelford, PK Water Supply, Fort Belknap WSC, Possum Kingdom WSC, and Westbound WSC; and 12 purchased water systems have working relationships with their providers. Despite this history, some PWSs did not see a need for interference (in the form of regionalization); many systems in the area mentioned ways they have helped each other out for several years without formalized agreements. Several systems (City of Eastland, Shackelford, City of Cross Plains, City of Rising Star, Westbound WSC) felt their needs were currently being met, but indicated they were available to help out neighbors (e.g., loaning equipment, operators) if there was an overwhelming need.

Of the eleven PWSs surveyed, eight were interested in being evaluated for regionalization:

- Shackelford WSC,
- Stephens Regional SUD,
- City of Moran,
- Morton Valley WSC,
- City of Ranger,
- City of Eastland,

- City of Baird, and
- City of Cross Plains.

5.0 Considerations for Regionalization of Two Candidate Groups

Section 5.0 describes in detail the variety and complexity of issues that selected groups of small and medium PWSs in Brazos G are currently addressing. This section describes the final identification of two candidate regional systems and the considerations and recommendations for regionalization. In Section 5.1, the final selection criteria is defined and applied to each regional group to determine the final two candidate groups for regionalization. In Sections 5.2 and 5.3, the financial, engineering, and other considerations for regionalization are discussed for the two candidate groups.

5.1 Identification of Final Candidate Groups

The focus of this study is to identify two candidate groups where some form of regionalization might be feasible, and explore the various engineering, financial, and other considerations that would influence a regional scheme. Identification of the final candidate groups for regionalization was based on four factors: (1) the severity of the issues as it relates to Safe Drinking Water Act compliance; (2) the extent to which the issues were shared among neighboring systems; (3) the engineering, political, and economic feasibility of regionalizing resources; and (4) the expected cost versus benefit for systems under regionalization. These criteria were chosen to target areas in Brazos G where regionalization of systems would be most effective in protecting human and environmental health. Each group described in Sections 4.1-4.3 was evaluated using these final selection criteria and the rationale for selection is summarized below.

Group 1 in the Burleson-Washington County area, described in Section 4.1, was not recommended as a final candidate group for regionalization primarily because there was low immediate risk to human health from existing system deficiencies and interest for collaboration in the region was scattered. Although several PWSs in the region had records of elevated DBPs, these systems had undergone recent changes to the process or system configuration and were expected to have lower DBP concentrations in the future. Financing and infrastructure issues dominated the needs of some surveyed systems in the region, although only two close systems (less than 5 miles apart) shared a common need for replacing old water lines. There was some interest in regional sharing of operators for a handful of systems in a 15-mile radius, although all interested PWSs currently employ their own operators. However, consistently occurring TCR monitoring and reporting violations indicate a need for improved operations for these afflicted systems. Backup, qualified operators or better management of coliform issues on a regional scale could be solutions to these reporting and monitoring problems. Overall, there are systems in the Group 1 area that may benefit from regionalization of resources, but the needs are less immediate than those found for other evaluated groups.

Group 2 in the Falls-Hill-Limestone-McLennan County area, described in Section 4.2, was recommended as a final candidate group for regionalization, because a very specific MCL issue with serious consequences for human health was shared by several PWSs in the area, and these PWSs have demonstrated an ability to work together. Elevated arsenic concentrations in groundwater sources have forced several PWSs to look towards treatment or blending options in the system in order to meet SDWA compliance. A preliminary partnership of systems has already formed to look into the available alternatives. Further recommendations regarding financial, engineering, and other considerations for the regionalization of resources in this area are provided in Section 5.2.

Group 3A in the Haskell/North Jones/Northwest Shackelford/South Knox Counties north of Abilene, described in Section 4.3.1, was also recommended as a final candidate group for regionalization, because a very specific SDWA compliance problem with human health risks was shared by several PWSs. Nitrate concentrations in groundwater in the area are among the highest in the state, and some PWSs in the group are unable to maintain compliance despite blending with a nearby low-nitrate surface water source. Although there may be some political considerations to address between member systems and non-member systems that have different purchased water contract requirements, the non-member systems have indicated interest in working together if a regional solution is possible. Further recommendations and considerations for the regionalization of resources for these non-member systems in the area are provided in Section 5.3.

Group 3B in the Fisher, Nolan, Taylor, South Jones and West Callahan County area south and west of Abilene, described in Section 4.3.2, was not recommended as a final candidate group for regionalization, because the most widespread SDWA compliance issues with greatest risk to human health (elevated DBPs) were generally not acknowledged as a pressing concern by affected PWSs. Most of the systems in the group with a history of elevated DBPs were purchased water systems whose suppliers did *not* show correspondingly high levels of DBPs, indicating DBP formation may result from improper boosting of disinfectant prior to distribution, or may be occurring elsewhere in the system. There is potential for the formation of a regional partnership of water purchasers sharing a common supplier to address overall water quality issues. For example, systems could share knowledge and operational resources to ensure proper disinfectant boosting and reduce the potential for DBP formation. However, this would require overcoming the lack of shared interest in the DBP issue at this point in time, as most PWSs in the group were more concerned with very diverse issues specific to their individual PWS system needs (e.g., infrastructure, equipment, operator, mapping, etc.).

Group 3C, located east of Abilene in Stephens, Eastland, East Shackelford, and East Callahan Counties and described in Section 4.3.3, was also not recommended as a final candidate group for regionalization, because most of the systems in this area had greater concern for issues not directly related to complying with provisions in the SDWA. Elevated DBPs and/or coliform were the most common SDWA compliance problems for the group, and some systems even had problems with both contaminants. However, like Group 3B, most of these systems were purchased water systems that did not indicate a shared concern with DBPs. The number of DBP violations and the number of affected PWSs fell drastically every year since 2005, indicating that most systems have found solutions to the problem. PWSs in this group were most concerned with various infrastructure issues, mostly related to replacing old distribution system lines.

5.2 Group 2: Falls, Hill, Limestone, and McLennan Counties

The FHLM area was selected as a candidate group for regionalization based on the selection criteria of high risk to human health and the feasibility of systems in the area to work together.

5.2.1 Engineering Considerations

Engineering considerations described in this section are focused primarily on those considerations that directly address the mitigation of arsenic in groundwater for the FHLM area. There are several mitigation strategies available for high levels of arsenic in groundwater sources including abandonment, seasonal use, treatment, blending, or sidestream treatment.[23] Each

[23] Environmental Protection Agency (EPA), 2003. *Arsenic Treatment Technology Evaluation Handbook for Small Systems*. EPA 816-R-03-014.

strategy is comprised of a variety of options or technologies that need to be evaluated and prioritized in order to determine what is most appropriate for any system or group of systems. Some considerations for choosing an appropriate engineering alternative are shown in Table 6.

Table 6.
Considerations for Choosing an Appropriate Engineering Alternative

Quality of Water	How effective is the alternative? Does the water meet the MCL and other standards? Are any new contaminants introduced? Are there multiple-barrier protection systems in place in case of failure? Can the risk of human error be reduced?
Quantity of Water	What are the source flows? What is the historical availability and reliability of the water source? What are the options and risks involved if an insufficient quantity of water is provided? What are the source controls (i.e., how do humans affect withdrawal, and how does nature affect recharge)? What are the consequences of using unsafe resources? What are the water losses?
Reliability	Does the process run under sub-optimal conditions?
Operation and Maintenance	Does the manufacturer (e.g., media, equipment, or otherwise) have a proven track record, financial stability, and service commitment? What are the operation and maintenance requirements? What is the labor commitment?
Robustness	What happens upon system failure (is the user or operator made aware)? Are there easy-to-understand indicators in place to determine these failures points?
Convenience	What are the location and accessibility of the water treatment facility and sources? How is water delivered to consumers?
Social Acceptance	Is the technology accessible and understandable for operators? Is proper training given to operators?
Environmental Factors	What is the land availability? Are there issues in water extraction, transport, or disposal? How should the chosen technology be weighed against other environmental contamination impacts of using the technology?
Regulatory Factors	What are the federal (EPA), state, or local requirements?
Costs	Perhaps the biggest factor in choosing an appropriate treatment technology is the cost of treatment. Detailed cost curves and instructions on calculating capital and operation and maintenance costs for various treatment technologies can be found in the 2000 EPA document on "Technologies and Costs for Removal of Arsenic from Drinking Water." Financial considerations are discussed further in Sections 5.2.2 and 5.3.2

Abandonment of a high arsenic water source and/or procurement of a low arsenic water source within the system or purchased from a neighboring system is the simplest strategy for meeting the MCL. However, simple abandonment of a high arsenic source is unlikely to work in the FHLM area where several systems depend on only a handful of groundwater sources. For example, at least five PWSs in the FHLM area with high arsenic concentrations obtain water from only one or two sources, and cannot easily switch or abandon sources for a higher quality source because the resultant supply will not meet existing demand. PWSs in the area could attempt to find and utilize new low-arsenic sources of water, but considering that aquifers in the area are associated with naturally high groundwater arsenic concentrations, locating new wells with low arsenic concentrations is likely to be futile and far more costly than treatment. In addition, regulation of water sources limits the extent of PWSs to search for new sources. For example, difficulty in obtaining surface water rights could preclude systems from simply developing new surface water sources. Although Falls, Hill, and Limestone Counties are not located in a local groundwater conservation district, and therefore the "rule of capture" would apply for developing new groundwater resources, groundwater development in McLennan County, where many of the afflicted systems are located, will be regulated by the newly-formed McLennan County Groundwater Conservation District. Interconnections currently do not exist between most of the systems under evaluation, but construction of interconnections could allow these PWSs to purchase water and either completely abandon groundwater sources or use the purchased water for blending.

Seasonal use, where a high arsenic water source is switched from full-time use to peak or seasonal use only, is also likely unsuitable for the FHLM area, because many of the systems rely on groundwater with high arsenic as a primary water source. In theory, because compliance with the arsenic rule in Texas is based on a running annual average (RAA) of quarterly sample results, PWSs could exceed the MCL for one or more quarters of the year, as long as the running annual average (over four quarters) remains below the MCL. PWSs could therefore use high arsenic water sources seasonally, and either abandon or blend the high arsenic sources the remainder of the year. Again, since most PWSs rely on high arsenic groundwater as a primary source, seasonal use as a mitigation strategy alone will not suffice. Meeting the MCL will still require systems to treat all or some of the source water or locate an outside-the-system, low-arsenic source by investing in infrastructure to convey purchased water for distribution or blending.

Treating or processing of all or part of a water source to lower arsenic concentrations below the MCL is a possible mitigation strategy for the FHLM area. Treatment can occur at three places in a given system: at the wellhead (for a single water source), at point-of-use (typically for a single delivery point), or at a centralized location (for several water sources). Because this study is concerned with regionalization strategies, the only option described here is treatment at a centralized location for one or more PWSs, where each system has one or more water sources. Important factors relating to the location of a centralized treatment facility include

(1) the proximity of wells to be treated to one another, (2) the feasibility of piping sources to a central location, and (3) the availability of land and power at the site.

There are several technology options available for the physical/chemical treatment and removal of arsenic. Table 7 shows an example of the range of arsenic removal efficiencies for several common treatment technologies. Note that all the technologies listed, except for possibly reverse osmosis,[24] require pre-oxidation for effective removal; all removal efficiencies reported in Table 7 are for oxidized arsenic in the form of As(V). Different technologies lead to different outcomes for the engineering considerations described in Table 7. For example, reverse osmosis may treat arsenic to result in a higher water quality (> 95% removal from Table 7) than conventional coagulation/filtration using alum (90%), but water losses associated with the former technology may be much higher (15-50% of feed water) than losses associated with the latter technology (1-2%). The relative lower WTP capital cost using coagulation and filtration technology might be offset by the need for a higher level operator skill and operation and maintenance costs. In addition, although Table 7 gives a relative comparison of technologies, the design assumptions are neither absolute nor consistent for a given technology. For example, without knowing the source water quality or process empty bed contact time, cost comparisons for adsorptive media processes (e.g., activated alumina, ion exchange) have limited applicability because treatment media requirements, which comprise a large fraction of total treatment costs, vary greatly. However, guaranteed costs for pursuing a centralized treatment strategy include investment in not only the treatment plant, but also in conveyance structures to carry raw water from sources to the plant and treated water back to the individual distribution systems.

Blending, or the combination of multiple water sources to lower arsenic concentrations below the MCL, is another possible mitigation strategy for the FHLM area. Blending of high arsenic groundwater with low-arsenic groundwater or surface water is a non-treatment alternative that can be achieved at the individual PWS level or a more regional level. Most PWSs in the FHLM area do not have enough high quality sources available for blending on an individual basis, and blending to lower arsenic concentrations would need to be accomplished using outside water sources. Using the blending strategy in the FHLM area will require large infrastructure investments in the form of piping and interconnections to allow for the outside purchase and procurement of low-arsenic water.

[24] For reverse osmosis, removal efficiencies of reduced As(III) are inconsistent and much lower than oxidized As(V).

Table 7.
EPA Arsenic Treatment Technology Comparison

Treatment Technology	***Water Quality Requirements***	***Maximum Removal As(V)***	***Water Loss***	***Potential Application***	***System Size (Population)***	***Operator Skill***	***Waste Generated***	***WTP Cost***
Coagulation/ Filtration	pH 5.5-8.5	95% ($FeCl_2$) < 90% (Alum)	1-2%	GW, SW, Large systems, Small systems	25-10,000	High	Backwash water, sludge	Low
Lime Softening	pH 10.5-11 Fe > 5 mg/L	90%	1-2%	GW, SW, Large systems, Small systems	25-10,000	High	Backwash water, sludge (high volume)	Low
Ion Exchange	pH 6.5-9 NO_3 < 5 mg/L SO_4^{2-} < 50 mg/L TDS < 500 mg/L Turbidity < 0.3 NTU	95%	1-2%	GW, Small systems, POE/POU	25-10,000	High	Spent resin, spent brine, backwash water	Medium
Activated Alumina	pH 5.5-8.3 Cl^- < 250 mg/L F^- < 2 mg/L SO_4^{2-} < 360 mg/L Silica < 30 mg/L Fe^{3+} < 0.5 mg/L Mn^{2+} < 0.05 mg/L TDS < 1000 mg/L TOC < 4 mg/L Turbidity < 0.3 NTU	95%	1-2%	GW, Large systems, Small systems, POE/POU, Wellhead	25-10,000	Low	Spent media, backwash water	Medium
Reverse Osmosis	No particulates	> 95%	15-50%	GW, SW, POE/POU, Large systems, Small systems	501-10,000	Medium	Reject Water	High
Greensand Filtration (Oxidation Filtration)	pH 5.5-8.5 Fe > 0.3 mg/L Fe:As Ratio > 20:1	50-90%	1-2%	GW, Large systems, Small systems, POE/POU, Wellhead	25-10,000	Medium	Backwash water, sludge	Medium

Information compiled from Table 3-12 (EPA, 2000)[1], Table 1 (Clifford, 2002)[2], and Table 3-3 (EPA, 2003)[3]

[1]Environmental Protection Agency (EPA). 2000. Technologies and Costs for Removal of Arsenic from Drinking Water. EPA 815 -R00-028.

2Clifford, DA; Ghurye, GL. 2002. Metal-Oxide Adsorption, Ion-Exchange, and Coagulation-Microfiltration for Arsenic Removal from Groundwater. In Frankenberger, WT (ed.): Environmental Chemistry of Arsenic. Marcek Dekker, Inc., New York. pp217 -245.

[3]EPA, 2003. Op. cit.

GW=groundwater, SW=surface water, POE=point of entry, POU=point of use.

Side-stream treatment is a combination of treatment and blending strategies, where one portion of a high arsenic water stream is treated and blended back into the untreated portion to lower final concentrations below the MCL. This strategy is useful for water sources that exceed the MCL by a small amount, such as is the case for PWSs in the FHLM area, which typically have concentrations only 1-2 μg/L above the limit. Most treatment processes can remove arsenic from water at such a high level (Table 7), that it is unnecessary, not to mention costly, to treat the entire stream. Side-stream treatment for the FHLM area will require investment in both treatment technology and piping infrastructure.

5.2.2 Financial Considerations

Over the course of the survey, PWSs in the Brazos G Area expressed financial concerns on at least ten separate occasions (Table 4). Access to funding is a fundamental requirement for any infrastructure project, and several PWSs in the region are rightfully concerned about the affordability of remaining in compliance. Regardless of the engineering strategy ultimately employed by PWSs in the FHLM area, some investment will be required to regionalize infrastructure or resources. For example, using a treatment strategy will require investment in conveyance to a new central treatment facility. Using a blending strategy will require investment in purchased water and conveyance to the systems. Using a side-stream treatment strategy may require investments in both treatment and blending. The financial considerations for these strategies and the resources for financing are briefly discussed below.

Affordability is a subjective concept and can be defined in many ways, but the EPA defines affordability of water service as two percent of the median household income (MHI). In March 2006, EPA announced a review revision to the SDWA's affordability criterion for small system variance (71 Federal Register 10671) and suggested 2.5% of median household income (EPA has not announced when its review will be completed). At the state level, the TWDB calculates a "household cost factor" metric (31 TAC 371.24(b)) to determine unaffordability for disadvantaged communities and suggests that regionalization resulting in rates with a household cost factor greater than 1% for water service may not be affordable. Grants and loans may have requirements based on different definitions of "affordability," but this metric may not accurately reflect the true ability-to-pay for PWS customers, because oftentimes affordability is calculated without taking into consideration the economic stratification or the overall poverty rate of the community. The Rural Community Assistance Partnership (RCAP), for example, is an outspoken opponent of the EPA revision and believes that changing the currently adopted standards and procedures "would jeopardize public health while providing little, if any, financial relief for small communities."[25] For reference, the MHI, 2% MHI, and poverty rate are shown for regionalization counties of interest in Table 8. According to the most recent census data, Falls, Hill, Limestone, and McLennan counties all have median incomes below the Texas median, and Limestone and Falls Counties have median incomes less than 75% of the Texas median.

Table 8.
Median Household Income, 2% MHI, and Poverty Rate for Select Texas Counties in the Group 2 Area

County	*MHI (2004)*	*2% MHI**	*Poverty Rate (1999)*
Texas	$41,645	$833	16.2%
Falls	$27,818	$556	21.7%
Hill	$33,280	$666	16.2%
Limestone	$30,792	$616	17.8%
McLennan	$35,225	$705	18.3%
* Maximum affordable yearly water bill according to EPA			

There are several strategies PWSs can use to try to make regionalization "affordable," using both internal and external funding resources. Investment necessary for regionalization can be funded internally by tapping into utility rates, service fees, impact fees, funding depreciation expenses, or making cost reductions throughout the system. External funding sources include short- and long-term debt financing, low interest loans and grants, and accessing better capital markets through the creation of special districts or authorities.

Several systems expressed concern about financing projects because their customers are unable to afford rate changes. Rates are the fundamental source of revenue funding for a system, and if costs cannot be funded using other means, rate changes are often used as the fallback position. However, rate restructuring might be one way systems can make projects more affordable. For example, by moving from a flat rate structure to a volume-based rate structure, PWS customers can have begin to exert some control over costs by varying the amount of usage based on ability to pay. However, any rate change or restructuring strategy that leads to increases in overall rates for some or all customers will have to balance the effects of decreased demand

[25] Stewart, R.B. 2007. Affordability for Small Drinking Water Systems. Water and Wastes Digest: August 2007. 40-42.

and lower revenue from those affected customers with any increase in revenue from higher rates. The ability for a PWS to change rates may also depend on the rate jurisdiction. City-owned systems and non-profit WSCs have exclusive jurisdiction over retail rates, unlike investor-owned utilities.

Debt financing through revenue bonds or contract revenue bonds, certificates of obligation bonds, and general obligation bonds is also an option for external funding, but low-interest loans and grant money are the preferred methods of external funding for most PWSs, because they often incur the least amount of cost over the long run. However, obtaining low interest loans and grants is a long and competitive process for limited available funds. Some of the PWSs that were surveyed discovered the quickest way to be bumped to the top of the preferred low-interest loan or grant list was to be issued a violation (For example, TCEQ is involved in prioritizing potential loan applicants for the Drinking Water State Revolving Fund by assigning ratings based on compliance and other information in their files, which the TWDB reviews as part of a pre-application process). Although several currently violating systems had been awarded recent grants, most were primarily for wastewater-related improvements. Several PWSs have taken advantage of their disadvantaged status to apply for low interest loans or grants, but other PWSs are unfamiliar with these programs and are in need of technical and application assistance. Because of the interest presented by PWSs and the universal attractiveness of inexpensive money for regionalization, some of the most applicable sources of funding for regionalization and drinking water system improvements are described here. Of those, the TWDB's Financial Assistance Programs provide much of the financing for water supply projects in the state, through state-backed bonds or the combination of state bond proceeds with federal grant funds.

The 1996 SDWA amendments established the Drinking Water State Revolving Fund (DWSRF) to provide funding to drinking water systems to finance infrastructure projects. The TWDB makes these funds available to public drinking water systems at interest rates lower than market rates to facilitate compliance with primary drinking water regulations or otherwise significantly further the health protection objectives of the federal SDWA. The TWDB uses a priority ranking for applicants from TCEQ. For "disadvantaged communities," defined as communities at 75% of MHI and meeting the aforementioned household cost factor requirements, a limited amount of funding each year is available at even greater subsidies and loan terms of up to 30 years. Two of the targeted counties and areas in the FHLM area (Limestone and Falls Counties) meet this “disadvantaged community” requirement (Table 8).

In addition to the DWSRF, the 71st Texas Legislature (1989) established an Economically Distressed Areas Program (EDAP) to provide grants, loans, or a combination for water services in economically distressed areas when the present facilities are inadequate to meet state standards or residents’ minimal needs and the financial resources are inadequate to provide the services to meet those needs. Financial assistance from the EDAP is available for any economically distressed county, sub-county, or utility service area where the median household income is not greater than 75% of the median state household income. Again, two of the counties (Limestone and Falls Counties) and portions of the other two counties (McLennan and Hill Counties) may meet this 75% requirement (Table 8).

The TWDB also administers the Rural Water Assistance Fund (RWAF), created by the 77th Texas Legislature (2001) that assists small rural water utilities to obtain low cost financing for water related projects. Nonprofit water supply corporations, water districts or municipalities with population less than 10,000, or counties and counties where no urban area has a population exceeding 50,000, can apply for funds to be used for line extensions, elevated storage, well field purchase, the purchase or lease of rights to produce groundwater, or interim financing of construction projects.

The Water Infrastructure Fund (WIF) Loan Program, established by the 80th Texas Legislature (2007), also provides financial assistance for political subdivisions in the planning, design, and construction of projects specifically included in the State Water Plan. Projects must be recommended water management strategies in the most recent TWDB approved regional water plan and State Water Plan.

The State Loan Program (Development Fund II) is the source of funding from which TWDB makes state loans, including loans for water supply. These loans are available at tax-exempt rates for political subdivisions and WSCs. Financial assistance can be used for acquisitions, improvements or construction of wells, retail distribution and wholesale transmission lines, pumping facilities, storage reservoirs and tanks, water treatment plants, and water rights purchases.

More specific for regional systems is the TWDB-administered Regional Water Supply and Wastewater Facilities Planning Program. This program offers grants to political subdivisions for studies and analyses to evaluate and determine the most feasible alternatives to meet regional water supply and wastewater facility needs, estimate the costs associated with implementing feasible regional water supply and wastewater facility alternatives, and identify institutional arrangements to provide regional water supply and wastewater services for areas in Texas. The proposed planning must be regional in nature by inclusion of more than one service areas or more than one political subdivision and all plans must be consistent with applicable regional or statewide plans. Political subdivisions (including cities, counties, districts, authorities, non-profit WSCs, and any other political subdivision of the State or interstate compact commission for which the State is a party) that have the legal authority to plan, develop, and operate regional facilities are eligible applicants for regional water supply and wastewater planning grants.

Another TWDB program directed towards regional systems is the State Participation Program. This program enables the TWDB to assume a temporary ownership interest (i.e., ownership interest in water rights or co-ownership in property or treatment works) in a regional project when the local sponsors are unable to assume debt for the optimally sized facility. The loan repayments that would have been required, if the assistance had been from a loan, are deferred. The cost of the funding is ultimately repaid to the TWDB based upon purchase payments, allowing the TWDB to recover its principal and interest costs and issuance expenses, but on a deferred timetable. The program is intended to allow for optimization of regional projects through limited State participation where the benefits can be documented, and such development is unaffordable without State participation. The goal is to allow for the "right sizing" of projects in consideration of future growth. The program recognizes two types of State Participation Projects, those that create a new supply of water and those that do not, with different requirements for each. Any political subdivision of the state and water supply corporations which are sponsoring construction of a regional water (or wastewater) project can apply for the program.

Several other state agencies and organizations also provide financing for needy PWSs. The Texas Office of Rural Community Affairs (ORCA), provides funding to eligible cities and counties through the U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant Program (CDBG). Counties can apply for ORCA assistance for unincorporated areas in that county for projects funded through regional competition and made available based on state and federal appropriations. In addition, ORCA provides construction funds for non-border colonias[26] for water and wastewater improvements (including first-time service for low to moderate-income persons); some communities in the FHLM area might qualify for colonia status, on the basis of low income and high poverty level. Another state program is the Texas Small Town Environment Program (Texas STEP) from the Texas Department of Health, which uses community self help resources to cut costs on water projects. Grants or loan funds may be available for political subdivisions and communities in incorporated areas for projects that have a significant component of self-help. Finally, the Texas Association of Resource and Conservation Development Areas also provides periodic funding for water improvements

At the national level, funding may be provided by EPA, the US Army Corps of Engineers, USDA Rural Development, HUD, or any large number of other government or non-government organization. For example, the Rural Utilities Service of the USDA Rural Development Program allocates funds used to develop water systems in rural areas and towns with population of 10,000 or less, where grants may be given for up to 75% of eligible project costs. HUD provides Community Development Block Grants (CDBGs) to ORCA which redistributes these grants to low income small towns and rural communities. Funding in the past has helped communities develop new water sources, improve treatment techniques, construct wells and pump stations, and replace distribution system pipes. Co-Bank provides financing (with loan amounts that start at $1 million) for water supply corporations (WSCs) serving predominantly unincorporated areas of 20,000 people. Community Resource Group, Inc. provides loans for small water system projects (population 2,000-150,000) as well as publications, on-site management, and technical assistance for political subdivisions and WSCs in rural areas of less than 25,000. The Government Capital Corporation arranges financing for political subdivisions and provides minimum loan amounts of $10,000 to political subdivisions and WSCs. Melbeye and Associates provides financing to WSCs and political subdivisions in the form of lease/purchase, straight leasing, and loans (beginning at $20,000). United Financial of Illinois, Inc. finances capital equipment and projects for counties, cities, WSCs, and local governments in the form of loans, sale and leaseback, and master lease. United Financial loans

[26] Non-border colonia areas would be an identifiable unincorporated community that is determined to be colonia-like on the basis of objective criteria, including lack of potable water supply, lack of adequate sewage systems, and lack of decent, safe, and sanitary housing; and was in existence as a colonia before November 28, 1990.

vary from $50,000 to $10,000,000, and they offer 100% financing on engineering and construction costs.

Although there are several financing options available for PWSs in the FHLM area, the investment requirements depend on the engineering strategy employed. As expected, the cost considerations for the three engineering strategies described previously (blending, treatment, and side-stream treatment) have different capital and operations and maintenance costs.

For a blending strategy, capital costs include the costs of new conveyance for purchased water, including new transmission lines, pump stations, and mixing equipment. Pipeline costs for a 12-inch transmission line in relatively rural areas run between $50/ft (non-rocky soil conditions) to $76/ft (rocky conditions), but increase to $80 (non-rocky conditions) to $113/ft (rocky conditions) for urban areas, excluding costs of tunneling or boring for crossings.[27] Considering that interested PWSs are up to 25 miles apart from one another, and up to 22 miles away from the closest and most reliable low-arsenic blending source, the construction of transmission lines for blended water will likely represent the largest capital costs. Operations and maintenance costs include pumping and mixing costs for blending source waters and the training and maintaining of qualified operators.

For a treatment strategy, capital costs include infrastructure costs of building a new treatment plant and lines for conveying both raw and treated water between PWSs and the treatment facility. The operation and maintenance costs include media, chemical, and energy costs for arsenic treatment and finished water distribution, recurring costs for disposing arsenic, and costs of training and maintaining qualified operators for an advanced treatment system. O&M costs are higher for the treatment strategy than the blending strategy. Together, there are tremendous costs that are incurred from the start (with infrastructure intensive construction of a plant and conveyance systems) through the life of the facility. Arsenic waste displosal is regulated heavily and can be costly.[28]

For a sidestream treatment strategy at a regional level, some combination of treatment and blending costs will be required, although treatment is conducted on a much smaller scale.

[27] Values are estimated for October 2008.

[28] TCEQ regulates disposal of wastes whether waste is discharged to a receiving water, discharged to publicly owned treatment works, land applied via irrigation or evaporation, or deposited in a landfill. State requirements for disposal can be found in Chapters 317, 319, 311, 312, 335, and 336 in the Texas Administrative Code, Title 30.

Because arsenic levels in the area are just slightly higher than the MCL, large-scale treatment is likely to be unnecessarily costly when compared to side-stream treatment. However, any regionalized treatment strategy (full-stream or sidestream) will likely be more costly than a regionalized blending strategy, because in addition to conveyance infrastructure, additional (treatment) infrastructure is required. The final comparison in costs, however, will depend on the negotiated rates of purchased water for blending.

5.2.3 Other Regionalization Considerations

Although it was found that either the treatment or blending strategies would be most appropriate for PWSs in the FHLM area in Section 5.2.1., some strategies and technologies are better than others for regionalizing.

In terms of a treatment strategy, a central treatment facility that treats water for several public water systems is one possible way for systems to regionalize, and may be far easier in terms of operation and maintenance than having several small treatment facilities scattered throughout the region. Not only can a central facility use economies of scale for the acquisition of equipment and treatment media, it is also less susceptible to flow variability. In addition, several small-scale treatment facilities may have difficulty finding the expertise to manage and operate some of the more complicated treatment processes. However, a centralized treatment facility will require a large energy and land footprint, in addition to the infrastructure necessary to convey source water to the treatment facility and treated water to the individual PWSs for distribution. Although the maximum distance between interested PWSs is only 25 miles, there are some obstacles that may prevent easy conveyance of water sources to a central plant, including water bodies such as Tehuacana Creek (in western McLennan County) and Tradinghouse Creek Reservoir (near the City of Mart), or urban development around the City of Waco.

Based on surveyed interest of PWSs in the FHLM partnership, blending is the strategy deemed most suitable for the group of systems in the area[29] and regionalization of this option benefits participating PWSs in many ways. First, systems in a partnership may have better

[29] The reason given for opting for a blending strategy rather than a treatment strategy comes down to the difficult issue of waste disposal, according to surveyed PWSs in the FHLM partnership. All treatment options result in wastes such as backwash or reject water, sludge, or spent media containing high arsenic concentrations.

negotiating power than individual systems when pursuing purchased water contracts with outside providers of low-arsenic water sources. Second, multiple systems together will have greater “creditworthiness” and may be able to secure grants and loans far more easily. Third, the systems can share costs and conveyance infrastructure for blending water, which is far less expensive than it would be if each PWS invested individually. Finally, although the blending strategy requires less operator skill than treatment strategy, skilled and licensed operators in the region are still in high demand. Systems can pool labor resources to better ensure that adequate numbers of qualified operators are available to oversee blending strategies in the area.

Systems in the region that could be possible providers of low-arsenic water for blending are shown in Figure 8. The City of Waco is the most obvious and largest of the nearby surface water providers, located between 6 and 22 miles away from interested PWSs. The only other large (>10,000 service population) systems in the region are the cities of Woodway, Bellmead, and Hewitt, all of which purchase surface water from Waco to supplement their groundwater resources and are located about the same distance away from interested PWSs. Although PWSs in the partnership could opt to purchase water from neighboring groundwater systems that are not currently experiencing elevated arsenic concentrations, this is not a recommended strategy unless geological and hydrologic testing can show that eventual contamination of the source is unlikely to occur. This is because arsenic concentrations in groundwater can fluctuate over time due to various changes in aquifer conditions (e.g., redox potential, microbiological activity, etc.), and cross contamination of aquifers is a common occurrence.

Along with the blending engineering strategy that can be regionalized, the PWSs in the FHLM area have the opportunity to regionalize other resources, including operators, equipment, contracted services, managerial and administrative duties, and education and technical assistance. As briefly described above, sharing licensed operators is one approach to ensuring reporting, monitoring, and system performance compliance for areas that have had an historically difficult time finding or retaining qualified individuals. In addition, using blending as a mitigation strategy will lead to several additional monitoring and reporting requirements that will call for operators with additional qualifications. Since source water quality can change quickly, the blending strategy requires skilled operators who can likewise make changes quickly to the process and ensure arsenic levels remain steady and below the MCL.

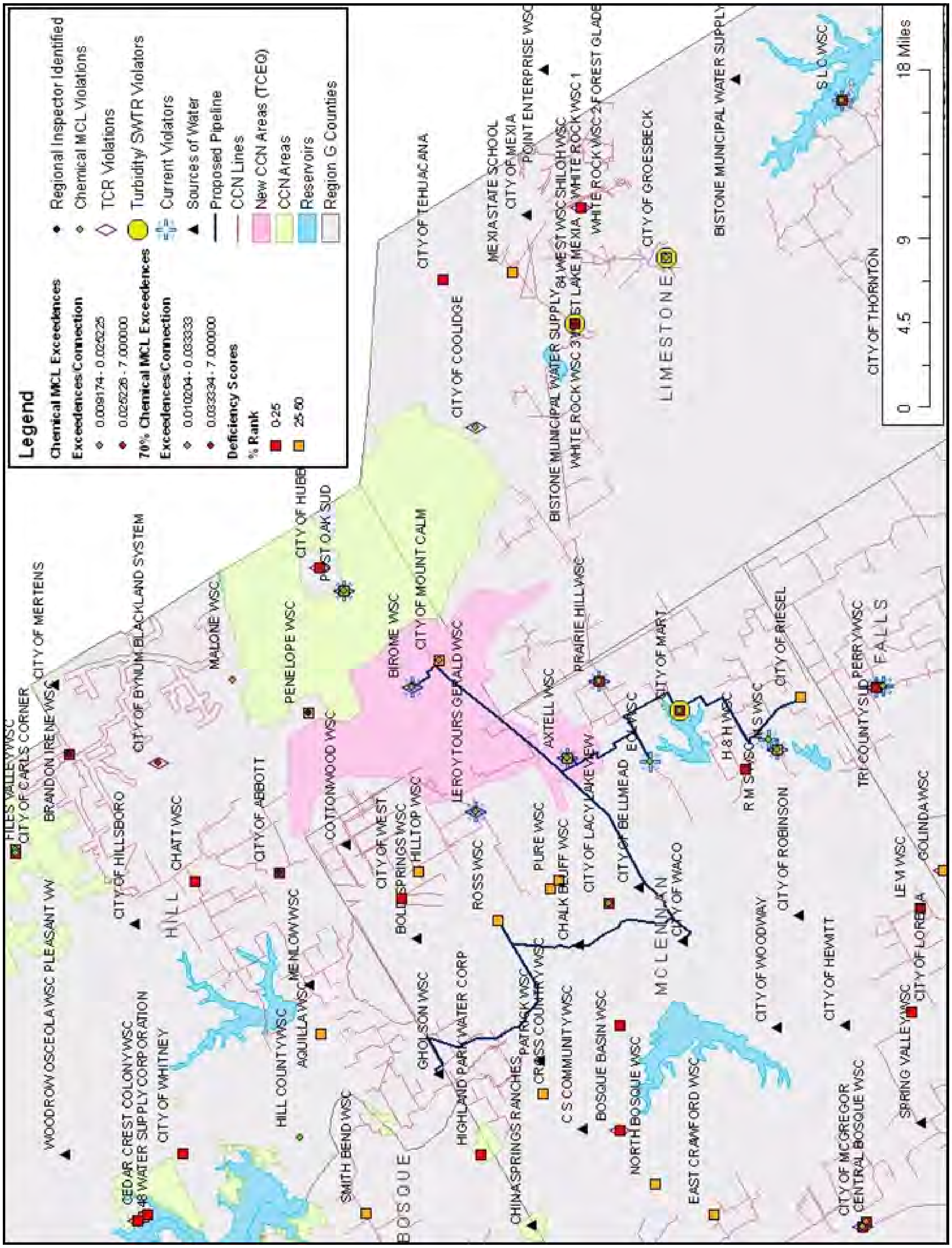

Figure 8. Location of Sources of Water for Blending in the FHLM Area (Black Triangle)

Equipment sharing between systems is another way interested systems can reduce internal costs and divert funds to investing in mitigation strategies. Shared equipment can range from small metering and testing equipment to large backhoes and everything else in between, where the sharing possibilities are only limited by the equipment that all PWSs already have. Shared managerial resources (e.g., satellite management using SCADA systems) can provide more reliable oversight and knowledge-sharing for these systems that share similar problems. The sharing of administrative resources such centralized billing and accounting could cut down on the need for individual accounting and billing software licenses. Contracted services can be also shared. For example, inspections, equipment calibration, and lab sampling and testing are all services often contracted to outside parties. PWSs in a partnership could reduce costs of these services by negotiating contracts together or by scheduling services for the area to coincide around the same time. Educational, technical assistance, and training resources are perhaps the easiest resources that can be shared between systems in a regional partnership. Some PWSs in the FHLM have the knowledge and experience to address process performance problems and others may have specific staff experienced in grant writing. These PWSs can "mentor" systems that have less experience. Multiple systems in a partnership with a cohesive need will also be in a position to better attract more training and education programs to the area.

5.3 Subgroup 3A: Haskell, North Jones, Northwest Shackelford, South Knox Counties

The Haskell/North Jones/Northwest Shackelford/South Knox County Subgroup 3A area was selected as a candidate group for regionalization based on the need to quickly mitigate a SDWA-regulated chemical (nitrate) and the apparent financial and engineering challenges PWSs in the area are facing to mitigate the problem.

5.3.1 Engineering Considerations

Engineering considerations described in this section are focused primarily on those considerations that directly address the mitigation of nitrate in groundwater for the Subgroup 3A area. There are several mitigation strategies available for high levels of nitrate in groundwater sources including treatment, non-treatment (abandonment/alternative sources, blending), and source protection strategies. Each strategy is comprised of a variety of options or technologies that need to be evaluated and prioritized in order to determine what is most appropriate for any system or group of systems. Like arsenic mitigation for the FHLM area, some universal considerations for choosing an appropriate engineering alternative are listed in Table 9.

The abandonment of low quality sources and procurement of alternative high quality sources is one approach that is not entirely feasible for high-nitrate PWSs in the Subgroup 3A area. First, afflicted PWSs depend almost entirely on groundwater as a source of water, and would find it difficult to afford to simply abandon this relatively low-cost supply for an alternative low-nitrate surface water source at larger purchase water rates. Second, any new development of groundwater resources in Knox and Haskell counties, where all of the nitrate-violating PWSs are located in this subgroup, cannot occur using the "rule of capture" and pumping rates will likely be regulated by the Rolling Plains Groundwater Conservation District. Third, even if drilling new wells or redeveloping new wells in the area were possible, it is unlikely that a higher quality groundwater can be found, because of the consistently high levels of nitrate present throughout the Seymour aquifer. Although it is possible for the high-nitrate systems to tie into and purchase water from other low-nitrate systems, these connections may be too distant to economically convey the purchased water.

Blending is another non-treatment engineering option, but requires an adequate supply of low-nitrate water and careful control of the process to ensure the reliability of meeting MCL under fluctuating nitrate conditions. All of the systems with high-nitrate levels in the subgroup currently have the infrastructure and history of purchasing low-nitrate surface water for blending from Millers Creek Reservoir. However, based on surveyed responses, some non-member systems may ultimately abandon this relatively close low-nitrate surface water source for another option. Blending with water from other systems further away with lower rates is possible for the area, but will require new infrastructure investment to tap into those sources. An optimized blending strategy using existing Millers Creek water (and facilitated by sharing qualified operators between systems) may improve overall water quality at a far lower cost.

Source protection is a final non-treatment possibility, but can be much more difficult to control and works on a longer time scale than most other engineering options. Source protection relies on the elimination or control of the sources of nitrate contamination. As discussed in Section 4.3.1., nitrate contamination of the Seymour aquifer results primarily from agricultural activities, as irrigation water seeps into the underlying, shallow aquifer. Land management practices that reduce or remove the infiltration of nitrates into the unconfined aquifer will lead to

Table 9.
Nitrate Treatment Technology Comparison

Treatment Technology	**Water Quality Requirements**	**Maximum Removal**	**Water Loss**	**Potential Application**	**System Size (Population)**	**Operator Skill**	**Post-treatment Issues**	**Waste Generated**	**WTP Cost**
Ion exchange	Sensitive to presence of sulfate, organic matter, chloride, and bicarbonate	30-95%	1-2%	GW, Small systems, POE/POU	25-10,000	High	Corrosive product water	Spent resin, spent regeneration brine (treated water: waste up to 40:1)	Medium
	Fe, Mn, and Metals <0.1 mg/L								
Reverse Osmosis	Low organic matter and TDS	95-98%	15-75%	GW, SW, POE/POU, Large systems, Small systems	501-10,000	Medium	None	High TDS reject water	High
Electrodialysis	Fe < 0.3 mg/L	50-85%	5-6%	GW, SW, POE/POU, Large systems, Small systems	501-10,000	Medium	None	High TDS concentrate	High
	Mn < 0.1 mg/L								
	H_2S <0.3 mg/L								
	Turbidity < 2 NTU								
Engineered Biological Treatment	DO < 0.1 mg/L	> 95%	1-2%	No systems currently operating in U.S.	501-10,000	High	Microorganisms and substrate	Biomass	Medium
	pH 7-8								
	Temperature > 5ºC								

Information compiled from Kapoor (1997)[1] and WA DOH (2005)[2]
GW=groundwater, SW=surface water, POE=point of entry, POU=point of use.
[1]Kapoor, A, and Viraraghanvan, T. 1997. Nitrate Remova l from Drinking Water – Review. Journal of Environmental Engineering. 123(4): 371-380
[2]Washington State Department of Health, Office of Drinking Water. 2005. Guidance Document: Nitrate Treatment Alternatives for Small Water Systems. DOH PUB. #331-309

reduced nitrate concentrations over time. Several programs have been developed by the USDA to protect drinking water resources and include the Conservation Reserve Program, the Environmental Quality Initiative Program, and the Conservation Security Program. Because these programs primarily target land users and are voluntary, the PWSs in the area have little control over the effectiveness of this strategy. In addition, it may take years for improved source protection to affect groundwater quality. Source protection is attractive for the overall health of the environment and is likely to emerge as an important future strategy to control other emerging contaminants, such as pesticides. However, it is not currently the most appropriate option because implementation is beyond the control of most PWSs and mitigation is needed on a much more immediate time-scale.

Treatment is final strategy available for PWSs in Subgroup 3A to reduce nitrate concentrations below the MCL. Although treatment can occur at various locations in the system, the only option considered here is treatment at a central location for one or more PWSs. Several treatment technologies are available, including chemical, physical, and biological technologies. Some common treatment options are described in Table 9. As was seen with arsenic treatment technologies, the advantages and disadvantages of each technology will need to be weighed to determine which technology is most appropriate for systems in the region. Although pilot testing is often a useful way to determine the appropriateness of a technology and determine the factors important for full-scale development, the cost of pilot testing approaches the cost of full-scale testing for smaller treatment systems. Regardless of the technology chosen, investment will be required for treatment plant infrastructure and equipment, as well as infrastructure to convey source waters to the treatment facility and treated water to individual PWSs for distribution.

5.3.2 Financial Considerations

Much of the financial discussion elaborated in Section 5.2.2 for the FHLM group also applies to the PWSs in Subgroup 3A. PWSs in this region will require creative ways of financing any regionalization strategy. Several of the systems in the area have been issued recent violations and all counties in the subgroup have a median income lower than the Texas median. Three of the four counties (Knox, Haskell, and Jones) and three of the four cities indicating possible interest in regionalizing (City of Weinert, City of Rochester, and City of Obrien) in this subgroup have a median income of less than 75% of the 2004 Texas median, and are therefore eligible for many, if not all, of the low-interest loan and grant programs described previously (Table 10).

Table 10.
Median Household Income, 2% MHI, and Poverty Rate for Select Texas Counties in the Subgroup 3A Area

County/City	*MHI*	*2% MHI*	*Poverty Rate (1999)*
Texas	$41,645 (2004)	$833	16.2%
Knox	$27,370 (2004)	$547	20.6%
Haskell	$26,452 (2004)	$529	20.5%
Jones	$29,670 (2004)	$593	20.5%
Shackelford	$36,118 (2004)	$722	12.1%
City of Rochester	$24,200 (2007)	$484	29.4%
City of Weinert	$26,500 (2007)	$530	19.0%
City of Obrien	$20,800 (2007)	$416	18.7%
City of Benjamin	$36,800 (2007)	$736	14.2%
Note: Places with a MHI less than 75% of the state MHI are indicated in bold.			

As discussed in Section 5.3.1, the two most apparent options available for PWSs to develop a regional engineering strategy in the area are either blending high-nitrate groundwater with a low-nitrate source, or by removing nitrate using an advanced treatment process. Blending with the nearest source of low-nitrate water (Millers Creek Reservoir) may not be politically feasible in the long run, and the next closest low-nitrate source for water is Lake Stamford in southeast Haskell County, between 18 and 30 miles away from interested PWSs in Knox and Haskell County. Transmission lines of up to 30 miles in length are not uncommon in West Texas, but construction costs for long distances, despite being located in a relatively rural area, can run high, between $50/ft (non-rocky soil conditions) to $76/ft (rock conditions) for a 12-inch transmission line,[30] excluding crossing costs with tunneling or boring construction. For a blending strategy, capital costs include the costs of new conveyance for purchased water, including new transmission lines, pump stations, and mixing equipment. Operations and maintenance costs include pumping transmission and mixing costs for blending source waters, and the training of licensed operators.

For a treatment strategy, capital costs include infrastructure costs of building a new treatment plant and lines for conveying both raw and treated water between the PWSs and the treatment facility. The operation and maintenance costs include media, chemical, and energy costs for nitrate treatment and finished water transmission, recurring costs for disposing nitrate

[30] Values are estimated for October 2008.

wastes, and costs of training and maintaining qualified operators for an advanced treatment system. O&M costs are higher for the treatment strategy than the blending strategy for all processes listed in Table 9, because of the possible need for pretreatment (if source waters are of insufficient quality), replacement of media (for ion exchange) or membranes (for reverse osmosis), greater energy requirements, and nitrate waste disposal. Interested PWSs in the region are separated a maximum of 14 miles, and a regional nitrate treatment system could conceivably be centrally located to allow a maximum of only 8 miles between the currently interested PWSs and the facility (Figure 9). The total feet of transmission line between each of the interested PWSs and this possible central treatment plant location is 22 miles, far less than estimated 50 total miles of new transmission line required to bring water from Lake Stamford to the same interested PWSs. However, the additional capital and operating costs for a treatment facility make the total cost of a regionalized treatment system exceed that of the blended water system. The cost differential between the two strategies may hinge on differences between the rates in a negotiated water contract for the purchased blending water source and the ultimate cost of the method of nitrate treatment ultimately selected.

5.3.3 Other Regionalization Considerations

In Section 5.3.2, it was found that either the treatment or blending strategies would be most appropriate for PWSs in the Subgroup 3A area, yet some strategies and technologies may be better suited for regionalization than others.

Using a regional blending strategy in this area may prove to be difficult. Interested non-member PWSs in the area already have the infrastructure to purchase low-nitrate water from Millers Creek Reservoir, although renegotiating contracts for non-member PWSs may not be politically feasible. Blending using source waters from as far away as Lake Stamford will require both shared investment in conveyance infrastructure and well-negotiated purchased water contracts. A regional partnership in the area can beget greater “creditworthiness” to secure grants and loans for conveyance investment. Systems may also be able to pool labor resources to better ensure that adequate numbers of qualified operators are available to oversee blending strategies, regardless of whether they continue to use the existing blending water source (Millers Creek Reservoir) or acquire new sources.

The non-member PWSs appear to be most interested in pursuing the treatment alternative, but all interested systems seem to be evaluating treatment technologies on an individual, not regional, basis. For example, one PWS is considering a small reverse osmosis unit, and two other PWSs are considering ion exchange units for possible installation in the near future. Because groundwater conditions in the Seymour aquifer are expected to not vary geographically, it is safe to assume that a given treatment technology would work similarly for all systems in the afflicted area. Interested systems could either install the same type of treatment unit at each individual PWS location or look at the possibility of investing in a regional treatment facility. If the former is a more attractive option, finding enough skilled operators who are knowledgeable on the treatment technology will be difficult and may necessitate sharing backup operators between the individual PWSs. For systems using the same treatment technology, some process-specific equipment could be shared between the systems. Systems using the same technology could also save by negotiating bulk purchases of chemicals and treatment media. Satellite management of the individual facilities with the help of SCADA equipment and the sharing of administrative, accounting, billing, and contracted services could also help reduce costs.

Alternatively, if high-nitrate systems in Subgroup 3A are interested in looking at a centralized regional treatment facility, it appears possible to locate a facility so that no single currently interested system is more than 8-10 miles away (Figure 9). Centralized treatment might require a higher initial capital investment than multiple individual treatment facilities because of the additional need for conveyance infrastructure to join the systems. However, operations and maintenance costs would likely be much lower for a regional facility, because of the improved process efficiency (e.g., lower chemical and energy usage) and reduced labor requirements (e.g., lower total number of operators and managers) associated with moving from several small systems to a single, large system.

Regardless of the strategy that PWSs in the area choose to adopt, systems in the Subgroup 3A area may want to look to the Red River Authority, just north of the Brazos G Area, for regionalization advice and technical assistance. The Red River Authority provides public water services for 27 independent community water systems within a 15 county service area (including northern Knox County) of North Texas, and over 2,150 miles of transmission lines and 65 pumping facilities. Although the Red River Authority operates at a much larger scale

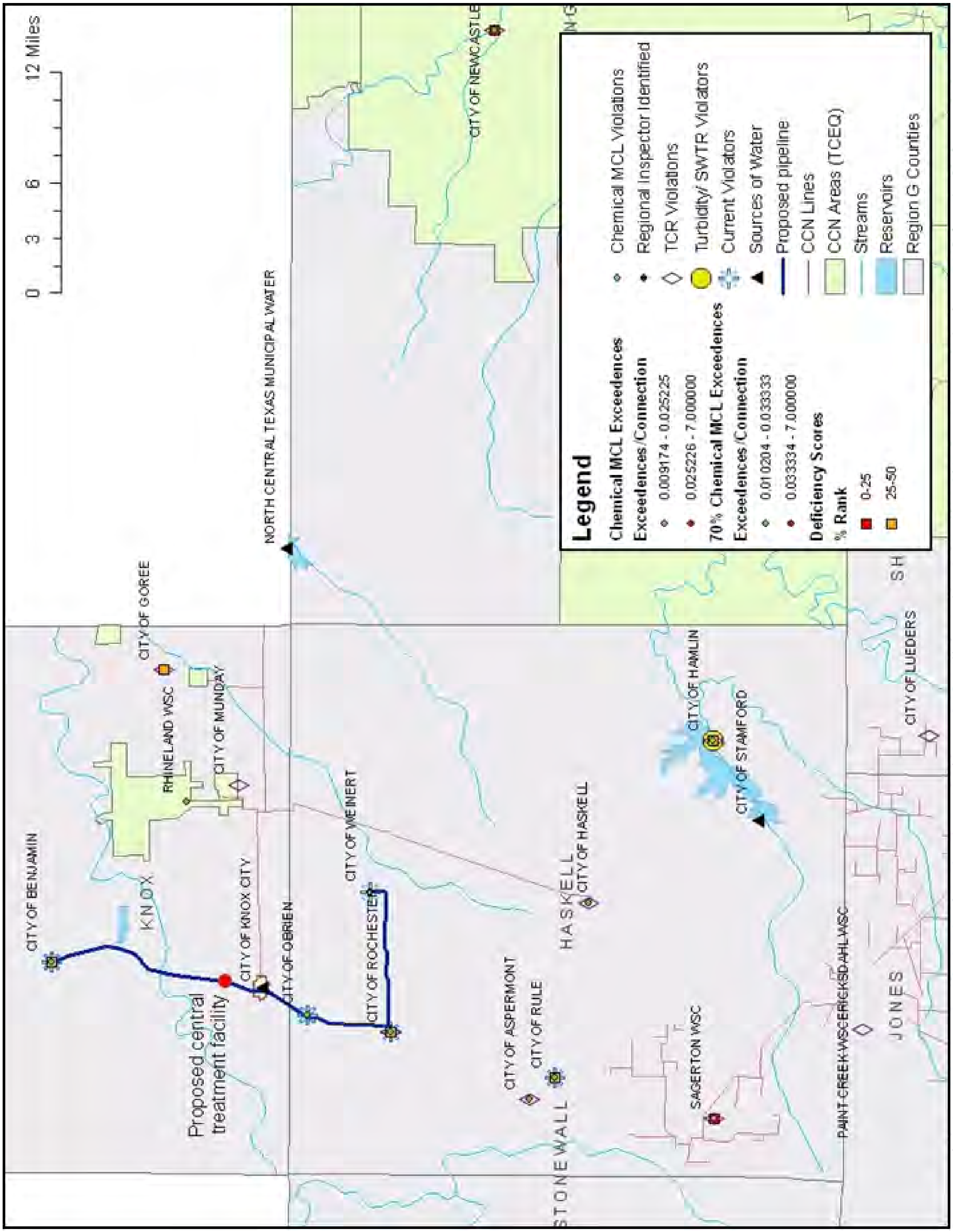

Figure 9. Location of Sources of Water for Blending in the Subgroup 3A Area (Black Triangle) and Proposed Central Treatment Facility

than this proposed regional grouping in the Abilene area, the individual systems that comprise the Red River Authority regional system are small, rural systems that share some of the same concerns as those in Subgroup 3A.

6.0 Summary

Regional cooperation between small PWSs can provide the opportunity for small, rural systems to share resources to reduce capital and operating costs, and to mitigate concerns regarding meeting SDWA requirements. Potential strategies include improving education and technical assistance, sharing skilled operators and other personnel, consolidating managerial and billing tasks, sharing centralized advanced treatment technologies, and sharing regional water resources. Regional cooperation can take many forms, ranging from simple cooperative agreements to assist neighboring utilities during times of need to ceding control to a regional entity created for the purpose of operating a regional water utility. Successful partnerships appear to require either that the entities involved all share a common concern (i.e., regional water quality issues), or can each provide some level of expertise or service that is needed by other entities. As is common to most rural water systems, distressed rural economies preclude straight-forward capital-intensive solutions without outside sources of funding, for which many programs exist. Creative solutions for sharing common functions (billing, operations, etc.) could free up resources for capital investment, but in many cases will be difficult to achieve given administrative, political, and other "non-technical" constraints that would impair the development of such local cooperation.

Regardless of these difficulties, there are several next steps that can be taken to develop the regionalization strategies described this report. The two identified regional systems, as well as the alternate systems that were discussed in this report and also have potential for regionalization, should all be considered in future evaluations and follow-up studies. The process of regionalizing resources in Brazos G will involve (1) creating a role for a "convener" to lead the implementation of regionalization strategies described in this report; (2) conducting a follow-up study to re-screen identified areas, consolidate PWS interest, define participant roles and responsibilities, and determine the preliminary engineering and financial feasibility of interconnecting system resources; (3) incorporating the findings of the feasibility study as part of a regional water plan recommendation; (4) applying for grants and/or loans to fund the regionalization projects; and (5) implementing regionalization of systems or system resources.

First, it is recommended that a convener role or responsible party be created to provide technical assistance or guidance in the regionalization planning process. This "convener" could be a regional agency or entity that is familiar with systems regionalization and/or an entity that has expressed some interest in taking on such a role (e.g., the Brazos River Authority, the Red River Authority, or the West Central Texas Municipal Water District). The "convener" would be responsible for bringing together interested PWSs, carrying out steps described in the regionalization process outlined above, and generally leading the implementation of the most feasible regionalization strategies.

Next, there is the need for more detailed analyses in areas identified for regionalization. Although most PWSs surveyed in this report indicated initial interest in being evaluated for regionalization, continued interest is highly dependent on the outcome of more detailed cost-benefit analyses and the participation of other systems. Future studies will need to solidify PWS interest and determine the roles and responsibilities (financial, technical, and otherwise) for each participating system. Engineering strategies to address SDWA compliance issues on a more regional level will need to be finalized, as will the costs of implementing those strategies.

The TWDB Regional Water Supply and Wastewater Facilities Planning Program could be used to provide up to 50 percent of the cost of a detailed analysis of regionalization opportunities, to encourage small water systems to actively consider and begin implementation of a regionalization strategy. In some instances, the TWDB can pay for more than 50% of the study costs (75% in areas which have unemployment rates exceeding the state average by 50% or more and per-capita income is 65% or less than the state average for the last reporting period available). After a more detailed feasibility study is completed, and if the findings of the study justify a small systems regionalization, a recommendation can be incorporated into the regional water plan and State Water Plan. A recommendation in the regional of State plans would allow participating systems improved access to grant and loan resources. For example, several of the State Water Plan Funding Programs, including the Water Infrastructure Fund, the State Participation Fund, and the Economically Distressed Areas Program, require recommendation as a water management strategy in the most recent State and regional water plans.

Following approval of a loan or grant application, participating PWSs can begin implementing a resource regionalization program. Some of the regionalization strategies that may comprise the program are outlined briefly in this report, and some strategies may emerge following more detailed analyses. The success of a regionalization program will ultimately be determined by the cooperation of each participating PWS, and the emergence of a convening entity to lead the process.

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Appendix A
Script of Survey to Gauge Regionalization Interest by PWS – Long Version

Purpose of Project:

To identify PWSs that are struggling to remain in compliance with provisions in the Safe Drinking Water Act or PWSs that may benefit from the sharing of resources (administrative, financial, technical, etc.)

Script

My name is [name] and I'm an engineer with HDR Engineering in Austin, Texas. HDR is the consulting engineer for the Brazos G Regional Water Planning Group. The Group is responsible for water planning in 37 counties, including ________County where your PWS is located. The Group is currently in the process of updating the 2006 Brazos G Regional Water Plan for approval by the Texas Water Development Board. This process includes several studies to aid future water resources planning in the area.

One of our tasks for the planning group seeks to determine possible areas for regionalization, by identifying smaller public water systems that may be susceptible to non-compliance with provisions in the Safe Drinking Water Act AND who may greatly benefit from the sharing of financial, administrative, operational, or technical resources with their neighbors to reduce treatment or personnel costs.

We are trying to identify potential areas where systems may benefit from sharing regional resources in a cooperative manner. Those would not necessarily be formal regional systems, but more likely interlocal agreements allowing resources to be shared (operator, equipment, book-keeping, administrative). We are looking at various mechanisms that utilities might pursue.

This phase in the planning cycle is just meant to gauge interest and requires no commitment whatsoever. We are only trying to identify potential partnerships and report back to the planning group and the Texas Water Development Board.

Would you be willing to answer a few questions so we can better understand your system?

→ GO TO SURVEY

In summary, we're just trying to identify those PWSs that could benefit from sharing resources. If you think your PWS might benefit, and you'd like to explore the option, we'll record your interest and will keep you updated on the results of our study.

Possible PWS concerns (add as necessary)

The details of publicly-available information (e.g. violations, MCL exceedences, etc) are to only be used for regional planning purposes.

This phase in the planning cycle is just meant to gauge interest and requires no commitment whatsoever. We are only trying to identify potential partnerships and report back to the planning group.

We're not sure at this point what a partnership system in your area would look like. A lot is dependent on the interest of other PWSs in your area, and with whom each PWS is willing to work with. If you have suggestions, let us know.

Appendix B
Survey for PWS Interest in Regionalization

Survey for PWS Interest in Regionalization

PWS Name ______________________________
TCEQ PWS ID ______________________________
PWS County ______________________________
Survey Date ______________________________

____
PWS Contact Name ______________________________
PWS Phone ______________________________
PWS Email ______________________________

Questions

*You were identified by TCEQ (publicly-available **W**ater **U**tility **D**atabase) as the contact for this PWS. What is your role with respect to the PWS (e.g., administrative, operator, manager, engineer)?*

PWS Contact Role ______________________________

Can you identify any other contact who may be as knowledgeable regarding PWS operational issues?

Alt. Contact & Role ______________________________

This study is already fully funded as part of the regional planning process so there is no cost associated with including your system in the overall evaluation. Do you think you might be interested in having your system looked at further as part of this study? Y / N

In your opinion…

Are there any specific areas of concern with how your system is currently configured?

____

____

Are there any issues with water quality or regulatory compliance that could possibly be improved by sharing resources on a regional basis?

____

____

We've identified your PWS as a potential candidate for regionalization by:

…looking at (chemical analysis, violation, or inspection) data for the last couple years, publicly available from TCEQ

OR

…discussion with regional inspectors at TCEQ who suggested that your system might benefit from participating in a regional partnership

Here are some of the issues we've identified:

(Describe issue, date, and source of data)

Issue 1: ______________________________
Issue 2: ______________________________
Issue 3: ______________________________

As far as you know, is this information correct? Y / N
If not, explain ____
How, if at all, have these issues been addressed?

____
Do you foresee these issues becoming a problem in the future? Y / N

If PWS expresses interest
You indicated previously that the PWS might be interested in continuing to be evaluated as part of the study.

Would your PWS benefit from sharing the following resources?

Operator	Y / N
Equipment	Y / N
Administrative	Y / N
Bookkeeping/ billing	Y / N
Physical (e.g. office space)	Y / N
Other (please specify)	______________________

If feasible from a financial, administrative, and engineering perspective, how amenable would your PWS be to participating in a regional partnership? On a scale of 1-5, with 1 being least and 5 being most amenable:
Amenability Level __________

If PWS is not interested
You indicated previously that you were not interested in continuing to be evaluated as part of the study

If not interested, what are the reasons why you choose not to participate?
Problems already addressed
Currently working out issues
Wrong information was provided
Already part of regionalized system
Trying another solution (list)
Other ____

All PWSs
What would be the most important factors determining whether or not you would join a partnership?

____

How would you envision your PWSs role in a regional partnership?

____

Do you want to be updated on the results of our study? Y / N

Appendix C
Comments from the Texas Water Development Board Regarding Phase I Reports and Responses from the Brazos G Regional Water Planning Group

TEXAS WATER DEVELOPMENT BOARD

February 20, 2009

RECEIVED

MAR 2 2009

GENERAL MANAGER

copy to Troy Burgher

Mr. Phillip J. Ford
General Manager/CEO
Brazos River Authority
P.O. Box 7555
Waco, Texas 76714-7555

Re: Region G, Region-Specific Studies Contract for Regional Water Planning between the Texas Water Development Board (TWDB) and the Brazos River Authority (BRA), TWDB Contract No. 0704830692, Draft Final Study Report Comments.

Dear Mr. Ford:

Staff members of TWDB have completed a review of the Draft Final Study Report under TWDB Contract No. 0704830692. As stated in the above-referenced contract, BRA will consider incorporating Draft Final Study Report comments, shown in Attachment 1, as well as other comments received, into the Final Study Report. In accordance with paragraph F, Article III, Section II of the contract, a copy of these TWDB Executive Administrator comments as well as a written summary of how the Draft Final Study Report was revised in response must be included in all the Final Study Report documents, for example, as an appendix.

TWDB looks forward to receiving one (1) electronic copy of all files, one electronic copy of each Final Study Report in Portable Document Format (PDF), and nine (9) bound double-sided copies of each Final Study Report to the TWDB Executive Administrator no later than the contract Final Study Report Deadline (April 30, 2009 for most reports). Please also transfer copies of all data and reports generated by the planning process and used in developing the Final Study Report to the TWDB Executive Administrator no later than the contract Final Study Report Deadline.

As a reminder, if any portion of the Final Study Report is to be included in a 2011 regional water plan it will be reviewed as part of the Initially Prepared Plan for meeting all statutory and agency rule requirements regarding the preparation of regional water plans.

If you have any questions concerning this contract, please contact Matt Nelson, TWDB's designated Contract Manager for this study at (512) 936-0829.

Sincerely,

Dan Harden for

Carolyn L. Brittin
Deputy Executive Administrator
Water Resources Planning and Information

Enclosures
Attachment 1

c: Matt Nelson, TWDB

ATTACHMENT 1

TWDB Contract No. 0704830692

Region G, Region-Specific Studies 1-5:

<u>TWDB Comments on Draft Final Region-Specific Study Reports:</u>
1) Updated Drought of Record and Water Quality Implications for Reservoirs Upstream of Possum Kingdom Reservoir

2) Groundwater Availability Model of the Edwards-Trinity (Plateau) and Dockum Aquifer in Western Nolan and Eastern Mitchell Counties, Texas

3) Regionalization Strategies to Assist Small Water Systems in Meeting New SDWA Requirements

4) Brazos G Activities in Support of Region C's Water Supply Study for Ellis, Johnson, Southern Dallas, and Southern Tarrant Counties

5) Updated Water Management Strategies for Water User Groups in McLennan County

Region-Specific Study 1: Updated Drought of Record and Water Quality Implications for Reservoirs Upstream of Possum Kingdom Reservoir

1. Report does not present newly developed model input datasets developed under Task 1, for example, the raw numerical naturalized flow dataset (including from 1998) through June 2008 as used in the model. Please present these data as appendices in report.

2. Page 8, Table 2.1: Please clarify where the rating curves came from for elevation-content calculations.

Region-Specific Study 2: Groundwater Availability Model of the Edwards-Trinity (Plateau) and Dockum Aquifer in Western Nolan and Eastern Mitchell Counties, Texas

1. The data discussed on page 12 does not appear to match the data referred to in Appendix A. In the second to last paragraph, the report refers to the data showing 4,300 acre-feet of municipal pumpage in year 2005. The data in Appendix A do not appear to support this total. Please correct or clarify the basis of the 4,300 reference in the report.

2. Page 12, last paragraph discusses data in Appendix A and states that the total pumping in 2003 was 4,600 acre-feet. The value for 2003 in the Appendix A table however, appears to be 3,823 acre-feet. This paragraph also states the average is 3,240 acft/year, although the data as presented in the Appendix averages 2,851 acre-feet/year. Please correct

reference or clarify how numbers referred to in text were derived. Also, it appears that the totals for years 2001-2004 and 2007 are off by 1 acre-foot.

3. According to Task 1, subtask C in the contract Scope of Work, the report was to "estimate long-term supplies available from the well field." The report does not appear to directly provide estimates of long-term supplies. Please provide information regarding estimated long-term supplies in the report.

Region-Specific Study 3: Regionalization Strategies to Assist Small Water Systems in Meeting New SDWA Requirements

1. Page 58, paragraph 3 states that "the TWDB Regional Water Supply and Wastewater Facilities Planning Program could be used to provide up to 50 % of the cost of a detailed analysis of regionalization opportunities to encourage small water systems to actively consider and begin implementation of a regionalization strategy". Please clarify in the report that "TWDB can pay up to 50% of the study costs (75% in areas which have unemployment rates exceeding the state average by 50% or more and per-capita income is 65% or less than the state average for the last reporting period available)..."

Region-Specific Study 4: Brazos G Activities in Support of Region C's Water Supply Study for Ellis, Johnson, Southern Dallas, and Southern Tarrant Counties

TWDB's acceptance of the final report does not constitute approval of any revised population or water demand projections contained therein. The formal procedure for requesting revised projections is stated in TAC 357.5 (d) (2):

> *"Before requesting a revision to the population and water demand projections, the regional water planning group shall discuss the issue at a public meeting for which notice has been posted pursuant to the Open Meetings Act in addition to being published on the internet and mailed at least 14 days before the meeting to every person or entity that has requested notice of regional water planning group activities. The public will be able to submit oral or written comment at the meeting and written comments for 14 days following the meeting. The regional water planning group will summarize the public comments received in its request for projection revisions. Within 45 days of receipt of a request from a regional water planning group for revision of population or water demand projections, the executive administrator shall consult with the requesting regional water planning group and respond to their request."*

All requested revisions which receive a consensus recommendation from TWDB, the Texas Department of Agriculture, Texas Commission on Environmental Quality, and Texas Parks and Wildlife Department, will then be presented for consideration of Board approval at the next scheduled meeting.

1. Task 1 of the contract Scope of Work refers to reviewing recent studies. Please provide a general summary of findings regarding recent supply studies and activities in the area since the 2006 Brazos G Regional Water Plan was adopted.

2. Tasks 1 and 4 of the contract Scope of Work refer to reviews of studies and reviews of population projection estimates. While Section 1.0 of the report summarizes the associated activities performed by date, it does not provide a general summary of the findings of these reviews or copies of or summaries of the comments that were provided by Region G consultant as a result of these reviews. Please provide a summary of findings or copies of written comments resulting from this work, for example, as an appendix in the report.

3. The report does not include or make specific reference to the raw population/water demand projections that were provided from individual water providers in the regional study area (e.g. Alvarado, Burleson, JCSUD, Mansfield, and Venus). Please provide copies of these water planning projections that are generally greater than TWDB population and/or water demand projections. If this raw data was included in another available report, please provide a reference.

4. Please consider adding clarifying language to the Executive Summary that more clearly sets forth the purpose and content of this specific report and that explains the need for a reader to also review the "Region C Water Supply Study for Johnson, Southern Dallas, and Southern Tarrant Counties". Consider including a copy of the associated Region C study Table of Contents for reference, for example, in an appendix.

5. Page B-3: Table B-2 is missing from report. Please include in final report.

Region-Specific Study 5: Updated Water Management Strategies for Water User Groups in McLennan County

1. Task 3 of the contract scope of work states that the following sections will be included in the draft and final report: "... purpose of study including how the study supports regional water planning, methodology, results, and recommendations, if applicable." These sections are not present in the draft report. Please include them in the final report.

Memo

To:	Brazos G Regional Water Planning Group		
From:	David Dunn, PE	Project:	Brazos G 2011 Regional Water Plan
CC:	Trey Buzbee, Brazos River Authority		
Date:	April 7, 2009	Job No:	00044257-001

RE: Suggested responses to TWDB comments regarding the five Phase I Reports

On December 29, 2008, HDR submitted to the Texas Water Development Board (TWDB) draft copies of the reports summarizing the five Phase I studies completed pursuant to the 2011 Brazos G Regional Water Plan. On February 20, 2009, the TWDB provided review comments on each draft report. Those review comments are repeated in this memorandum, followed by HDR's suggested response to each comment.

HDR recommends that the Brazos G RWPG accept these suggested responses to the TWDB comments, and direct HDR and the Brazos River Authority to incorporate the responses into the final versions of the reports, and submit the final reports to the TWDB prior to the report submission deadline of April 30, 2009. A copy of the TWDB review comments and the planning group's responses will be included as an appendix to each report.

Region-Specific Study 1: Updated Drought of Record and Water Quality Implications for Reservoirs Upstream of Possum Kingdom Reservoir

1. Report does not present newly developed model input datasets developed under Task 1, for example, the raw numerical naturalized flow dataset (including from 1998) through June 2008 as used in the model. Please present these data as appendices in report.

Suggested Response: The newly developed data sets have been printed and included as an appendix to the report.

2. Page 8, Table 2.1: Please clarify where the rating curves came from for elevation-content calculations.

Suggested Response: The reservoir elevation-area-capacity relations were obtained from the most recent bathymetric survey available for each reservoir. The last paragraph on page 7 has been updated to make the source of the data more clear.

Region-Specific Study 2: Groundwater Availability Model of the Edwards-Trinity (Plateau) and Dockum Aquifer in Western Nolan and Eastern Mitchell Counties, Texas

1. The data discussed on page 12 does not appear to match the data referred to in Appendix A. In the second to last paragraph, the report refers to the data showing 4,300 acre-feet of

municipal pumpage in year 2005. The data in Appendix A do not appear to support this total. Please correct or clarify the basis of the 4,300 reference in the report.

Suggested Response: The data shown in Table A-3 of Appendix A have been corrected.

2. Page 12, last paragraph discusses data in Appendix A and states that the total pumping in 2003 was 4,600 acre-feet. The value for 2003 in the Appendix A table however, appears to be 3,823 acre-feet. This paragraph also states the average is 3,240 acft/year, although the data as presented in the Appendix averages 2,851 acre-feet/year. Please correct reference or clarify how numbers referred to in text were derived. Also, it appears that the totals for years 2001-2004 and 2007 are off by 1 acre-foot.

Suggested Response: The numbers in the text have been corrected.

3. According to Task 1, subtask C in the contract Scope of Work, the report was to "estimate long-term supplies available from the well field." The report does not appear to directly provide estimates of long-term supplies. Please provide information regarding estimated long-term supplies in the report.

Suggested Response: The following text has been added to the report as a final paragraph in Section 7 Water Management Strategy for Sweetwater:

"If a groundwater only strategy is considered, the performance of the current Champion Well Field from 2001-2007 and the groundwater modeling suggests that the Edwards-Trinity and Dockum Aquifers could meet this average demand, which was about 2,850 acft/yr. If the well field was substantially expanded to the south-southwest, the modeling analysis suggests that it could meet the projected demand of 3,900 acft/yr for the planning period."

And the following text has been added to Section 9 Conclusions:

"If a groundwater only strategy is considered, the analysis suggests that the aquifers could meet 2001-2007 average demand of about 2,850 acft/yr. If the well field was substantially expanded to the south-southwest, the analysis suggests that the projected demand of 3,900 acft/yr for the planning period could be met."

Region-Specific Study 3: Regionalization Strategies to Assist Small Water Systems in Meeting New SDWA Requirements

1. Page 58, paragraph 3 states that "the TWDB Regional Water Supply and Wastewater Facilities Planning Program could be used to provide up to 50 % of the cost of a detailed analysis of regionalization opportunities to encourage small water systems to actively consider and begin implementation of a regionalization strategy". Please clarify in the report that "TWDB can pay up to 50% of the study costs (75% in areas which have unemployment rates exceeding the state average by 50% or more and per-capita income is 65% or less than the state average for the last reporting period available)..."

Suggested Response: The following text has been added as the second sentence of paragraph 3 on page 58:

"In some instances, the TWDB can pay for more than 50% of the study costs (75% in areas which have unemployment rates exceeding the state average by 50% or more and per-capita income is 65% or less than the state average for the last reporting period available)."

Region-Specific Study 4: Brazos G Activities in Support of Region C's Water Supply Study for Ellis, Johnson, Southern Dallas, and Southern Tarrant Counties

1. Task 1 of the contract Scope of Work refers to reviewing recent studies. Please provide a general summary of findings regarding recent supply studies and activities in the area since the 2006 Brazos G Regional Water Plan was adopted.

Suggested Response: The following text will be added to Section 1.0:

"A review was conducted of recent water supply studies in the four-county area, with a primary emphasis on Johnson County entities. The overall message from the studies indicates that population and water demand projections are increasing at a faster pace than the Texas Water Development Board (TWDB) projections from the 2006 Plan. The City of Cleburne conducted a study[1] in May 2007 that showed that new industrial development and oil and gas exploration in the area have increased rapidly, which has led to increased water requirements. A study conducted by Johnson County Special Utility District (JCSUD)[2] showed substantially higher projected population and water demands in Year 2030 than TWDB estimates. The JCSUD study was used as a basis for recommending population and water demand updates, which show a 37% increase in projected population in Year 2030 and nearly 40% increase in projected Year 2030 water demands as compared to TWDB projections used in the 2006 Brazos G Plan. Since the 2006 Brazos G Plan, Johnson County Fresh Water Supply District No. 1 has merged with JCSUD and is shown accordingly in the Four County Study report. Additional studies in the area were reviewed and considered including: information from the City of Arlington regarding their wholesale water rate study, and a report developed jointly by the Brazos River Authority and Tarrant Regional Water District in April 2004 entitled "Regional Water Supply and Wastewater Service Study for Johnson and Parker County."

2. Tasks 1 and 4 of the contract Scope of Work refer to reviews of studies and reviews of population projection estimates. While Section 1.0 of the report summarizes the associated activities performed by date, it does not provide a general summary of the findings of these reviews or copies of or summaries of the comments that were provided by Region G consultant as a result of these reviews. Please provide a summary of findings or copies of written comments resulting from this work, for example, as an appendix in the report.

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[1] *City of Cleburne and Freese and Nichols, "Cleburne Long-Range Water Supply Study- Draft," May 2007.*
[2] *Johnson County Special Utility District and HDR Engineering, Inc, "Evaluation of Additional Water Supplies from the Trinity and Brazos River Basins," December 2006.*

Suggested Response: Copies of selected email correspondence with comments provided by Brazos G consultants have been added as Attachment B-1. An interim progress report update with proposed population and water demand projections was provided to the Brazos G RWPG on October 28, 2008 (as described in Section 1.0). A copy of this presentation has been added as Attachment B-2.

In addition, the following text will be added to Section 1:0:

"The population and water demand recommendations were reviewed for consistency with information provided by each of the Johnson County entities. In some cases, historical population and water use information was provided which was used to assess the reasonableness of extrapolating historical trends to future population and water demands projections. Due to the large number of entities over the study area, there were numerous review processes required to ensure that the recommended population and water demand projections used in the study were consistent with current trends that Johnson County entities are experiencing and their local plans. A copy of selected email correspondence from Brazos G consultants with comments and results of their reviews of Region C's interim analyses and reported results is presented in Attachment B-1."

3. The report does not include or make specific reference to the raw population/water demand projections that were provided from individual water providers in the regional study area (e.g. Alvarado, Burleson, JCSUD, Mansfield, and Venus). Please provide copies of these water planning projections that are generally greater than TWDB population and/or water demand projections. If this raw data was included in another available report, please provide a reference.

Suggested Response: The raw population and water demand projections provided by Johnson County water entities will be provided as Attachment A. Text will be added to Section 1.0 to reference Attachment A. For more information regarding how raw population and water demand projections were used to develop recommended projections, please consult Region C's report entitled "Water Supply Study for Ellis County, Johnson County, Southern Dallas County, and Southern Tarrant County."

4. Please consider adding clarifying language to the Executive Summary that more clearly sets forth the purpose and content of this specific report and that explains the need for a reader to also review the "Region C Water Supply Study for Johnson, Southern Dallas, and Southern Tarrant Counties". Consider including a copy of the associated Region C study Table of Contents for reference, for example, in an appendix.

Suggested Response: The purpose and content of the specific report was included in the draft report in the executive summary as follows:

"The purpose of this study is to review recent growth in the study area, make adjustments to population and demand projections to account for the growth, and update the current and future water plans of the water user groups and wholesale water providers in the study area. This study included conducting meetings and compiling survey data provided by water suppliers regarding their current and future water plans, determining revisions to population and demand projections, and developing a water supply plan for the study area. This report describes the

assistance provided by Brazos G to the study effort, and summarizes the information resulting from the study that is pertinent to the Brazos G Area."

The following additional text will be added to the Executive Summary:

"Those reading this summary should also consult the 'Region C Water Supply Study for Ellis County, Johnson County, Southern Dallas County, and Southern Tarrant County,' which provides the full report and results of the Four County study."

5. Page B-3: Table B-2 is missing from report. Please include in final report.

Suggested Response: Table B-2 (which has been relabeled as Table D-2 in response to renumbering attachments) will be included in the final report.

Region-Specific Study 5: Updated Water Management Strategies for Water User Groups in McLennan County

1. Task 3 of the contract scope of work states that the following sections will be included in the draft and final report: "… purpose of study including how the study supports regional water planning, methodology, results, and recommendations, if applicable." These sections are not present in the draft report. Please include them in the final report.

Suggested Response: The organization of the report has been restructured as follows:

<u>Section 1.0 Introduction</u> has been subdivided into <u>Section 1.1 Purpose of Study</u> and <u>Section 1.2 Methodology</u>. The text states how the study supports regional water planning. Sections 2.0 through 5.0 have been made subdivisions 2.1 through 2.4 of a new <u>Section 2.0 Results</u>, while retaining their original text and organization. <u>Section 5.0 Summary</u> has been titled <u>Section 3.0 Summary and Recommendations</u> with two new subdivisions <u>3.1 Summary</u> and <u>3.2 Recommendations</u>, while retaining its original text.

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